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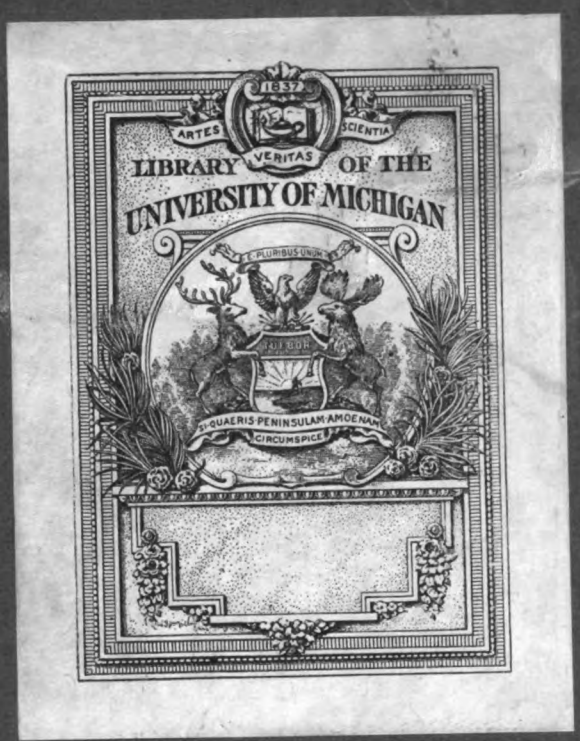

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THE

ELECTRICAL ENGINEER.

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NOTES.

Cauvery Water Scheme.—The Madras Government has vetoed the proposed utilisation of the Cauvery waterfalls for electrical purposes. It is said that the scheme would have interfered with irrigation rights.

The Electrical Reduction of Zinc.—It is stated that a company has been formed in Milan with a capital of £10,000 to develop the patent of Mr. Bertani for the reduction of calamine in an electrical furnace.

Broomhill.—Sir David Salomons, who was prevented last year from giving his usual series of scientific dinners at Broomhill owing to family bereavement, is again this year forced to the same course, owing to the recent loss of his second daughter.

Books Received.—We have received from Messrs. Macmillan and Co. a copy of "Magnetism and Electricity for Beginners," by Mr. H. E. Hadley; from Messrs. Whittaker and Co., "Alternating Currents of Electricity," by Mr. T. H. Blakesley, M.A.; and from the *Electrical World and Engineer* Company, of New York, "Electric Power Transmission," by Prof. Louis Bell, A.M.I.E.E.

Automatic Telegraphy. — We are informed by *Indian Engineering* that the Government of India are making early arrangements for the introduction of the Whitestone automatic system of telegraphy, and that Mr. F. Kinsman, who has been placed on special duty in this connection, has opened a training class. It is understood that it will take about a couple of years to complete the installation all over India.

Technical Education.—The pioneer lectures in connection with the Technical Education Board having proved very successful at Hammersmith in the two previous courses, the Board propose that, subject to the Vestry allowing the free use of the town hall, as on previous occasions, they should give another course of 10 lectures. The subject chosen for the lectures is "Electric Power and Lighting," and it is proposed to hold them on Wednesday evenings, commencing on Jan. 24 next.

Ætheric Telegraphy.—We are given to understand that Prof. Reginald A. Fessenden and his assistant, Prof. Kintner, of the Western University, of Pennsylvania, claim to have a receiver for wireless telegraphy that is two thousand times more sensitive than the so-called "coherer" of the Marconi system. In speaking of the discovery, Prof. Fessenden states that they realised that they had not yet begun to see the limit of their invention. Marconi had demonstrated that messages could be sent over 90 miles. By his method it should be possible to send messages across the Atlantic with poles less than 200ft. high.

The Automobile Club.—On Friday last a meeting was held in Newcastle in connection with the Automobile Club to consider the proposed 1,000 miles' trial which it is stated will probably commence on April 23. After the secretary of the club had explained the objects of this 1,000 miles' trial, it was agreed that the gentlemen present should form themselves into a local committee, with power to add to their number, in order to make the necessary local arrangements. The programme of the run provides that Newcastle shall be reached, from Edinburgh, on May 4, and that the exhibition of cars shall be held on the following day.

Electricity Thieves. — Up to the present time stealers of electricity have had a good chance in Germany, as the law courts have refused to convict because electricity is not a material. To get over the quibble of the legal lights, a new law is about to be passed which will impose a penalty of £75 on anyone who takes electricity from the public mains with intent to defraud. In the event of the fine not being paid, a term of imprisonment can be given. Under a second clause it is provided that if electricity is taken from the mains with the idea of damaging either the company or some outside party, a fine of £50 or two years' imprisonment can be imposed.

The New Cable to South Africa.—It is stated that the Telegraph Construction and Maintenance Company will not be able to dispatch the completing section of the third cable to connect Great Britain with South Africa until the end of this month. This section is to be laid between St. Vincent and Ascension. From this it will be gathered that the third cable route is not likely to be in operation much before the middle of February, as the laying of this last section will take about 12 days. We understand that the Government, after considering the question of the present cables breaking down, has arranged fast cruisers at certain points so that emergency messages may be got through as quickly as possible.

Transition Curves.—We have received from Mr. E. S. M. Lovelace a proof of a paper which he read before the Canadian Society of Civil Engineers on Dec. 7, on the above important subject. The paper in question is a further development of the use of the lemniscata as a transition curve, on which the author had previously published a pamphlet. The improvements since this was issued lie in the simplification of the general formula. Even when simplified, the formulæ are rather too extensive to reproduce in our notes, but the paper is worthy of careful reading by tramway engineers. The paper is accompanied by tabulated general formulæ which will ensure the transition and mean curves closing under any or all conditions.

Electric Lighting in Bombay.—We gather from *Indian Engineering* that the municipality of Bombay is still playing with the electric supply question. It has recently received at least two applications that we know of for permission to lay cables beneath the streets, and to provide a complete system of electric lighting and power distribution. The consideration of these offers has been deferred in order to give other firms of standing a chance to apply. We trust that in this matter all will be straightforward, and that the pioneering offers will not be disclosed until

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the other firms of standing have definitely committed themselves to figures. We gather from our contemporary that a strong financial backing would be of great assistance in carrying a scheme through the municipality.

Isolated Plants.—The American Institution of Electrical Engineers has collected some useful information as to the cost of lighting large buildings in New York with isolated plants, as compared with the cost of obtaining the same supply from the public mains. The records were obtained from over 100 buildings owning their own plant, and the conclusion is that in every case the private plant has given the cheaper supply. The cost of electrical energy as obtained from the public supply mains in New York averages 5·3d., while the cost per unit with isolated plants was less than half this. In fact, the highest cost recorded with the private plant was 2·53d. per kilowatt-hour, while the lowest price came out at ·83d. per hour, and was obtained in a large hotel in which steam plant was also used for heating purposes. We are not told as to whether interest and depreciation are included in the above figures.

Regulating Motorcar Traffic.—The Highways Committee of the Essex County Council has forwarded some curious recommendations to the Local Government Board with respect to rules for motorcar traffic. The committee desires, for instance, that motorcars should be confined to a speed of five miles per hour when turning corners, and that they should only be driven by persons holding certificates of proficiency, which the Local Government Board is asked to issue. Unless the angle of the turn is given, it would be absurd to fix any limit for the speed when going round a corner, and it would be equally absurd to prevent private owners of motorcars from driving without first obtaining a certificate from the Local Government Board. The greater part of the accidents which have occurred with motorcars has been due to the bad driving of horsed vehicles, and we think that the Essex County Council would be well advised to withdraw their proposals on the above subject.

An Unusual Accident.—An unusual and costly accident recently occurred in the yards of the Pennsylvania Steel Company at Harrisburg. A large overhead electric crane, used to convey material from one part of the department to another, began to move while the operator was absent. No one could get at the motor to reverse it. Onward and faster it travelled, until it came to the end of the track, when it went over to the ground, 20ft. below. The heavy framework was jammed together, stays were bent, the motor shed demolished, and a portion buried deep in the ground. The accident is attributed to the strong wind that was blowing at the time. The above information is taken from our contemporary *Electricity*, and reading between the lines we should say that electricity had nothing to do with the occurrence. It is so unusual to have a heavy traveller like this exposed to the weather, that one does not provide an automatic brake gear for the horizontal travel.

Government Telephones.—In the *Journal Télégraphique* for Dec. 25 a report is given on the evolution of the telephonic system in the different countries of Europe. This *résumé* is most interesting to read, as showing that in nearly every case the advisability of having the telephones controlled directly by Government is strong felt. In a large proportion of the countries the Government has retained the telephone service in its hands from the first, while in other cases, such as Austria, licenses were issued in the early days, under which companies were constructed. These have since been bought out by the Government at a price which we should think represents a premium. One also gathers from a perusal of these notes that the premium to be paid on repurchase has gone up with the length of time in which the companies have been allowed to exercise rights under a concession. Of the various countries referred to, England has the most space devoted to it, and we regret to think that in real telephonic progress England should be far behind certain small States on the Continent.

Electrical Volunteers.—As is to be expected, the electrical engineers in this country are nowise behindhand in offering their services in connection with the war in South Africa. Further than this, their services are particularly valuable in so far as they have received training in the corps of Electrical Engineers Volunteers attached to the Royal Engineers. This corps has, we understand, offered to send out about 60 rank and file and five officers for active service in Africa, and from members of the corps who have volunteered to go we gather that this offer has been practically accepted. In connection with these volunteers two complete sets of searchlight apparatus will be dispatched, which will afterwards be worked by them. It is exceedingly gratifying to find that a corps organised by the late Dr. John Hopkinson, and since under the command of Mr. R. E. Crompton, should so soon have an opportunity for displaying its efficiency. When the date of departure has been definitely fixed, we trust that arrangements will be made to give a good send off to the Electrical Engineers proceeding to the front.

Cable Work.—There seems every likelihood of a great impetus being given to cable laying during the present year, and it is most probable that the year will see a commencement in the laying of cables across the Pacific. It is still an open question as to how far English manufacturers of cables will be able to retain the hold which they have had up to the present of the supply of submarine cables to other countries. Thus we notice that a strong attempt is being made in the United States to confine to American manufacturers the Pacific cable to be laid from that country to Hawaii. In submarine cable laying, more than anything else, the value of actual experience is incalculable, and we are sure that, even if the work is given to American manufacturers, expert advice from our side of the water will be obtained in carrying out this important work. In the meanwhile, our own Pacific cable scheme is to be thoroughly thrashed out by the Pacific Cable Commission during the present month, and we trust that an early start will be made with the construction and laying of the cable, the worth of which is now fully appreciated.

Atmospheric Electricity.—Our contemporary *Electricity* of New York makes an interesting *résumé* of the various attempts which have been made to collect and utilise atmospheric electricity by means of kites. Commencing with the old experiments of Franklin, it goes on to refer to three or four recent experimenters in the States who have attempted to use for signalling purposes the electricity so collected. Amongst these, Prof. A. G. McAdie, of the United States Weather Bureau, is said to actually believe that in the twentieth century atmospheric electricity will be used as a motive power. The most practical work on the subject has, however, been done by Mr. W. A. Eddy, who has used kite wires for signalling with the Marconi system of wireless telegraphy. He now proposes to obtain electricity from the atmosphere for this signalling, but we fail to see from the description given how the charging and discharging of the wire with oscillatory effects is obtained by the experimenter. Mr Eddy adds that with a kite some 400ft. or 500ft. above the earth he has caused a wire to emit sparks at regular intervals, which he can vary.

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Unipolar Dynamos.—Mr. R. W. Lohman, writing to the *Electrical World* on the subject of unipolar dynamos, gives a drawing of a machine which he has designed which would be coupled direct to the shaft of a De Laval steam-turbine running at 30,000 revolutions per minute. In this case he proposes to collect the current from the edges of the revolving disc by means of steel balls pressing against the sides of a V groove. He states that he has made experiments with $\frac{5}{16}$in. and $\frac{1}{4}$in. steel balls running at about 4,000ft. per minute in such grooves in bronze and steel, from which he concludes that 62 balls $\frac{5}{16}$in. and 40 of $\frac{1}{4}$in. diameter for the outer and inner bearings respectively would carry 200 amperes without trouble. He is not sure, however, how far the higher speed required with the steam-turbine would affect the carrying capacity of the balls. He proposes to make the cylinder revolve between the steel magnet poles, and with the speed mentioned above calculates that 50 volts can be easily obtained from a single cylinder. As mentioned before, with these high speeds, which are necessary to get a working voltage with a unipolar machine, the collecting gear troubles become serious.

Electric Cabs.—The failure of the London Electric Cab Company has been a serious set back to electric cabs as a whole, as the direct outcome of the failure will be that it will be exceedingly difficult to obtain financial support for improved vehicles. The work now being done in New York by the Electric Transportation Company will, we hope, result in a profit being earned in spite of the fact that the initial outlay for an electric cab with its proportion of plant is considerable. The chief item up to the present which has to be largely reduced in order that the cabs may run at a profit is that of repairs, both to the accumulators and to the motors and gear. In this first item we are afraid that very large reductions are not to be expected, but there is every reason for a very large reduction in the cost of maintaining the motors, gear, and the tyres. The items of expenditure by the London Electric Cab Company in this respect were excessive, as was also the price which the company had to pay for electric energy during the early stages of its career. With improved driving gear, as suggested by past experience, and a really cheap supply of electrical energy, a very different financial result could be obtained from electric cabs.

A High-Tension Switch.—The Power Development Company, of Bakersfield, California, are using a novel form of high-tension switch and fuse for potentials varying between 10,000 and 11,000 volts. The switch is used on all the branch lines and pumping stations of the Kern County Land Company. It consists of a rectangular wooden framework made out of 4 × 4 timber, on each of the two long sides of which are fixed three insulators of the high-tension type, which carry the switch contacts. Parallel with these long sides another 4 × 4 timber is placed in bearings in the framework. Three insulators on this carry long tubes in which are the fuses, and at the end of which are the contacts which engage with the switch contacts on the sides. This central part is rotated by means of a lever, on the end of which is attached ordinary window cord. A stop is provided so that the switch can be rotated by 90deg. With this arrangement each line is broken at two points simultaneously. The framework is mounted on the supports for the operating line and in a horizontal position, so that it is quite exposed to the weather. The fuse used in the tube consists of a copper wire about 28in. long. According to the *Journal of Electricity, Power, and Gas*, this switch and fuse was designed by Mr. F. T. Whorff, and it has given every satisfaction.

Electricity in Mining.—In *Kuhlow's Review* we notice some interesting details of an important method now being tried in Prussia for bringing down coal, from which the following information as to the use of electricity in connection with coal-winning was obtained. Recently some experiments were made by the Clausthal mine inspectors with an electrically-driven percussion rock-drill supplied by the Union Elektricitäts-Gesellschaft, of Berlin. They state that a practical opinion as to the practicability of the drill cannot be obtained at present, as the machine in its present form is both too long and too heavy. The great length in certain cases prevents the holes being put in where they are wanted, while the excessive weight increases the loss of time in working. Some small defects are also complained of in the cable connectors. On the other hand, the Siemens and Halske electrically-driven percussion rock-drills have been used with success in the Olpe Arsberg mine district. With these drills, equipped with a 1-h.p. motor running at 250 revolutions, holes can be sunk at the rate of 3½in. per minute in the solid rock, and to about 4¾in. in a mixture of rock and schist. With this drill the forward feed is effected automatically, being self-regulated according to the hardness of the rock. From the details given, we gather that this machine is doing regular work in a way which gives every satisfaction to its owners.

Therapeutic Electricity.—We are pleased to see that the *Lancet* publishes a favourable review of a new book by Dr. W. S. Hedley on "Therapeutic Electricity and Practical Muscle Testing." We gather from our contemporary that the book contains a great deal of good and new matter concerning the use of electricity for testing nerves and muscles. The high-frequency and high-potential methods of D'Arsonval are well described and well illustrated by means of photographs. The *Lancet* cordially agrees with Dr. Hedley as to the important work which can be done by means of electricity outside of the field of nervous diseases. Attention has for too long a time been concentrated upon the electrical treatment of these affections, and electricity has often been condemned because it has failed to effect cures in cases of progressive disease of the nerve-centres. The true value of electrical applications consists in their remarkable power of stimulating the activity, not merely of nerve and muscle, but of all living protoplasm. Most of the recent advances in electro-therapeutics have been in the direction of improving the apparatus and the methods for obtaining general trophic effects and of applying them to the relief of the numerous forms of defective or perverted nutrition which are met with in disease. These are the conditions in which electricity may be expected to give valuable aid to therapeutics.

The Mount Whitney Power Scheme.—California is most amply provided with water power, the only trouble being that in certain years the water power is rather apt to give out in summer. One most remarkable feature in that country is the exceedingly high falls which are obtainable for power work. We have recently seen in the *Electrical Review* of New York a full description of the works of the Mount Whitney Power Company, which distributes electricity over a large area for driving irrigation machinery and other purposes. In this case a head of water of no less than 1,300ft. is obtained. The water is led for some six miles on an open flume, and then diverted into a pipe line which is only 3,300ft. long. In this distance there is the fall mentioned above of 1,300ft. High-pressure Pelton wheels are used, direct coupled to three-phase dynamos. The present equipment consists of three 450-kw. machines which generate at 440 volts in each phase. The current is then transformed up to 34,000 volts for distribution.

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The greatest distance from the power-house to a consumer is 43 miles, while other towns at 29 and 40 miles respectively are supplied. Although the plant is a comparatively new one, already a large amount of power has been sold. A good amount of power is used to drive pumps for irrigation purposes, no less than 8,000 acres already being irrigated in this way. The price charged per horse-power per annum for this current is fixed by the company at £10.

Electrolysis.—Prof. J. L. Blake has made some interesting experiments on the electrolysis of cast-iron water-mains in Kansas City, U.S.A. The experiments were made to ascertain the actual resistance of cast-iron water-pipes as usually jointed, and to compare the resistance of the joints with the resistance of a given length of the pipe itself. The conclusions of the experimenter are that the resistance of the leaded joints increased exceedingly the whole resistance of the pipe line. In fact, the actual resistance of a given length of iron pipe was found to average nearly 40 times what it would have been if a continuous section of cast iron had been present. The influence of the high resistance at the joints under ordinary conditions is useful in preventing electrolytic effects. If, however, sufficient current returns along the pipe to cause an appreciable drop of voltage at individual joints, Prof. Blake thinks a harmful action at these joints may ensue. In fact, in certain cast-iron mains which the author obtained from the streets there were distinct evidences of such electrolytic effects at joints, and the inside of the pipe was attacked almost equally with the outside. This internal electrolysis had in some places caused a pitting of the iron ¼in. deep. The author points out that the bonding of water-pipes to the return conductors would in some cases intensify this electrolytic action at the joint. The outcome of the experiments would seem to us to emphasise again the need of keeping the drop in the return conductor low, as is done now in accordance with the regulations of our Board of Trade.

South Wales Power Distribution Scheme.—The Bill of the South Wales Electric Power Distribution Company, which is to be considered in the next session of Parliament, has been duly deposited, and we gather from it that the capital of the company is to be three-quarters of a million, and that the company propose to raise a quarter of a million more by means of debentures. A strong board has been got together, and it is proposed that the whole of the county of Glamorgan and a large portion of the county of Monmouth should be supplied by the company with electric power. As Cardiff, Swansea, and Newport come in this district, it is interesting to note that the company does not propose to supply electricity except to wholesale consumers within the district of any local authority already owning a provisional order, unless the written consent of such authority has been obtained. This raises an interesting point as to how far a large manufacturing works can be considered as a wholesale customer, insomuch as they distribute electricity to their different departments. In the Bill provision is made for the erection of three generating stations, the first of which will be erected in the parish of Llantwit Vardre on an area of 19 acres between the River Taff and the Taff Vale Railway on the Cardiff-to-Pontypridd line. The second station will occupy an area of 5½ acres in the parish of Panteg, between the Taff Vale and Aberdare extension line of the Great Western Railway and the Eastern Valleys section of the Great Western Railway. The third station will be erected in Neath on an area of 8½ acres between the Rhondda and Swansea Bay Railway and the Neath Canal. It will be remembered that this company propose to utilise railway lines as the general route of its distributing mains.

The Arrangement of Three-Phase Conductors. Mr. A. J. Bowie, jun., contributes to the *Journal of Electricity, Power, and Gas*, of San Francisco, an article on the arrangement of three-phase transmission lines. In it he points out that the actual physical arrangement of the wires on the poles with the three-phase system is a matter of great importance, as if the wires are badly arranged, the regulation of the system is interfered with. This is evidenced by the potential in some circuits rising, and in others falling, to a much greater extent than would be accounted for by the load on the circuits. The explanation of this is that the induction of one line wire is not the same as that of another, and that there is considerable medial inductance between the circuits. In order to avoid this, it is usual to arrange the line wires in a spiral. The author combats the commonly accepted idea that the more spirals one puts in the wire the better. He points out that the spiral arrangement may lead to considerable mechanical troubles, and that a faulty isolation, allowing the wire to drop, does much more damage when the wires are in spirals. When the three wires can be arranged on the three corners of an equilateral triangle, there is no need to change their positions, as this gives equal induction in each wire, and an equal drop in each wire, with a balanced load. The author then takes up the question of when the three wires are placed on the same cross-arm, and comes to the conclusion that if the relative positions of the three wires are changed by spiralling them at every one-third of the distance, equal drop will be secured. He gives calculations to prove this, and also calculates the variation in drop in different lines for certain assumed loads, power factors, and conductors.

An Electric Car Record.—Messrs. J. B. Entz and H. P. Maxim have again beaten the United States record for the greatest distance travelled in an electric motorcar without recharging the batteries, and this record certainly surpasses anything which has been done in this country. The trial in question was made on an electric car which weighed without batteries 1,200lb. The batteries weighed only 980lb., while the complement of passengers and luggage brought the total weight of the vehicle up to 2,600lb. The accumulators consisted of 48 cells, and each cell contained 11 plates. The capacity of the battery was rated at 154 ampere-hours at a discharge rate of 22 amperes. The vehicle was made by the Electric Vehicle Company, and was of their "Columbia" type. Details are given in the *Electrical World* of three trials made on three successive days. The first day a run of over 60 miles was made, while the next day, Nov. 16, the vehicle, without receiving any further charge, was run for a distance which brought the mileage up to 96 miles for one charge. The battery was then recharged, a total of 190 ampere-hours being put in. On Nov. 17 a 100-mile run was made in 7 hours and 45 minutes over ordinary roads. The average speed run was 12·9 miles per hour, and the voltage on the accumulators, while 22 amperes was being taken from them, at the end of the run was 78 volts. The records show that 13·6 kilowatt-hours were expended during the run, corresponding to 20·9 units of charge. With the cost of electrical energy at 3d. per unit this works out at 5s. 0½d. for the 100 miles journey, or about ·6d. per mile. On the next day, after a recharge, over 60 miles were accomplished at an average speed of 13·6 miles per hour. This speed was kept down owing to the bad state of the roads at the beginning and end of the journey, and also on account of an accident caused by a collision in the early part of the run. If it had not been for this a much higher speed

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would have been recorded, as an average speed of 20 miles per hour was maintained the greater part of the way. We find no mention in our contemporary as to the state of the weather, but there is no doubt but that records have been beaten by these trials. The following further details will therefore be of interest concerning the motor and method of driving. Only one motor was used, which was mounted in a self-contained case which enclosed all the gearing. This case was pivoted on to the rear axle, and supported in a vertical position by means of springs. The two wheels on this axle were independently geared to the motor. The driving wheels were 36in. diameter, and had wire spokes and solid rubber tyres. The wheel base of the car was 65½in. long.

New Filaments.—According to the *Electrical World*, a patent has just been issued in the States to Mr. W. L. Voelker, of London, for a new type of filament for incandescent electric lamps, and for the process of making the same. The following is a description of the process in question: The essential materials consist of the carbides of uranium and thorium. Two parts of chemically pure nitrate of the earth metal selected are combined with one part by weight of pure cane sugar, and dissolved in distilled water. The solution is then heated to the boiling point, when the mass will swell to a porous body largely increased in bulk, and presenting, if uranium nitrate be employed, a yellow colour. This body spontaneously ignites, and while burning gives off great quantities of nitrous fumes. When the fumes cease to be evolved, the vessel is covered with a porcelain lid, and the mass allowed to cool slowly. When cold it is of a brownish-black colour, and is soft and porous. The mass is then ground to a fine powder, and sufficient cane sugar added to give it a consistency of putty. It is then pressed into cakes, slowly dried, and baked hard in covered crucibles. The next operation consists in melting these cakes in a suitable electric furnace. The current required to reduce from 6oz. to 8oz. of the compressed mass to a perfectly fluid body in about 15 minutes should be approximately about 1,000 amperes at from 75 to 100 volts. When the whole mass is in a perfectly fluid state, the current is cut off, and the furnace allowed to cool down. The reaction in the furnace will have produced a carbide, which is next reduced with benzol or naphtha and ground to an impalpable powder. When the grinding is complete, the powder, freed of benzol or naphtha, is mixed with a viscous compound composed of gun-cotton and oil of cassia, and then rolled for about an hour between hard or polished steel rolls. Upon the completion of the rolling, the mass is transferred to a strong sealed cylinder provided with a tight-fitting piston, and a filament is squirted through a jewel die and wound on suitable forms of gas carbon. The filaments are then heated to a bright-red colour by means of an electric current of high voltage in an atmosphere of purified and attenuated gas. The surface of carbon deposited from the gas is then volatilised at a very high temperature and in a vacuum, thus finally completing the union of any uncombined carbon with the carbides in the core of the filaments by bringing them to the highest degree of incandescence. It is stated that the resulting finished lamps give in comparison with the best carbon-filament lamps a much higher candle-power with a great reduced consumption of current, the electrical resistance of the carbide filaments being so much higher. The carbide filaments are said also to have greater stability at the resulting high temperature, and the economic life of the lamps is thus greatly lengthened. For producing incandescent electric lamps yielding a pure characteristic light, uranium carbide filaments are employed, which give a light having an appearance of sunlight. The whiteness of the light can be increased by adding thorium nitrate to the uranium nitrate. If it be desired to increase the electrical resistance, titanium nitrate may be added.

Industrial Electrolytic Processes. — Dr. W. Borchers, the well-known expert on electrical furnaces and electrolytic methods of carrying out metallurgical operations, contributes a general article on the same to the *Engineering Magazine* for December. In his introduction he considers the sources of energy which are available, and makes, amongst others, a calculation as to the mechanical work which is done by the sun in evaporating water from the surface of the earth. Assuming a mean rainfall of 39in., and a mean height of cloud of nearly two miles, the author concludes that the work done by the sun equals about 660,000 million horse-power Of course only a very small portion of this energy can be utilised, but every attempt is now being made to harness the available water power in industrial countries. The question is also gone into of the thermal value of the wood which can be grown per annum on a given surface of suitable soil, and from this is traced the development of our coalfields, etc. Coming to the use of energy, however, produced in electro-chemical industry, the author has collected information as to the actual weights of the different metals and chemical compounds in the production of which electricity is used in some way or other. The figures which we give below are the minimum figures, as only actual information is included, whereas in certain cases where electrolytic processes are known to be in use, definite returns were not received by the author. The following figures express in tons the weight of the different substances reduced per annum: aluminium, 12,930 metric tons; gold, 21 tons; copper, 166,360 tons; sodium, 260 tons; nickel, 182½ tons; silver, 1½ tons; caustic soda, 82,060 tons; caustic potash, 17,280 tons; chloride of lime, 225,000 tons; chlorate of potash, 11,350 tons; calcium carbide, 256,244 tons; and carborundum, 1,585 tons. The average market price in each case is given, and the total value calculated from the same. The author then proceeds to describe in general terms various electrolytic processes, such as Castner's sodium apparatus, and the method devised by Mr. Becker for the production of metallic sodium electrolytically. Some interesting details are then given of an apparatus designed for the extraction of metallic magnesium from a fused mixture of magnesium sodium chloride. In this case the electrolyte is contained in an iron crucible which serves as the negative pole. A carbon rod hung in the crucible forms the anode. A porcelain tube surrounds the carbon rod and serves to collect the chlorine given off. The metallic sodium is then deposited on the side of the iron vessel in the form of small balls. Some interesting details are given of copper refining, which is now very largely carried on electrically. The apparatus for the production of alkali and chlorine is not so fully described, but the matter will prove interesting to the casual reader. Finally, slight mention is made of some electric bleaching processes now being developed on the Continent. In a table at the end of the article a list is made of the power plants which have been laid down for such work in the different countries. We are surprised to find that in this respect France takes the lead with 111,440 h.p. in plant, the major portion of which is driven by water power. The next country in order is the United States, after which Switzerland comes third with some 39,000 h.p. The table states that in England we have 11,500 h.p. developed by water power and 8,150 h.p. by steam. The total for water power seems to us to be somewhat large for the few power stations which we know of in the United Kingdom.

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LARGE ELECTRIC LIGHT ENGINES.

BY R. D. SUMMERFIELD.

The demand at the present day for electric generators of very large output has led to the introduction of a special class of large engines for driving these generators; by large engines the author means engines of over 500 h.p., but more especially of 2,000 h.p. or more, many of which have been and are being built in England, America, and the Continent.

The design of these large engines is generally a more difficult problem than the design of the generators which they are to drive, and engineers do not seem to have arrived yet at any definite conclusion as to which is the best type to employ. The type of generator, of course, influences the design of the engine to a great extent—in fact, the two cannot be taken separately, but must be designed each to suit the other; at the same time there are several requirements which should be fulfilled by all large engines for electric light work, no matter to what type of dynamo or alternator they may be coupled. These requirements are: that the engine must be well balanced and run smoothly and evenly, in order that the lights may not be affected; it must be provided with a sensitive governor which is capable of maintaining the speed practically constant during sudden and large variations of the load; it must be very efficient and should give its greatest efficiency at three-quarter and not full load, as in most cases it will run the greater part of its time at three-quarter load, and the relative efficiency of an engine is much less at light load than when overloaded. Then the engine must be as free as possible from vibration; it should be strong, not liable to get out of order, and capable of running continuously for long periods; and last, but not least, the various parts of the engine must be readily accessible for inspection or repairs, a point often overlooked by draughtsmen.

To these requirements may be added that of high speed, but it is here where the difficulty comes in, as steam-engines of the ordinary reciprocating type cannot be run economically at a greater piston speed than about 1,200ft. per minute, and this speed is only attained by locomotives and torpedo-boat engines, and would not be suitable for large electric light engines on account of the vibration and wear. Dynamos, on the other hand, can be economically run at very high speeds, the output being almost directly proportional to the speed—in fact, at low speeds, to double the number of revolutions will more than double the output, so that the size and weight of a generator can be kept down if its speed is made sufficiently great. This discrepancy between the economical speeds of engines and dynamos can be got over by running the engine slowly and driving the dynamo at a greater speed by means of ropes or belts, but as direct coupling is the simpler and more reliable method, besides taking up much less space, it is always adopted for large plants.

The steam-turbine is the only steam-engine whose speed is sufficiently high for direct coupling with a dynamo in order that both machines may give their greatest output with the least size and weight. Up to the present these turbines have only been made in small powers, but it is said that an American firm is about to build a 2,500-h.p. steam-turbine, and if this large engine is a success when built it will no doubt cause a great change in electric light engine practice. At present engineers design the engine and dynamo to suit one another, by running the engine at as high a speed as practicable, and making the armature of the generator of larger diameter than it would otherwise need to have been in order to make up for the lower speed.

In alternate-current work this practice is carried out in the design of what are known as "flywheel alternators"—that is, machines where the armature or field coils, or the inductors, as the case may be, are built up on the rim of the engine flywheel, engine and generator forming one complete machine. The advantages of this construction are that the engine can be run at a slow or moderate speed, while owing to the large diameter of the armature a high voltage and large output can be obtained from the generator; two main bearings only are required, one on each side of the flywheel, overhung disc cranks being used, and the arrangement is very compact. These engines are usually compound, having two cylinders, one on either side of the flywheel, with cranks at right angles, and on the Continent and in America they are generally made horizontal with Corliss valve gear, and run at a low speed, sometimes as low as 60 revolutions per minute. In England they are more often built vertical, with piston or slide valves, and run at a higher speed, up to about 150 revolutions per minute. The disadvantages of this type of engine are that having only two cylinders the various parts are very heavy and awkward to handle, the large flywheel is a source of danger, and the engine and generator being practically one machine, neither can be removed or altered without affecting the other.

Another type of engine for electric lighting which is largely used in England, and which has of late had a good deal of attention directed to it and is being made in much larger sizes, is the high-speed enclosed vertical engine. These engines are made single and double acting, and run at speeds of about 200 to 400 revolutions per minute, according to size. In the larger sizes they generally have three cranks, placed 120deg. apart, and they may be either simple, compound, tandem, or triple tandem, with three, six, or nine cylinders. The flywheels are simple discs of small diameter, and the oiling arrangements consist either of an oil bath into which the cranks dip, as in the single-acting engines, or of oil which is pumped under pressure to the various working parts, this system being usually adopted in the double-acting engines. This type of engine has several advantages: for its power it takes up but little floor space, the working parts are protected from dust and dirt, and owing to its high speed the size of the generator is reduced and the governor can be attached directly to the shaft; another advantage is that the engine is quite distinct from the generator, which is simply coupled up next to the flywheel. Although adding to the number of working parts, and in most cases to the cost, the use of three cranks is far preferable to two for electric light engines, three-crank engines being easier to start and running much more smoothly than engines with only two cranks, besides which it is an advantage to increase the number of cylinders for very large engines in order to keep down the size and weight of the moving parts. There is no reason, however, why engineers should restrict themselves to the use of three cranks only when designing engines of very large power, as marine engines with four and five cranks have been found very successful, and with slight modification this type of engine should be equally successful for electric light work. Another advantage of using more than two cranks is that the engine need not be disabled entirely by the breaking down of one cylinder or one set of motion, as the other two or more cylinders will run the engine quite well when the faulty part is disconnected; but if one cylinder of a large two-crank engine were to break down, the remaining cylinder would probably not be able to turn the engine smoothly enough for electric lighting, and possibly would not be able to turn it at all.

By increasing the number of cranks, and, therefore, the number of cylinders, the power of an engine may be increased without raising the piston speed or shortening the stroke. Thus, modern high-speed vertical engines consist generally of two or three lines of cylinders, each line being a separate compound or triple-expansion tandem engine, and the removal of one line of cylinders would not affect the working of the remaining cylinders, but would reduce the power of the engine by one-half or one-third as the case might be. By adding to the number of cylinders and cranks, therefore, a high-speed engine of large power with moderate piston speed could be produced, but this process could not be carried very far, on account of the cost of such an engine, the increased friction, large space occupied, and difficulty of adjusting the numerous shaft bearings required; this latter difficulty might, however, be got over by using swivel bearings capable of being adjusted in height by means of screws or wedges, and, in the author's opinion, the economical limit of size for this type of engine has not been nearly reached yet.

The question of governing is a very important one, and the advocates of the two systems in general use—viz., throttle and cut-off governing—each maintain that their

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system is the best. Throttle governing was the first method to be used, but it was soon largely discarded in favour of cut-off governing, as the latter is theoretically the best method, but engineers have now discovered that in practice the advantages of this system of governing are not so great as they expected, and in England the majority of high-speed engines for electric lighting are now made with throttle governors. American engineers, however, still swear by the cut-off governor. The disadvantage of a throttle valve is that it "wire-draws" the steam and reduces its pressure, which lowers the efficiency of the engine; but, on the other hand, the steam, by being "wire drawn"—that is, by being forced through the reduced passage in the throttle valve—is slightly superheated, which practically makes up for the loss of pressure by diminishing cylinder condensation. The simplicity of throttle governing is another point in its favour. The great disadvantage of a cut-off governor is that at light loads, when the steam is cut off at an early part of the stroke, the cylinder condensation becomes serious, causing loss of pressure and efficiency, as with the throttle valve. This loss is less with compound than simple engines, and less still with triple or quadruple expansion engines, as the range of temperature in each cylinder is less, but with an early cut off it is always sufficient to considerably modify the good results which should theoretically be obtained with this system of governing. Shaft governors have the great advantage of positive action, besides which they are simple and strong in construction, with few working parts. They are largely used for both throttle and cut-off governing, but are not satisfactory at speeds much below 200 revolutions per minute, as the centrifugal force is not sufficient at low speeds and the governor becomes sluggish in action with a tendency to hunt. For large horizontal engines a sensitive centre-weight ball governor is used, actuating some type of Corliss valve gear; engines fitted with this type of valves are more economical than any others, but the governors and valve gear are delicate and have many working parts, therefore the engines cannot be run at a high speed, 100 revolutions being about the maximum with Corliss valves. Then the governor is driven through gearing, or by belt, and not direct, which is a disadvantage.

The question of single-acting *versus* double-acting engines seems to the writer to be summed up thus: If, by making an engine double-acting it is possible to get twice the power out of it as out of a single-acting engine of the same size, why should single-acting engines be used? The champions of the single-acting engine are ready with an answer to this question. They say that at high speeds the distribution of the steam can be effected more economically in single than in double acting engines, that the constant thrust in one direction on the crank-pin obtained by using steam on one side of the piston only is conducive to smooth running and long life of the engine, and that a single-acting engine is practically self-draining. All this is quite true, and for engines of under, say, 200 h.p. running at speeds of 400 or 500 revolutions per minute or more the single-acting type is preferable to all others, but for large engines, which take up a good deal of space and necessarily run at only moderate speeds, the double-acting type possesses most advantages. The smooth running of the engine and freedom from jar and undue wear can be provided for by using three or more cranks, long connecting rods, sufficient cushioning, and by lubricating the crank-pins by means of oil forced under pressure between them and the brasses. Danger from water in the cylinders can be practically reduced to nothing by having steam separators placed in proper positions, large drains and relief valves on the cylinders, and by using slightly superheated steam. With regard to steam consumption, large high-speed double-acting engines have recently been built whose performance in this respect has been most satisfactory.

As the advantages of the single-acting engine where large powers are concerned are now equalled by the double acting type, which possess over and above the great advantage of double power for the same size, the author sees no reason why the double-acting engine should not be always used for large powers; and that this opinion is a growing one may be proved by the facts that many large English engine builders have turned their attention specially to this type of engine during the last few years, and that numbers of these engines have been put down in the latest electric light installations. The high-speed double-acting multi-cylinder engine has, however, a serious rival in the slow-speed two-cylinder compound engine, which is also being put down in large numbers; in fact, these two types practically divide the field between them where large powers are concerned, but for the reasons given above the author is of opinion that the former will prove to be more suitable for the work, and that it will survive until it is superseded by the steam-turbine, which will in all probability entirely take the place of reciprocating engines for electric lighting work in the future. This future is at present, however, too far ahead to be taken into account by engine builders, who are confining themselves almost entirely to the two types mentioned above.

A type of engine which the writer would suggest as most suitable for powers of over 1,000 h p. would be a double-acting vertical tandem compound engine running at about 200 revolutions per minute, and having eight cylinders and four cranks, 90deg. apart. The hollow crank-shaft would be supported on swivel bearings mounted on screwed pillars and capable of being raised or lowered by fine degrees. This would enable the bearings to be lined up with great accuracy, and would also permit of the bottom brasses being removed without lifting the shaft. The cylinders should be supported on eight cast-iron or steel columns, each pair of columns acting as a cross-head guide and the spaces between being filled in with thin sheets of iron, fitting oil-tight, but capable of being removed in a few minutes. This would give plenty of room for getting at the rod ends and shaft bearings, an important point in case of a breakdown. The connecting rods should be as long as possible, and ought to be hollow to minimise weight (the insides might be used as oil reservoirs for the big ends); swivel brasses should be fitted to both ends of the rods in order that they might set themselves in the easiest position.

With regard to the oiling of these large engines, the best arrangement seems to be a system of forced lubrication, the oil being pumped under pressure into the various bearings at the centre of each, and after being used falling into a tank at the base of the engine, from whence it is again pumped. As efficient oiling is of more importance than anything else in quick-speed double-acting engines, too much care cannot be taken in the design of the apparatus for accomplishing this; everything should be as simple and strong as possible, the pumps should be easily got at, the oil-pipes should have as few joints as possible, and these most carefully made, as it is at the joints where a forced lubrication service is most likely to fail. A hand-pump is generally added in case of breakdown to the power pump.

The governing is, of course, a matter of more importance with large engines than small ones, as variations in the speed of a very large generator, running alone or in parallel with only one or two others, will affect the lights more than variations in the speed of a smaller generator running in parallel with several others. As 200 revolutions per minute is too slow a speed for an ordinary shaft, governor to work really well, a separate governor shaft might be used, driven through carefully-cut gear from the end of the main shaft, at twice the speed of the latter. This would allow of the governor being made lighter and more sensitive. The moving collar on the governor shaft should be connected as directly as possible with a balanced throttle valve having a dashpot of some kind to steady it, and all working parts of the governor should be made of hard steel, as slackness in these parts is the principal cause of "hunting" and unsteadiness in electric light engines.

There is no need for large flywheels on this type of engine, which removes one source of danger, a heavy disc of comparatively small diameter being all that is needful, as the number of cranks ensures smooth running.

In this article the author has omitted many of the smaller details of the modern high-speed double-acting engine, but has endeavoured to give a general idea of the direction in which makers of these engines are trending, and his opinion as to which type will survive.

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THE ELECTRIC CONSTRUCTION COMPANY'S ELECTRIC LIFT.

The above company have devised and patented a new gear for driving lifts electrically, which is worthy of careful study. Two of these lifts have recently been fixed in the new factory and warehouse of Messrs. Bovril, Limited, where they have been subjected to trial under severe conditions. We are informed by the makers that, after considerable experience with them in regular work, they have given every satisfaction, in spite of the fact that they are called upon to deal with widely-varying loads.

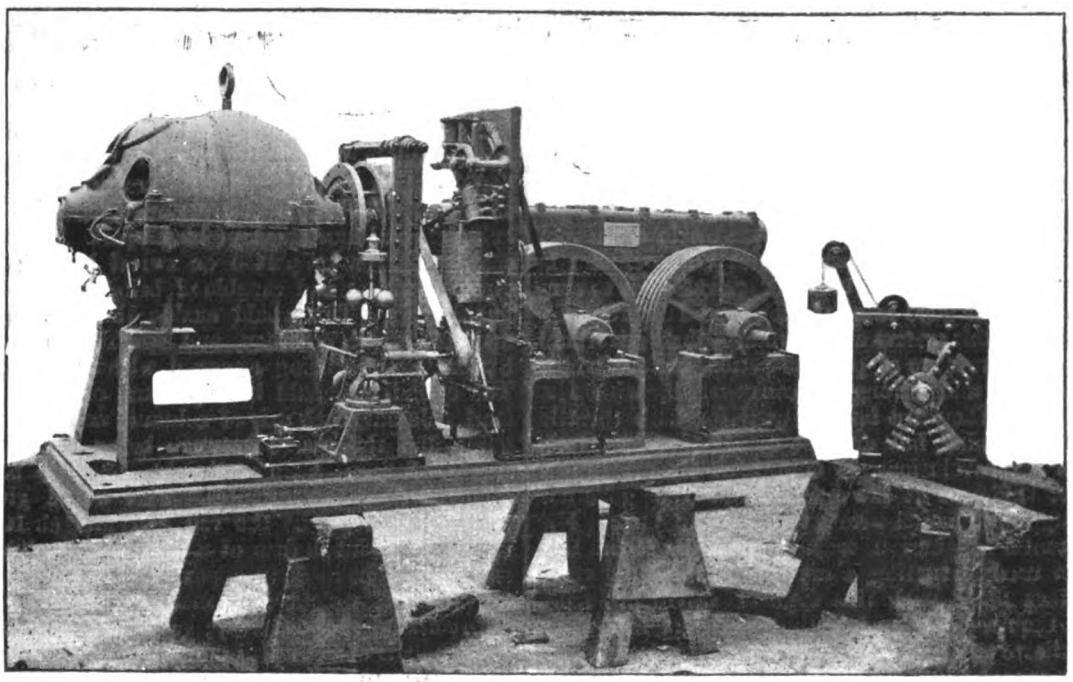

FIG. 1.—General View of the Electric Construction Company's Patent Lift Gear and Switch.

Fig. 1 shows a general view of one of these lift gears, while Fig. 2 shows diagrammatically the arrangement of the rope supporting the cage, and of the counterweight, by which the weight of the cage is balanced. It will be seen from this figure that there are two driving drums, revolving in opposite directions, and that the ropes supporting the cage pass over the first and under the second, so that there can be no chance of any slip taking place. The other advantage in having two driving drums is that, when they are driven by worm gearing on the same shaft, the friction of the worms can be done away with by making one worm right-handed and the other worm left-handed, as is done in this case. Another new feature in this gear is the means adopted for making the driving motor act as a dynamo when the load on the lift is sufficient to cause the speed to rise. In this way a considerable amount of energy can be returned to the supply mains when heavy loads are being lowered by the lift. The electric motor used with this lift gear is of the Electric Construction Company's enclosed iron-clad type.

The weight of the empty lift is balanced by counterweights to the usual extent. If the load is such, in ascending or descending, that it overtakes and drives the motor above its proper speed, it acts as a brake by generating current and returning it to the supply mains. Should the supply mains at any time be incapable of absorbing power, provision is made to prevent overrunning by applying a powerful friction brake through the action of a solenoid, the circuit of which is closed and opened by a centrifugal governor driven from the motor shaft. This brake consists of two arms, which are held clear of the brake drum by means of an electromagnet (Figs. 3 and 4) against the pull of a strong spiral spring; the coil of the magnet is in shunt across the mains, the circuit being made and broken by the starting switch. The motor is connected by a claw coupling having 90deg. play to two worm gears on one shaft, one of which is right-handed and the other left-handed. These take up the thrust, thus preventing loss of power by friction. Upon the axle of each wormwheel is mounted a pulley, round which the steel ropes run for supporting the cage and counterweights, as shown on the accompanying sketch (Fig. 2). The worm gears are completely enclosed in an oil bath, and will run for a considerable time without attention. An endless rope running through the cage actuates the starting and reversing switch, shown on the right hand of the photograph reproduced as Fig. 1. The motor is started up through a resistance, the cutting out of which is not under the control of the driver, but is performed automatically.

The accelerating switch, which automatically cuts out the starting resistance in series with the motor armature, is mounted on the bed-plate. This switch is put into action by an oscillating lever driven by an eccentric from the motor shaft. The lever carries a pawl which is actuated by a small magnet. When all the resistance is cut out, the magnet is short-circuited, and the switch-bar ceases to move, although the lever still oscillates.

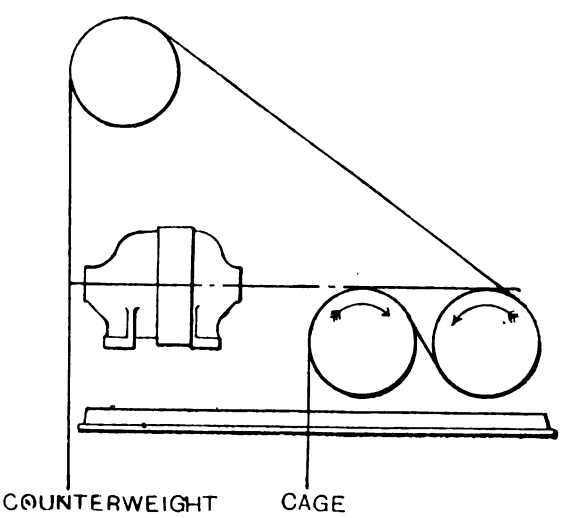

FIG. 2.—Diagram showing the arrangement for balancing the weight of the cage.

The switchbar is retained by a brake-band passed round a drum on the switchbar operated by another small magnet; and on the circuit being broken the switchbar is automatically returned to the position in which all resistance is in, by the weight which can be seen in the illustration. The gear to enable the motor to generate a current with increase of speed when it is called on to act as a brake, either when the cage is ascending with a light load or descending with a heavy one, consists of

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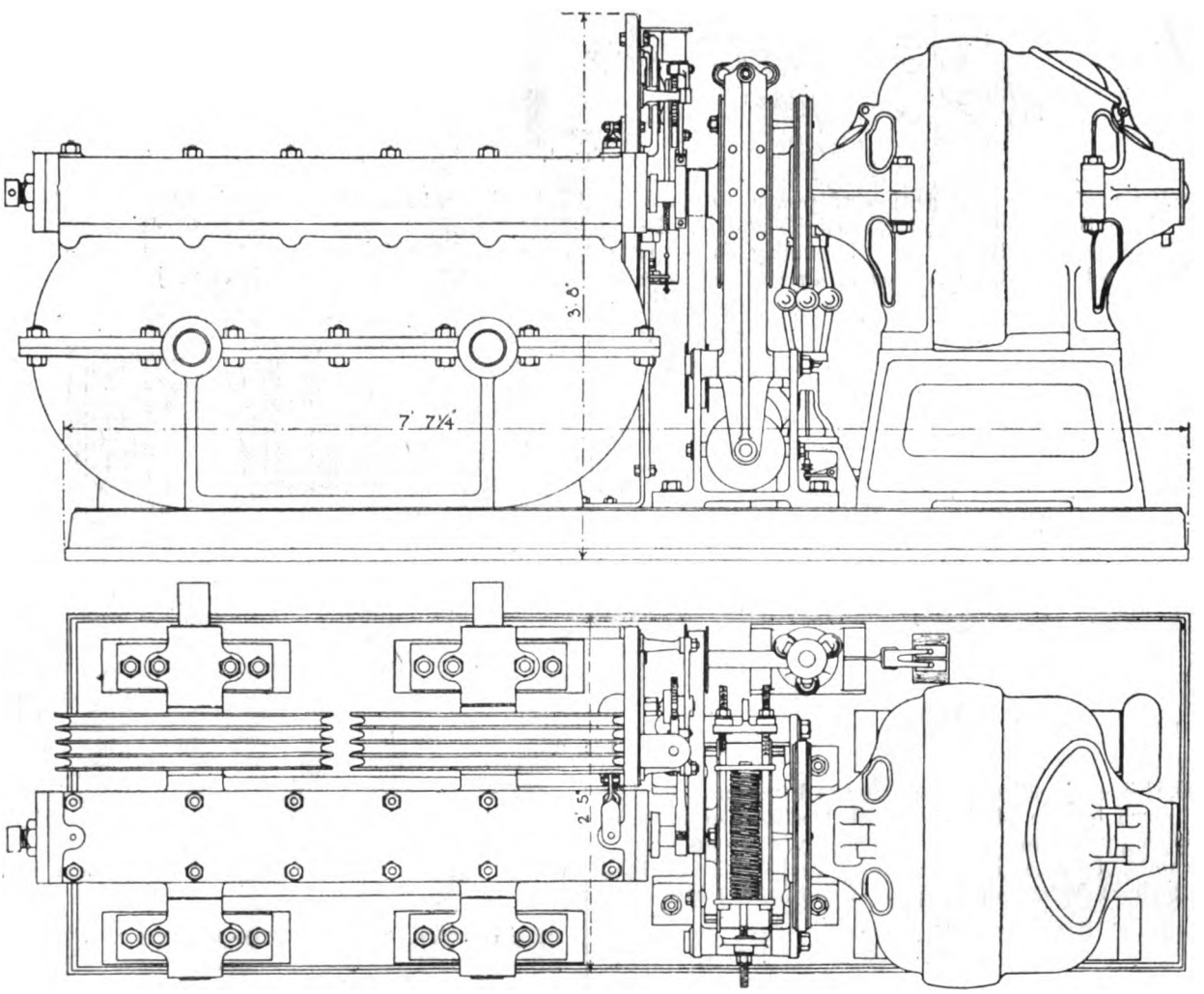
a disc mounted upon a screwed portion of the motor shaft and driven by a pin fixed to the gear half of the coupling. As mentioned above, there is 90deg. of play between the halves of the coupling, and should there be a tendency on the part of the gearing to drive the motor, it will be necessary for the half coupling on the gear side to travel through an angle of 90deg. before it comes into position for driving. In traversing this distance the disc will travel along the screwed shaft sufficiently to short-circuit a resistance in the motor field. The counter E.M.F. of the motor is correspondingly raised, and a braking current generated which prevents undue rise of speed. On closing the starting switch by means of the hand rope from the cage, the following action takes place: The brake is held off and the motor starts slowly, gradually increasing the speed as it cuts out the resistance in circuit with the armature until full speed is attained. On switching off, the motor is short-circuited upon itself through a fixed resistance of such amount that the motor is adequately retarded, the friction brake is applied, and the switchbar returns to its position of "resistance in," in readiness for a fresh run. Trip switches are provided in the lift hatchway should the cage exceed the limits of its travel. These are arranged so that the switchbar is carried clear of the contacts by the cage, and cannot be replaced in the contacts until the cage has been run back. When either of the trip switches is broken, the circuit is made by means of a switch placed in parallel with the trips. This switch is placed outside the hatchway, and is in a locked box, so arranged that the cover cannot be shut down until the switch is broken.



FIGS. 3 AND 4.—Plan and Elevation of e Electric Lift Gear as supplied by the Electric Construction Company to Messrs. Bovril, Limited.

SWITZERLAND.

Schaffhausen, like most other towns in Switzerland, was early afield to utilise its water power. The celebrated falls are nearer to Neuhausen than to Schaffhausen, but the latter is well worth a visit. Its old houses and streets are picturesque in the extreme, and one sees beauty on every side in the lines of its architecture—a beauty sadly wanting even in the handsomest streets of modern cities. There is in the current number of the *Contemporary* an excellent article upon the lost beauty in architecture, hinting that the modern designer can appreciate nothing outside of Euclid's first book, and that if he attempts to copy some beautiful building of olden times he fails because he does not understand lines outside a straight edge and a geometrical figure. The only objection that can be urged against visiting these *répertoires* of ancient art is that sanitarily the streets, and only too probably the houses, contravene modern ideas at every turn. But the subject of architecture must not keep us. The objective is the central station. Before describing this, did not Mr. Kapp, in a speech at Zürich, refer to a consulting job he once had in reference to the apparatus at Schaffhausen? If our memory is correct, there was a loss of efficiency somewhere, and several people had a try to find out where the offence lay, one of whom was Mr. Kapp. In the end, it turned out to be due to coagulated oil causing a much greater "bearing" resistance than was reckoned upon, hence the varying efficiency.

THE SUPPLY STATION.

In 1895 the Schaffhausen Town Council invited competitive plans for the erection of an electricity supply station. A number of schemes were submitted in open competition, upon which the Council obtained expert advice, with the result that it was decided to adopt a scheme proposed by the Maschinenfabrik Oerlikon, which provided for a single-phase alternating-current system of generation and supply. The actual work of instalment was commenced in the autumn of 1896, the supply of current to consumers being started in February of the following year after the scheme had been completed in every detail.

The prime motive power for driving the generators is obtained from a turbine plant put down on the Rhine

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opposite Schaffhausen by a private company in 1887-90. This plant is really an extension of a larger turbine plant installed by the same company a little farther up some years previously, and which still serves as the primary station of the celebrated cable and shafting transmission

The turbines (Figs. 1, 2, and 3) are of the Jonval type, by Escher, Wyss, and Co., Zürich, and have vertical shafts. They are designed for a normal fall of 15ft. and a volume of water amounting to 240 cubic feet per second, and run at 48 revolutions per minute. At high water the available

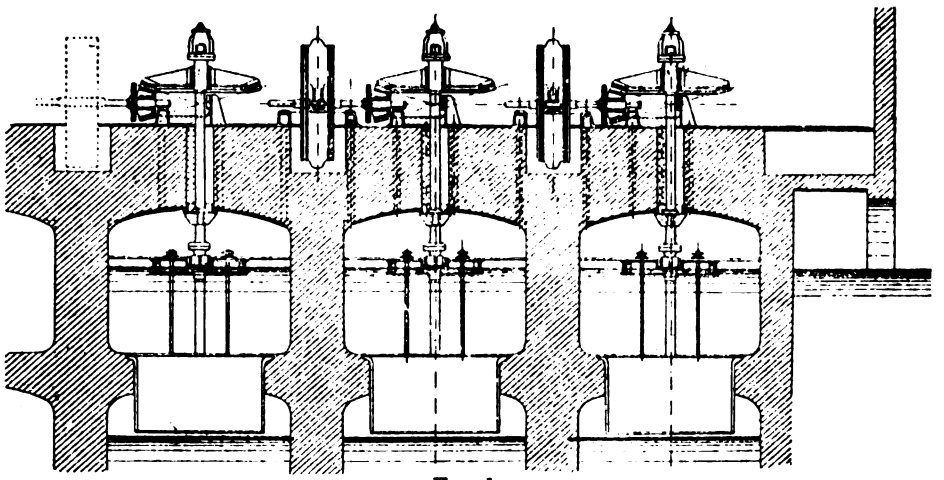


FIG. 1.

installation for the distribution of power to numerous factories in Schaffhausen and the neighbourhood. In the new turbine-house five turbines developing an output of 300 h.p. each have been installed. Two of the same are

fall sinks to 10ft., the volume of water per turbine being increased under these conditions to 400 cubic feet per second in order that the turbines may continue to develop their normal output. To enable this adjustment, the turbine

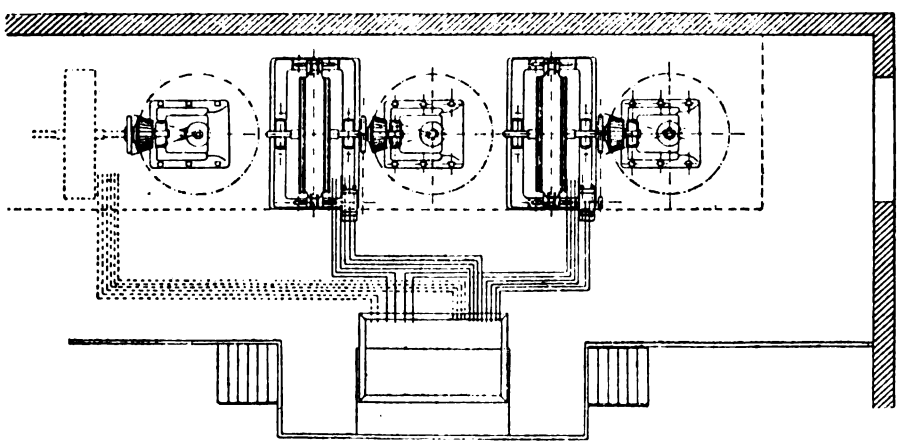


FIG. 2.

worked in conjunction with an electrical transmission plant put down by the Maschinenfabrik Oerlikon in 1890 for supplying power to a mill in the vicinity, the two primary machines, of the continuous-current type, being driven from the turbines by means of ropes. Two further turbines are

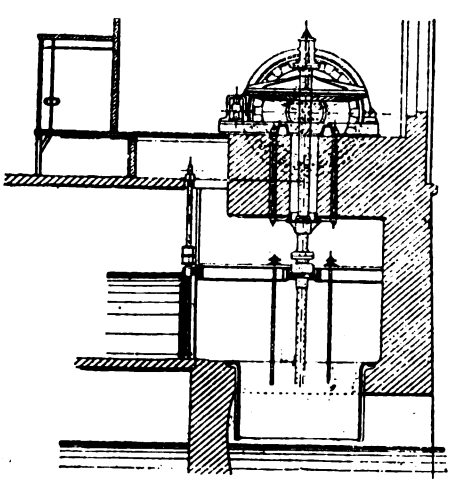
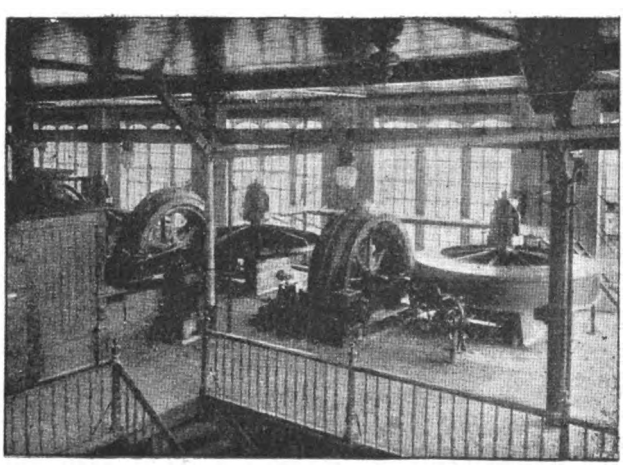


FIG 3.

rented by the town authorities for driving the alternating-current generators, which form a portion of the system now to be described. In the first place, one 300-h.p. generator only was installed, but a second machine of equal capacity soon became necessary.

wheels are provided each with two crowns of paddles containing 36 and 24 paddles respectively. Of these two crowns the outermost only is acted upon at low water, while at high water both are opened to the action of the



FIG, 4.

water. The turbines, which, it may be mentioned, were not originally intended for the driving of a lighting plant, are regulated by hand. The vertical shaft of each turbine drives a horizontal countershaft by means of a bevelled toothed wheel. This horizontal shaft was intended

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to drive in its turn a rope pulley, and constitutes, therefore, a sort of countershaft from which machines might have been driven in the same manner as the rope-driven generators previously mentioned.

In working out the details of the scheme the practicability of coupling the rotating portion of the alternator direct to the vertical shaft of the turbine was carefully considered. However, in view of the low speed of this shaft, and the limited space between the individual turbines, an alternative arrangement appeared to offer greater advantage. The magnet wheel, which constitutes the moving portion of the type of alternator in question, was therefore mounted upon the horizontal countershaft in place of the rope pulley originally intended. In this manner an arrangement was devised which corresponded to the most modern requirements. But as the horizontal shaft, to facilitate its original purpose, had been mounted upon a massive concrete foundation 6ft. above the floor level proper of the machine-room, it was perforce necessary to place the base frame of the generator likewise at this height, and in doing so it was found possible to utilise the existing concrete blocks as an anchor for the base plate without much alteration. In continuation with and at the same height as the foundation surface a floor was constructed, which facilitates the inspection of the generating plant, and at the same time serves as a switchboard platform. Beneath this platform the connections between the machines and switchboard are placed, besides a transformer plant for serving the station building and a consumer of energy for lighting purposes situated in the immediate vicinity, all of which connections and apparatus are easily accessible. Fig. 4 gives a view of the generator-room and switchboard recess.

The alternate-current generators (Fig. 5) are designed for an output equivalent to 300 h.p. when running at 167 revolutions per minute, which speed, with 18 pairs of poles, corresponds to a periodicity of 50 per second. Each machine generates a current of 100 amperes at a terminal potential of 2,000 volts when fully loaded, a margin over and above this voltage being allowed for to compensate for the loss in the primary and secondary network of mains, besides the transformer loss. The alternators are of the Oerlikon inductor type. The magnet wheel, therefore, carries no exciting or other coils, but carries on its circumference two sets of pole-shoes, each set containing 18 shoes built up of laminated iron, the two crowns of poles being so placed together that the shoes of the one crown correspond to the interstices of the other, each pair occupying, therefore, a diagonal position relative to the axis of rotation, and so forming the magnetic yoke-pieces necessary to the exterior exciting coils. This magnet wheel, which has a diameter of 8ft. 9in., revolves within the cast-iron frame of the armature, the frame having a clear bore of 8ft. 9⅜in., being, moreover, divided through its horizontal and vertical sections respective to its axis into four separate portions, which are bolted together from the exterior. Within this frame are two slotted armature cores of cylindrical form, built up of laminated iron. These are supported by the frame, and each carries 36 armature coils. The sections are wound and insulated before the machine is erected. Each coil consists of seven turns of copper strip 1in. broad by ·056in. thick. The coils of both halves of the armature are connected in series, and are all wound in the same direction. The initial turn of the first coil is connected with the initial turn of the second, the end of the second being connected with the end of the third coil, and so on. Provision is made for moving the armature frame sideways over the bed-plate of the machine clear of the inductor wheel, so that ready access may be obtained to the coils of either half of the armature. The field exciting coil is situated between the two halves of the armature within the cast-iron frame. It consists of a brass former, upon which 305 turns of well-insulated copper wire of ·28in. diameter are wound.

In Fig. 6 both the no-load and short-circuit characteristics of the machine are shown respectively by curves 1 and 2.

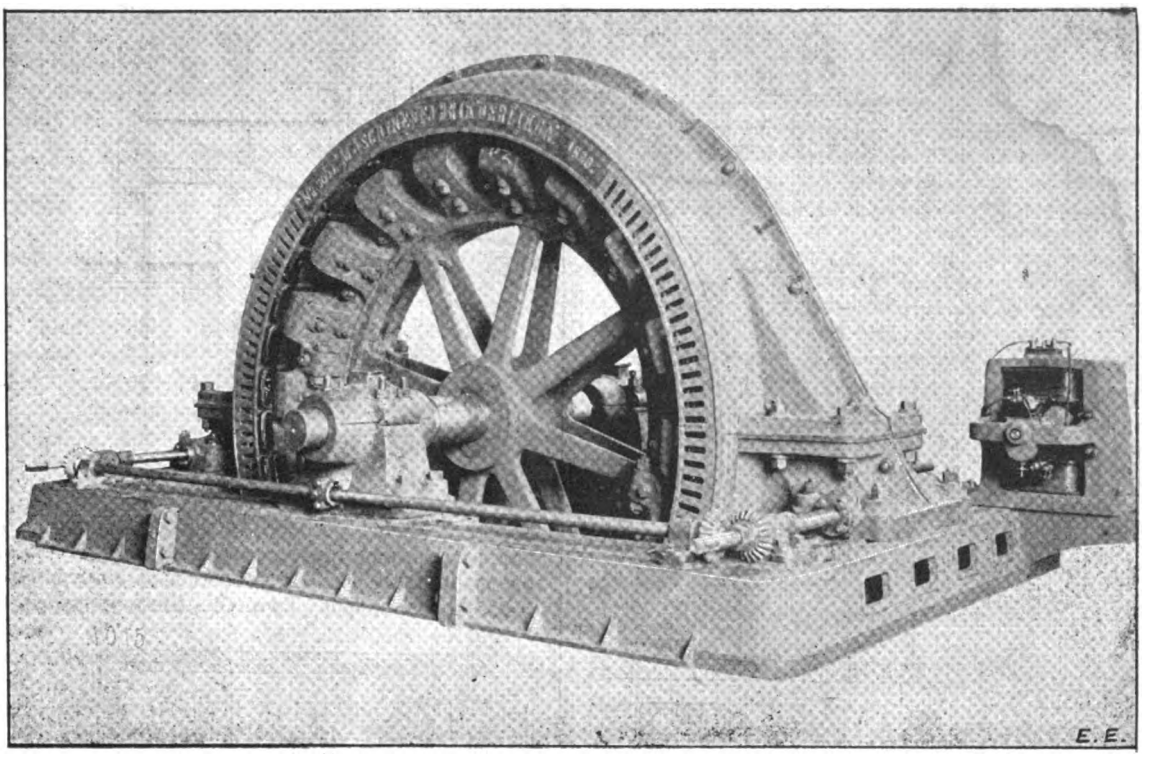

FIG. 5.

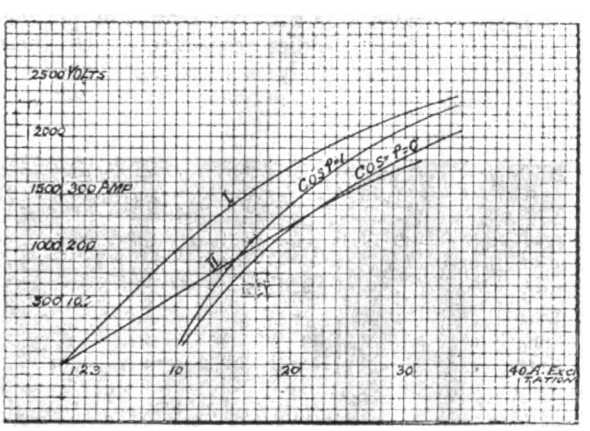

FIG. 6.

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These were plotted from actual trials. In the same figure the curve (cos $\phi = 1$) gives the terminal potential of the machine as function of the exciting current strength, corresponding to full load, on an approximately non-inductive load — *i.e.*, transformers with

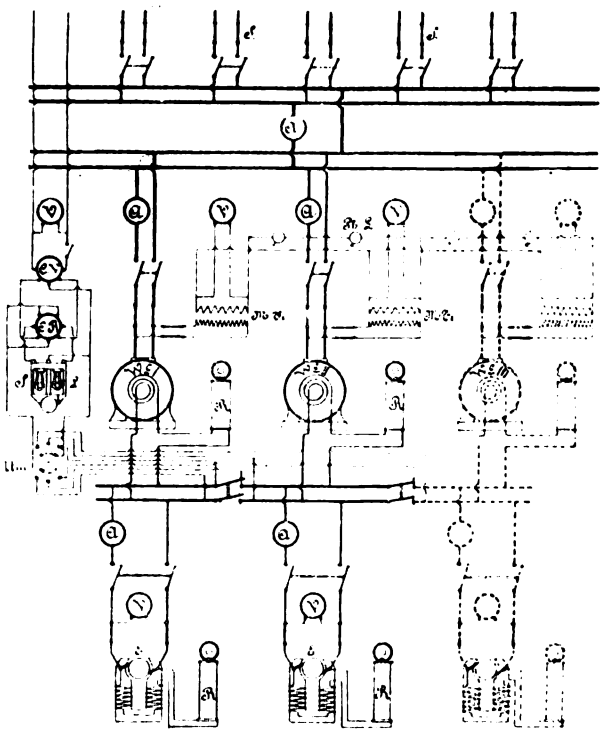

FIG. 7.

incandescent and arc lamps, while the remaining curve (cos $\phi = 0$) represents the fall of potential on a purely inductive load calculated from the short-circuit characteristic. Hence these two latter curves represent the limits of the fall of potential for all inductive

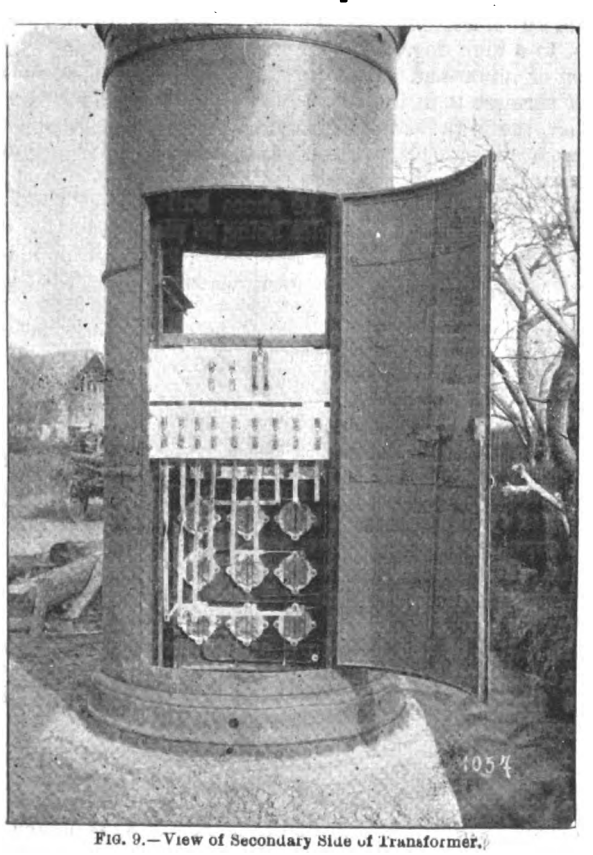

FIG. 9.—View of Secondary Side of Transformer.

loads—the maximum possible fall upon a lighting load amounting to 5·5 per cent., and that with the machine running light to 15 per cent. To the bed-plate of each generator a smaller plate, to carry an exciter dynamo, is attached. The latter machine is of the Oerlikon bipolar shunt-wound standard type, designed for an output of 120 amperes at 50 volts terminal potential running at 420 revolutions per minute. The exciter is driven by means of four 0·6in. ropes from a rope pulley keyed to the generator shaft. Since the excitation necessary for the alternator in question amounts to about 900 watts—that is to say, about 0·45 per cent. only of the machine's output—one of the exciter dynamos would, in case of necessity, amply suffice for the excitation of all the alternators at present installed in the station. The regulation of the terminal tension of the alternators is effected through resistances in their respective exciting circuits. Of necessity, the exciter dynamos are also provided with regulating resistances in their shunt circuits to enable

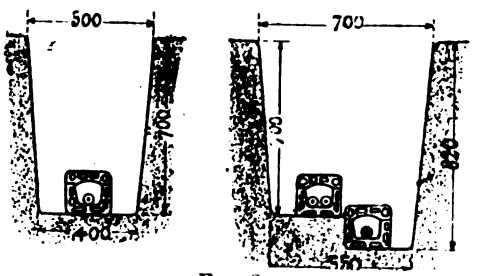

FIG. 8.

them to be run in parallel. The switchboard, which is erected at about 10ft. 9in. distance from the main wall of the dynamo-room, contains as many marble panels as there will ultimately be machines in the station, each of the exciter dynamos being treated as a separate machine. It is 13ft. in length and 8ft. 3in. high. The usual complement of instruments, switches, resistances, etc., needless to detail here, is provided for each machine, all being insulated, so that individual instruments or parts may be touched without danger. A static voltmeter, to which pilot wires are run, for testing the potential of the secondary mains at three feeding points in the town is also provided. The machine switches, regulating resistances, synchronising transformers, fuses, and single-pole lever switches for the feeders are placed behind the board, together with the 'bus bars, which latter are mounted upon porcelain insulators. The levers, however, actuating the

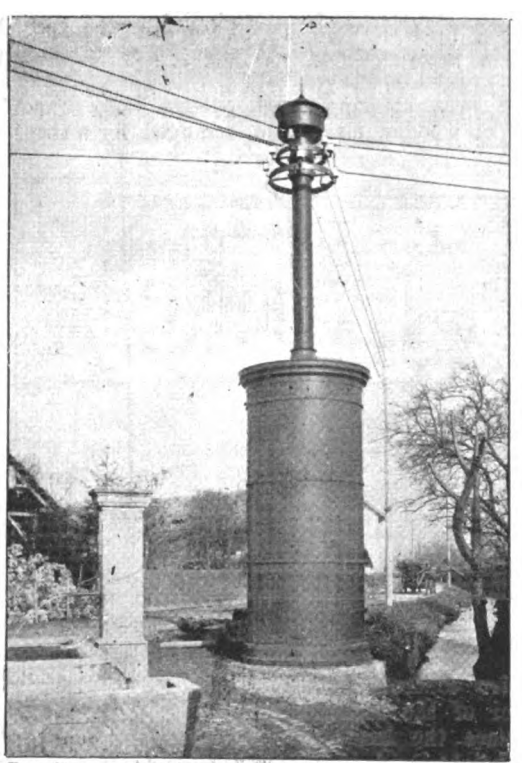

FIG. 10.—Transformer with Underground Primary Cables & Overhead Secondary.

switches belonging to the machines, together with the resistance regulating wheels, are placed on the face of the board. A diagram of the switchboard connections is shown in Fig. 7. Now we come to the feeders which distribute the primary current to the several transformers. These are without exception

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laid in the ground, and consist of concentric cable protected by means of a double covering of lead. Three feeders of ·092 square inch sectional area are run from the generating station, one being directly connected to several transformer sub-stations, while the other two conduct to a distributing station. The distributing station enables the four primary cables, which are run from this point in different directions, and to which 11 transformer sub-stations in all are connected, to be controlled from one centre. The transformer sub-stations are fed from this centre by concentric cables of ·092, ·062, and ·031 square inches sectional area, so that three

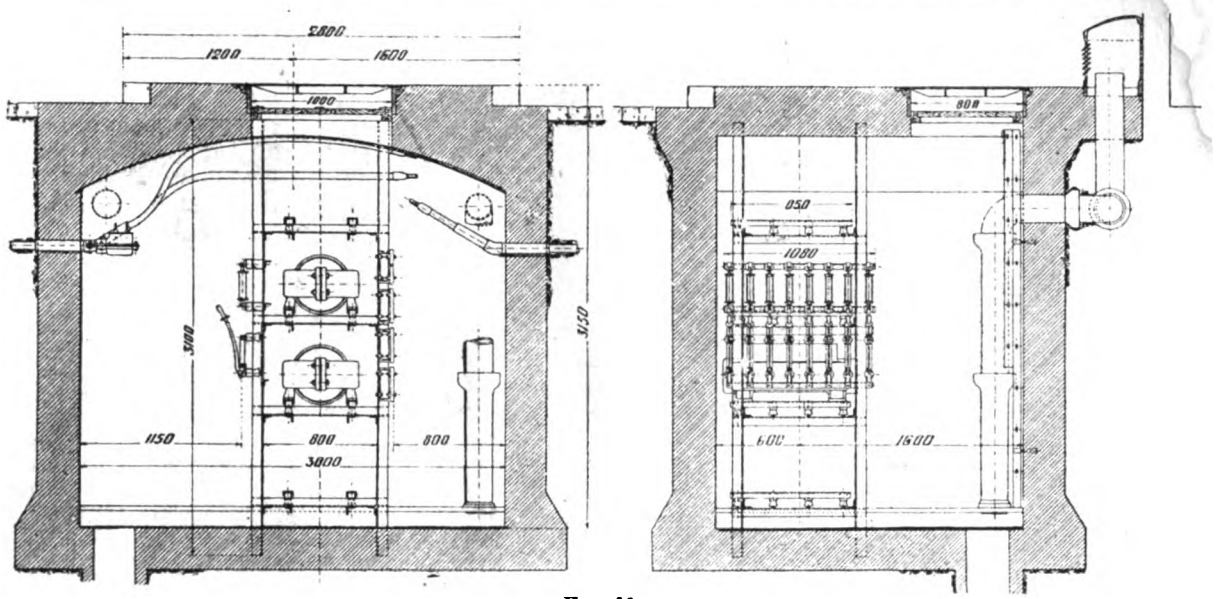

FIG. 11.

different sections of primary cables are employed. As previously mentioned, the transformer sub-stations may be switched off individually from the distributing centre. With regard to the secondary network, all the transformer sub-stations are independent of one another, but the distributing mains of the network are arranged to facilitate interconnection if an unequal distribution of load should render such a remedy necessary. While the secondary network of mains serving the inner area of supply is laid underground on the two-wire system, the mains serving the outer area of supply are, on the other hand, run overhead on wooden masts and arranged for a three-wire

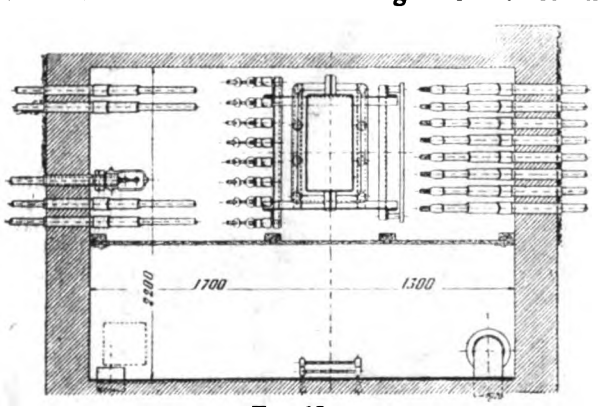

FIG. 12.

system of distribution. Stoneware conduits (Fig. 8) serve to protect both the primary and secondary cables, which are laid underground. Better distinction is made between the primary and secondary cables by laying the former somewhat deeper than the latter.

Three types of transformer sub-stations are in use, of which that shown in Figs. 9 and 10 is perhaps the most interesting. Underground transformer chambers arranged as shown in Figs. 11 and 12, are also employed. There are 19 transformer stations in all, containing some 21 transformers. As regards the transformers themselves two sizes only are employed, ranging in capacity from 10 kw. to 20 kw. In conclusion, it may be added that there has been no serious interruption of the supply since the station started, although the plant was at one time considerably overloaded pending the completion of extensions which soon became necessary.

RECTIFYING ALTERNATING CURRENTS.

An article which recently appeared in the *Elektrotechnische Rundschau* explains a simple method of rectifying alternating currents. Should it be desired to obtain a continuous current from an alternating-current source, this may be done by inserting a so-called unipolar conductor in the alternate-current circuit. Such a conductor allows current to flow only in one direction, the current in the opposite direction being partly or wholly suppressed. Aluminium electrodes possess this property, as is well known, to a high degree, if we immerse one of these in a solution of alum and other liquids and then discharge a current through it in the one direction. This method, however, has the disadvantage that half of the total current impulses are entirely suppressed, so that the effective output of the generating machine is reduced.

An arrangement suggested by Carl Liebenow, of Berlin, aims at utilising both the positive and negative impulses of the alternate-current source. One means of attaining this end is already known, and has been described by L. Graetz.

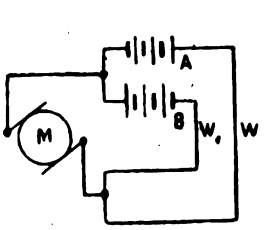

FIG. 1.

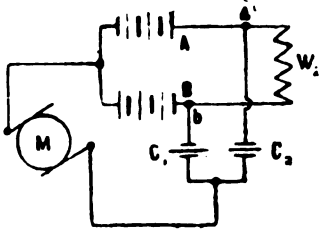

FIG. 2.

His method possesses the disadvantage, however, that four batteries of aluminium cells are necessary, which all generate oxy-hydrogen gas and reduce the efficiency of the system by double as much as the arrangement described below. In connection with the latter two batteries of cells only are necessary. Such an arrangement has also been described in principle by L. Graetz (Fig. 1), though he has not developed the method so far as to make full use of the energy generated by the machine in one circuit. In Fig. 1 M represents the generator, while W and W_1 are resistances, of which each absorbs half of the energy generated. In order to combine these two energised halves in a single continuous-current circuit, the following arrangement has been suggested by C. Liebenow: If we connect the points immediately behind the cells through a third resistance, W_2, this will be energised by a current impulse at each impulse of the generator, but these would not be in the

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same direction. The energy distributes itself, then, between all three resistances. But if we now make W and W_1 of very high resistance and insert in each of the same a condenser, C_1 and C_2 (Fig. 2), of sufficient capacity that each is capable of condensing a full impulse, the two condensers are then in series, and remain constantly charged so long as the resistance W_2 is open. However, if we switch W_2 in circuit the condensers discharge themselves through W_2, and a uni-directed current flows through this resistance, whereby the full output of the machine is utilised. In place of the resistance W_2, arc lamps, motors, galvanic baths, a battery of accumulators for charging, etc., might be inserted. The condensers might also be replaced by accumulators. We then have a single battery of accumulators between *a* and *b*, with one pole of the alternator connected to it in the centre. This battery may be employed as desired in the customary way. Should it be desired to maintain the potential of the battery constant for lighting purposes, it may be done in the usual manner by means of adding or withdrawing cells. But if the switching in or out of cells is accomplished from one end of the battery as usual, the charging current in the two halves of the battery would quickly become unequal. An arrangement must therefore be adopted whereby alternate cells respective to the one or other half may be switched in or out of circuit. Should it be desired to employ a double accumulator switch and so obtain complete independence of the charging and discharging potentials, end cells only of the battery must be switched in or out of circuit. Further, if it be desired under these circumstances to maintain a constant equality of the charging current in the two arms of the battery, an arrangement must be adopted whereby in case of an unequal number of cells in the two halves a resistance or auxiliary cell may be switched in circuit with that half containing the lesser number of elements, or, as an alternative, we may dispense with the alternate switching in or out of cells relative to the two halves, and simultaneously switch in or out of circuit a cell of each arm.

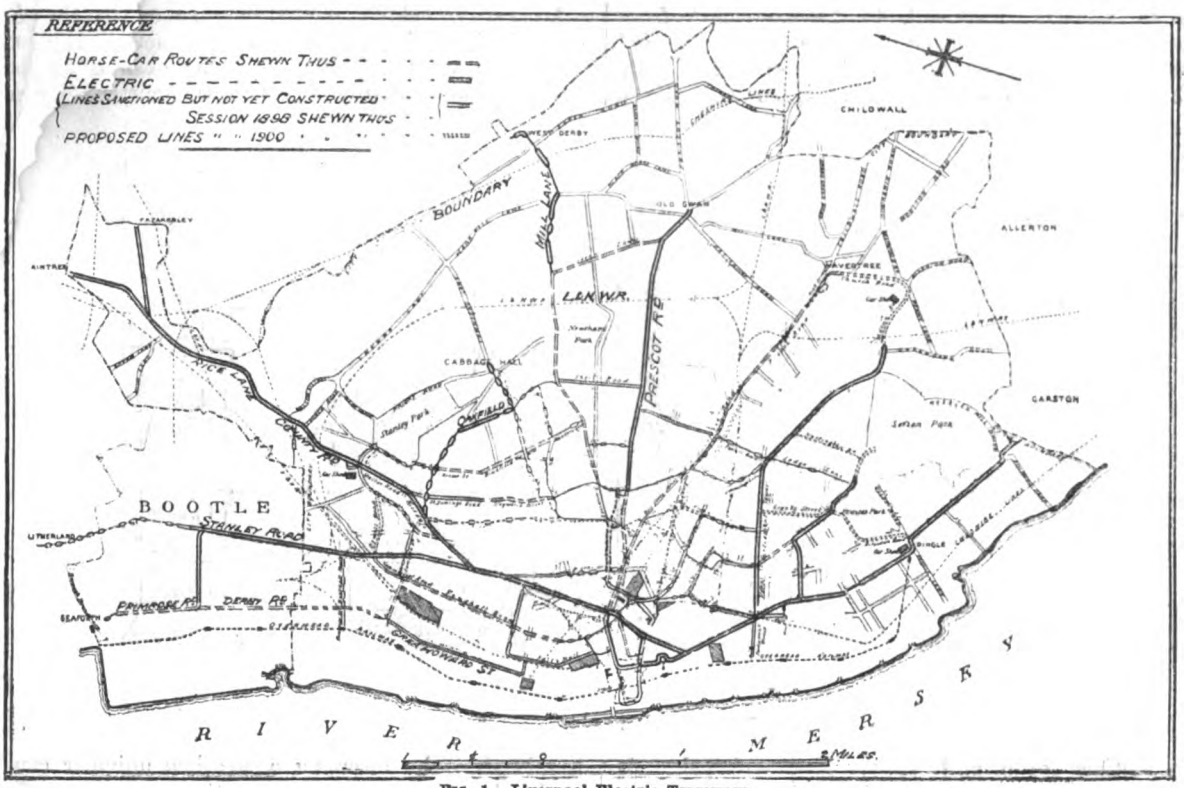

FIG. 1.—Liverpool Electric Tramways.

LIVERPOOL ELECTRIC TRAMWAYS.

Horse traction, so far as it is confined to tramway work, seems destined to be entirely superseded in Liverpool, and that at no distant date. The last report by the city engineer, Mr. John A. Brodie, M.I.C.E., which was recently presented to the City Council and unanimously adopted by them, provides for the conversion of the remaining horse-worked tracks, besides the construction of several new lines for electric traction. We have previously referred in these columns to this report and the decision of the Council thereon, but a few further details of the scheme may not be out of place here. The accompanying reference map (Fig. 1) is a reproduction of one given with the report, and requires no explanation. The length of horse-worked track still extant amounts to an equivalent of about 36 miles of single line within the city, and 1,200 yards in the district of Litherland, owned by the Corporation. Provision is made in the current estimates for the reconstruction of the whole of these lines for electric traction, and for the construction of several new lines, for which parliamentary powers are already in existence, together with the doubling of existing lines. The total expendi

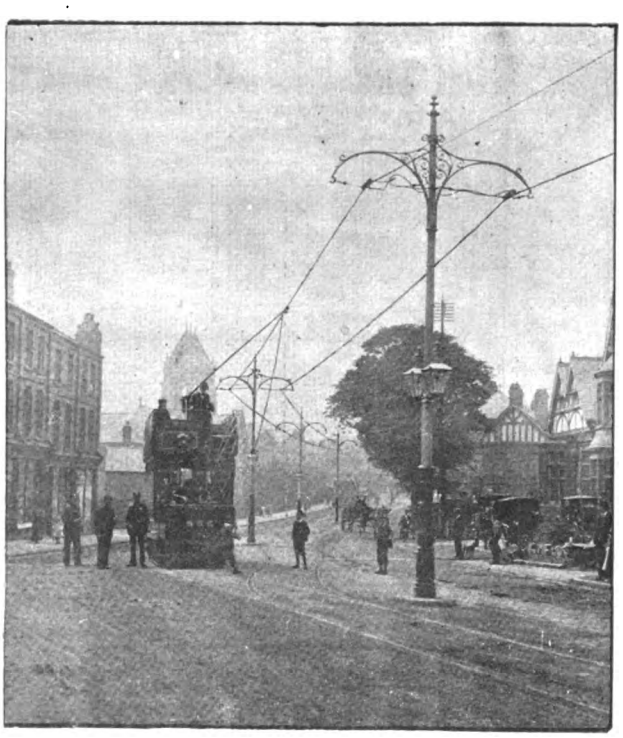

FIG. 2.—Liverpool Electric Tramways.

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ture involved by the proposed new work, including £5,000 for contingencies and £78,400 to cover the cost of 55 miles of overhead equipment for the lines in question, amounts to about £350,000. As regards the lines already converted, these are shown on the accompanying map.

electrical equipment of the lines, suffice it for the present to give a few illustrations showing the style of overhead construction adopted and the type of car which has found maximum favour in Liverpool.

Besides the type of overhead construction shown, span

FIG. 3.—Liverpool Electric Tramways

About £160,000 has been expended on the work of reconstruction during the past year, no less than 16 miles of track having been constructed by the city engineer's department since the middle of August last year, making a

wires attached to side poles have been used where absolutely necessary owing to the narrow width of the street. As far as possible these poles have been erected close to the buildings, in order to avoid interference with the traffic of

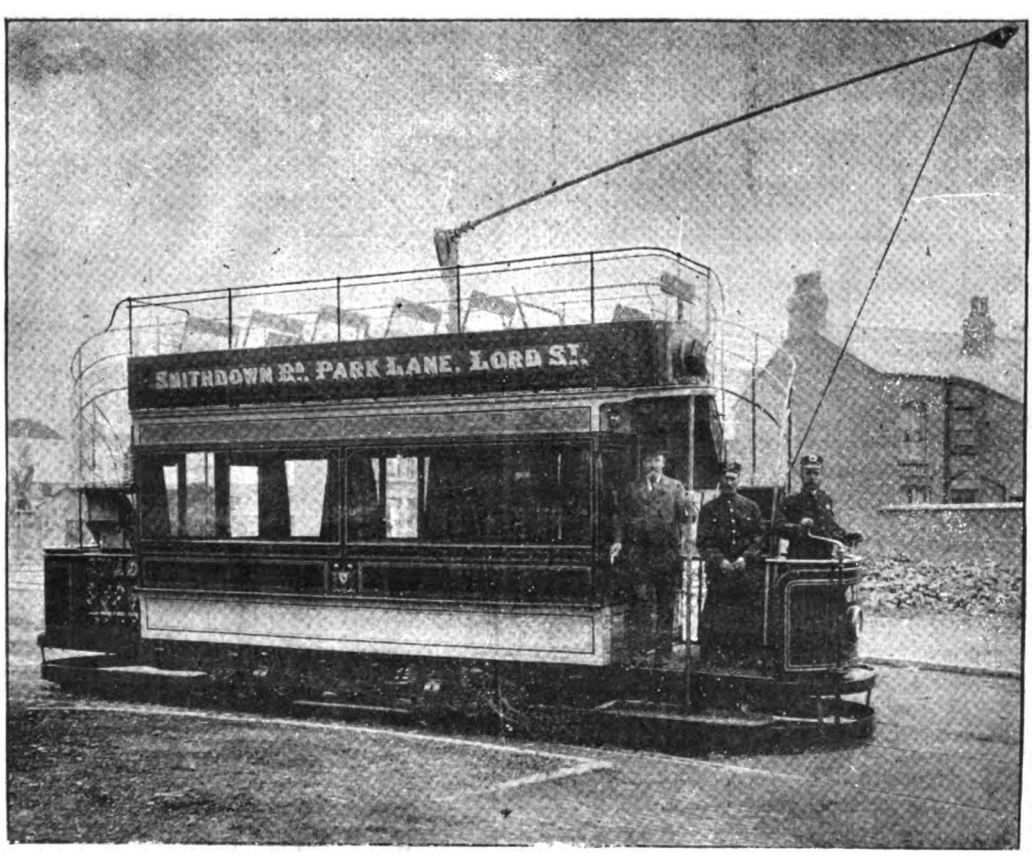

FIG. 4.—Liverpoo Llectric Tramways.

total of 37 miles completed up to date so far as permanent way is concerned Of the latter figure about 21 miles are already being electrically worked, while the electrical equipment of the remaining lines is proceeding apace. It is not our intention to enter into details with regard to the

the streets, while in some cases span wires attached to wall rosettes have been employed. But without exception a decidedly neat appearance has been effected. This is especially the case with regard to the centre-pole type of onstruction, as is sufficiently apparent from Figs. 2 and 3.

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Messrs. Robert W. Blackwell and Co., Limited, are the contractors responsible for the overhead equipment, and the work is being carried out in a very thorough manner throughout.

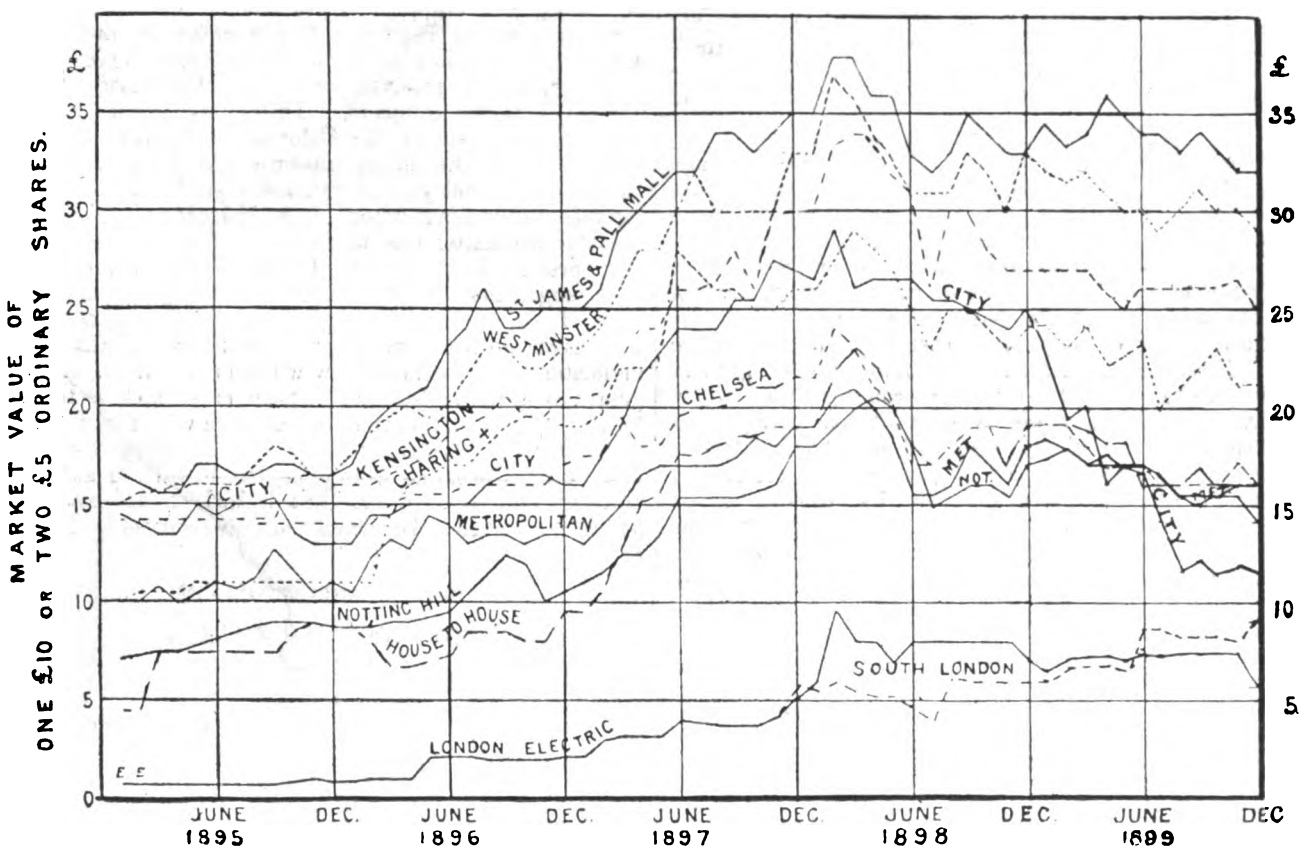
The cars operating the electric lines are of several types, including 16 double-bogie American cars supplied by Messrs. Dick, Kerr, and Co., and 16 cars with trailers similar to those used in Hamburg. Experience with cars in Liverpool has, however, shown that top-seated cars (Fig. 4) are preferred, and it is satisfactory to know that all recent orders have been secured by British firms, Messrs. Dick, Kerr, and Co., Limited, having been entrusted with the bulk of the orders, which they are executing from their Electric Railway and Tramway Carriage Works, Preston. The extent of these orders have been noted from time to time in our columns.

With regard to the power for working the lines, this has up till recently been obtained from the electric light station in Paradise-street, but a portion of the plant installed at the new power station in Pumpfields is now available for the purpose. It may be of some interest to mention that the power for working about five miles of line is obtained from steam generated by the consumption of house refuse at the Smithdown-road destructor, where the heat from an eight-cell destructor by Messrs. Manlove, Alliott, and Co., of Nottingham, is being utilised for the generation of steam, about 200 h.p. being so obtained. A much larger combined refuse destructor and electric generating plant is, however, now in hand, and the results obtained will be awaited with interest.

In conclusion, a few particulars may be given with regard to the permanent way. The rails employed are of the girder type with a surface width of 4in., a depth of 7in., and a base width of 7in., their weight per lineal yard amounting to 95lb. The joints are made with fishplates of the usual type, and are double bonded with "crown" Chicago bonds of ·4in. sectional area, tie-rods being used in addition at every 10ft. In streets where new work has been necessary the foundation of the pavement consists of 6in. Portland cement concrete from kerb to kerb, and in streets where reconstruction has taken place the existing concrete foundation has been utilised after having been dressed down and resurfaced, so as to form a level bed for the base of the rail. In several instances Australian hardwood blocks, 6in. by 4in. by 3in., have been employed, but, generally speaking, the pavement adopted in the streets traversed by tramways consists of 4in. by 4in. by 4in. granite cubes from quarries in North Wales, which pavement has given very satisfactory results, particularly from a maintenance point of view. The whole of the street work, including the permanent way, bonding, etc., has been carried out by Corporation workmen under the direction of the city engineer, Mr. J. A. Brodie, M.I.C.E., and great thoroughness characterises it throughout.

THE LONDON ELECTRIC LIGHTING COMPANIES.

We gave in our first issue for last year a curve showing the variation of the value of the shares of the electric lighting companies of London from the commencement of 1895 up to the December of 1898. These curves we have had extended, and the diagram given herewith shows the fluctuation in the market value of the ordinary shares of these companies up to the present time. A rough glance at these curves shows that the present value is in all cases slightly lower than at the corresponding time last year.



The only apparent exception to this is the South London Company, but the rise here is due to the fact that the shares, which were only £3 paid at the end of 1898, have now been fully paid up. The chief alteration to be seen in the diagram is the rapid fall of the curve representing the ordinary shares of the City of London Electric Lighting Company. The drop at the commencement of the year was due to the fact that only a 6 per cent. dividend was declared for 1898, as against a 10 per cent. dividend for the previous year. This was explained in the annual report as being due to the absence of fog and to the increased capital of the company, which had not become remunerative. The subsequent drop in the value of these shares has been due to the Board of Trade granting, and to Parliament confirming, a second electric lighting provisional order for the City of London. Having to face competition from the Charing Cross and Strand Electric Lighting Company, the directors of the City of London Company decided to reduce their price, and this reduction will, of course, temporarily reduce the profit earned by the company. It is curious to note at the same time that the shares of the Charing Cross and Strand Company have also fallen in value in spite of their application for the provisional order

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to light the City being granted. In the case of the other companies, the dividends paid for 1898 were higher in many cases than those for 1897. For instance, the House-to-House Company, now called the Brompton and Kensington Company, increased their dividend from 4 per cent. to 6 per cent., while the Charing Cross and Strand Company raised theirs from 7 per cent. to 8 per cent., but the Westminster and St. James and Pall Mall Companies did not increase their distribution of profit to the ordinary shareholders. The annual reports for 1899 will be issued shortly, and it will be interesting to see how far the companies have succeeded in increasing their profits in spite of the increased cost of coal. The slight fall in the value of the electric lighting shares generally over last year's prices is quite accounted for by the present state of the money market.

THE PACIFIC CABLE.

The following leading article, taken from the *Toronto Globe*, shows how keen the Canadians are on the construction of the all-British Pacific cable. The article was published in the early part of December, since when the Commission has met and adjourned :

"What has become of the all-British Pacific cable scheme? Nothing has been heard of it for some months now. Does South Africa monopolise the attention of the Colonial Office to the exclusion of all other questions? Howsoever it may concentrate attention on itself, there are circumstances which should make the subject of deep-sea cables of more than usual interest at this juncture. It was only the other day that owing to some defect in the means of communication between South Africa and the mother country the whole Empire was left to guess as to what was going on at the front. The list of the dead and wounded at Modder River was delayed in spite of the natural anxiety of relatives of soldiers to ascertain how the husband, son, or father had fared in the fray. It is easy to imagine how vital such an interruption of communication between the various portions of the Empire might at any time become. It would be thought, then, that now would be a particularly likely time for the Imperial Government to be concerned about all projects which promised to make such isolation reasonably improbable.

"It is nearly six months since we were all congratulating ourselves that every difficulty threatening the Pacific cable scheme had been overcome, and that the mysterious influences that interposed one barrier after another had at length been effectually defeated. But our hopes in this regard seem to have been ill-founded. So far as the general public can see, we are no further forward to-day than we were on July 6 last, when our representatives were told that the Imperial Government had come over to the Colonial view, and had determined to construct the work along with the Colonies, on the principle of partnership. That was a great point gained. It seemed the end of all difficulty, indeed, and there appeared to be nothing to do but go on with the work. Not a step in that direction seems to have been taken, however. What is the cause. We cannot suppose that a great department of the Imperial Government is so ill-organised that it can only deal with one great subject at a time. The principle of the cable having been decided on by the Minister and the Government, the carrying of it out would fall to the officials of the proper departments, and we cannot believe that the hundred and one interests of the Empire are allowed to stand still because a war is proceeding in South Africa.

"The delay is all the more annoying because it is but a chapter in a history that consists chiefly of delays. Whether rightly or wrongly, the Colonies have attributed these delays in the past to the machinations of the Eastern Extension Cable Company, and it will be hard to convince them that the same influence is not still at work. This view is supported by the fact that the company has recently been negotiating with the Australian Colonies with a view to gaining certain concessions in consideration of its laying a cable from some point in Australia to South Africa. The concessions it desires are that it should have the privilege of receiving and delivering messages over the Australian land lines, these being owned by the various Australian Governments. Against the project of laying such a cable not a word can be said, although the time seems to have come when all such works must have conditions attached to them that ensure at least ultimate public control. Before permission was given to lay the second cable between Singapore and Hong Kong a condition was attached that the Imperial Government could, upon giving 12 months' notice, assume the proprietorship by the payment of £300,000. A similar condition should apply henceforth to every ocean cable constructed by private capital, and if it were imposed on the proposed line from Australia to South Africa it could be welcomed as another addition to the nerve connections of the Empire.

"If it is being used, however, to delay the construction of the Pacific cable, with the hope finally to burke that project, the Colonies interested should not fail to enter a prompt protest. That the Eastern Extension Company hotly opposes the Pacific cable is a matter of knowledge, and it is not unnatural that the various checks which the project has received should be attributed to the intriguing of the company. The laying of such a cable was resolved upon at the Colonial Conference of 1887. The history of the enterprise since has been one of discouragements, delays, and retreats, a good example being the fact that the first report of the committee appointed to consider the matter was held back two years after it had been presented to the Government. The Colonies have not changed their minds, nor are they likely to do so, in spite of the persistent campaigning of adversaries whom they have already worsted at every point. A Bill is, we understand, to be presented at the present session of Congress providing for the construction of a cable from San Francisco to the Philippines on the strength of a Government subsidy of £80,000 a year. We can have nothing to urge against such an enterprise, but it will be anything but creditable to us if this line is laid on the ocean-bed before our much-talked-about but unaccountably delayed all-British line."

FORTHCOMING EVENTS.

SATURDAY, JAN. 6.

Royal Institution.—At 3 p.m., juvenile lecture V., on "Fluids in Motion and at Rest," by Mr. C. V. Boys, F.R.S.

MONDAY, JAN. 8.

Institution of Mechanical Engineers.—At 8 p.m., graduates' meeting. Paper on the "Treatment of Sewage and Sewage Sludge in Rural Districts," by Mr. H. H. Mogg.

TUESDAY, JAN. 9.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Papers on "The Purification of Water after its Use in Manufactories," by Mr. Reginald A. Tatton, M.I.C.E.; and "Experiments on the Purification of Waste Water from Factories," by Mr. W. O. E. Meade-King, M.I.C.E.

Royal Institution.—At 3 p.m., juvenile lecture VI., on "Fluids in Motion and at Rest," by Mr. C. V. Boys, F.R.S.

WEDNESDAY, JAN. 10.

Society of Arts.—At 7 p.m., juvenile lecture II. on "The Phenomena of Phosphorescence," by Mr. H. Jackson, M.A.

Electrical Standardising, Testing, and Training Institution.—First lecture to students on "The Construction and Use of Motors," by Prof. C. A. Carus-Wilson.

THURSDAY, JAN. 11.

Institution of Electrical Engineers.—At 8 p.m., report of the Institution's visit to Switzerland and discussion on "A Comparison between British and Continental Practice in Electrical Engineering."

FRIDAY, JAN. 12.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Address on "The Theory of Structures and Strength of Materials," by Prof. T. Claxton Fidler, M.I.C.E.

SATURDAY, JAN. 13.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., paper on "Repairs to Hulls and Machinery in Modern Steamships," by Mr. J. White Boyd, M.I.M.E.

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1900 AND ITS PROBLEMS.

To Every Reader we wish a Happy and Prosperous New Year.

Fancy, a civilised world in doubt as to whether it is in one century or another! Suppose another Newton to shine forth in the scientific horizon, will he be garnered by historians amongst the select of the one or of the other century? Whatever be his fate, and however verbose the arguments on one side or the other, no matter the claims of each side to "honours divided," there is no doubt but all are agreed that next year will be in the twentieth century, hence without superlative proof to the contrary we shall continue to look upon 1900 as within the nineteenth century, and, in fact, forming its last year. To-day we begin the twenty-fifth volume of the new series of this journal, and may therefore venture to indicate certain intentions. In the first place, there is to be a permanent enlargement of our issues. For some time past space has been cramped in both literary and advertising pages, and in many instances this has delayed the insertion of articles, and of other information, even when it has not been impossible to find room for these things at all. This extra space will permit us to treat more systematically that branch of electrical engineering devoted to traction. Perhaps tramway work is not the ideal direction in which progress should be made, but it is evidently a method to be largely adopted, it may be through a transition period, and will involve the expenditure of large amounts of capital, hence all that concerns its engineering and organisation is worthy of record and consideration. During the year we hope to give a series of monographs upon the electrical developments of the century.

The most troublous item is that concerning the Paris Exhibition. Scientific France has our warmest sympathy, but the Paris Exhibition is not the outcome of scientific France—it is merely a money-making concern with a pretence at science thrown in. The various congresses, on the one hand, are merely a set-off to hide the peepshows and other devices to catch the flying francs on the other. Taking France as a whole, and not arguing from the views of the minority, there is no country that hates us with a deeper hatred or one that has less reason for so doing, yet we are asked to put aside all our knowledge of these things and patronise an exhibition which if the English-speaking race stops away will be a miserable failure. We are but echoing the sentiments of thousands of our fellow countrymen when we say that a very little more of the pinpricking system will divert hundreds of thousands of pounds from France into other directions.

Coming back to homely things, we venture to assert that the most important problem for solution is that which defines the aim and scope of municipal action. There are those of our contemporaries whose policy is merely that of the mugwump—sitting on the fence till they see on which side the cat jumps. We know what tune to expect from a political paper when we know its colour, but half the non-political papers in the kingdom would sell their editorial souls to the devil for sixpence or an advertisement. It seems to us that the duty of the

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non-political Press is to earnestly endeavour to arrive at the truth, and not to pander to the direction which for the moment seems to pay best. It should look ahead, and try to indicate the right direction in which to move, so that as little capital be lost as possible and little time wasted. The fact existing that there is no definite opinion expressed as to what should and what should not constitute municipal enterprise, means that time and money are both being wasted right and left. Old municipal views are giving place to new, and the view that a municipality should be master within its own boundaries is passing away, never to return. Many operations, to be most successful, must now extend over areas not artificially limited within municipal boundaries. This is to be seen from an examination of waterworks, gasworks, electric light works, power works, and tramway schemes. Few have attempted to examine into the limit of municipal operations; only those feeling the pinch have been active in the matter, yet, like with a fire, what might be easy to do in the earlier stages, becomes more and more difficult as time rolls on. We do not believe the question can be solved by considerations of the concrete, but we do believe it capable of solution from another standpoint. There is no good to be served by painting black all members of corporations, and as incapable of justly considering the effects of their actions as other men; and to contend that all their work is uneconomical, wasteful, or carried on to serve self in pelf or position, is to dub all humanity as bad. Let it stand out clearly and unmistakably that the members of governing bodies of towns are trustees, and trustees only, then surely their duties can be fairly rigidly defined. The common tongue is the tongue of all, the common good is the good of all, and all who participate in the common good should pay according to their means. We hold that in no case is it the duty of a corporate body to tax one portion of the community for the benefit of another portion. The definite limits, whenever and however defined, will necessarily be of the nature of a compromise around a border line where principles and the line of least resistance touch. It is somewhat immaterial as to what shall in practice be defined as the limits of action, but while the present indefinite state of affairs continues capital is harassed in a number of directions, and the waste of time, temper, and money is deplorable.

Just a few words with regard to Governmental procrastination. Quite recently we mentioned that although a Bill was carried two sessions ago, licenses have not yet been granted to towns desiring local control of telephones. But this is not the worst phase of Government backwardness. For years pressure has been exerted to obtain what may be termed a system of strategic cables. If we have not felt the want of such cables during the past few months, we never shall. Our military movements are better known to our enemies than to folks at home, and there is no help for such a state of things while messages must be sent by the ordinary method. If we had had a strategic cable to the Cape, other cables would have been cut, and the world must have waited the best way it could. It would have survived, and, if it had not—well, perhaps the millennium would have commenced. Nothing will move a Governmental department except the loss of votes at the polls, or a reverse to our arms, traced home to the idiotcy of red-tapeism, and the system which survives in every Government office of having no person responsible for anything. Had our Government cared, we should not be now without at least the commencement of such a strategic system. Of course, such a system would be in addition to what might be termed the commercial system, and in such cases as that now existing at the Cape the commercial system would only suffer at the one point; at all other points it would be allowed to work as usual.

In light and power matters, things would have gone smoothly and swiftly had not war come along. The existing state of affairs will assuredly have an influence upon the getting of capital, hence many ventures may be delayed for a time. The engineering problems confronting us here are merely those brought about by development—larger units, larger stations, longer distances, greater economy. The solution of some of these problems depends largely upon the settlement of the municipal question. It is now an almost universally recognised fact, that if tramways are necessary at all, the best mode of traction to be used thereon is electrical.

REVIEWS.

Central-Station Electric Supply. By ALBERT GAY, M.I.E.E., and C. H. YEAMAN, A.I.E.E. Whittaker and Co. 10s. 6d.

The book before us is called an introduction to the study of central-station electricity supply, and forms a valuable addition to the "Specialist" series of technical books issued by the publishers. In central-station working and also in the design of the Islington electricity works the authors have had very extended experience, and they are in consequence able to write as experts on the subject. They are, however, hampered in their task by the excessively wide range which they have attempted to cover, and we think that the book would be rather more valuable if certain attempts at detailed descriptions of electrical machinery had been omitted in favour of more expert opinions on the relative advantages of the different classes of such machinery. In the introduction it is pointed out that since the early days experts have agreed to differ as to the best system of electric lighting, and the authors state that they think this has hampered the progress of the industry considerably. We quite agree with them that in the battle of the systems too much stress was laid by certain manufacturers on the advantages of the class of machine which they manufacture, and that in consequence certain supply stations were equipped with unsuitable machinery. In spite of this, reliable expert opinion on the subject has always been obtainable, and we note that the value of the work of the consulting engineer in this respect is recognised by the authors. The first chapter of the book deals with the history and present position of electricity supply, and, finally, takes up the commercial aspect of electric lighting undertakings. The second chapter is devoted to the rules and regulations which affect electric supply, and to the procedure which has to be taken in order to obtain a provisional order from the Board of Trade. The authors then plunge into the real subject of the book, and give some most valuable hints on the choice of a system, the site, and the general considerations which affect the design of buildings to contain electrical machinery. Different methods of charging for electrical energy are then described in detail, together with the object of the

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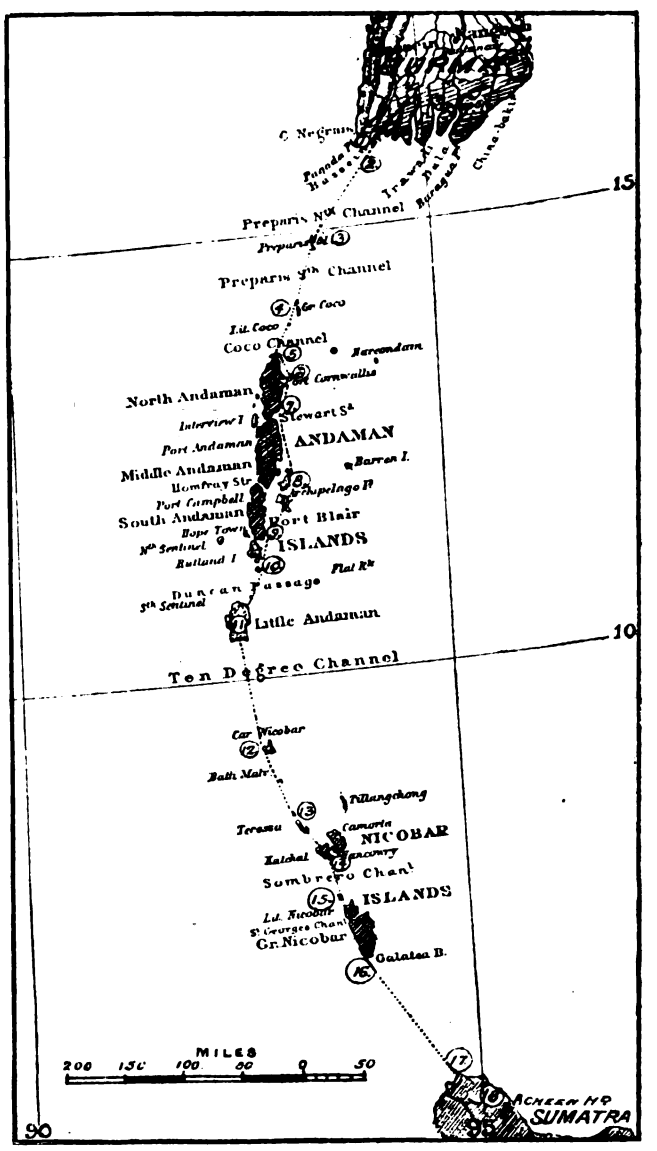
same, in encouraging profitable consumers to take up the light. The regulation of the pressure with different systems of supply is then gone into, and the ground appears to us to be fairly well covered. When speaking, however, of the means of balancing the load of a three-wire direct-current system, undue prominence is given to the use of a double wound armature running in a single field-magnet system. This, we are told by the authors, is most commonly used, in spite of the fact that it is not a convenient arrangement on account of the pressure falling on the heavily-loaded side. To avoid this, it is suggested to add accumulators as well for regulating purposes, but we think that even then the arrangement is not so good as using independent machines with their shafts coupled together. The arrangement described by the authors necessitates hand regulation, which can be to a large extent avoided if independent balancers are used. The various systems of supply using transformers of either the direct-current or alternating-current type are fully gone into, and we are pleased to see that the practice of placing alternate-current transformers in boxes in the streets is most strongly advocated. The vexed question of the best system of steam-pipes is duly considered after a small section devoted to boilers, but the diagrams given in connection with the steam-pipe arrangements lose somewhat in value from the fact that they are drawn on the assumption that the individual engines and boilers are of equal capacity, and that the space occupied longitudinally is the same. Under this assumption steam-pipe arrangements can be made much more simple than is the case when a number of boilers have to be grouped together to supply a single engine. The drainage of and provision for expansion in steam-pipes is well considered, and valuable hints are given as to the best design for a system of feed pipes. We should like to have seen figures given to illustrate the advantage of superheating, to which only a few paragraphs are devoted, and the relative advantages of the different systems of condensing could also be amplified with advantage in future issues of the book. In the section devoted to the electrical equipment of the station we notice that no definite opinion is expressed on the vexed question of the excitation for an alternate-current station. The various systems of connections are referred to, but sufficient stress is not laid on the effects of the failure of the excitation of one machine working in parallel with a number of others. When, however, the authors come to the switch gear and regulating appliances we find evidences of careful arrangement, and due consideration is paid to those faults in design which usually cause trouble on switchboards. We notice that the employment of light fuses during the day time is advocated, in spite of the risk that these may be inadvertently left in circuit when the load comes on suddenly. The sections devoted to the work on the mains is good, and we have nothing but praise for the section dealing with street-lighting. On the whole, we consider that the volume is a most useful addition to the literature on electric lighting matters, and are sure that if more space was at their disposal the authors would be pleased to rectify the few shortcomings of the book to which we have called attention.

WIRELESS TELEGRAPHY AND THE ANDAMAN AND NICOBAR ISLANDS.

In the course of a very interesting paper read by Colonel R. C. Temple before the Society of Arts, the subject of which was the Andaman and Nicobar Islands, the value of telegraphic communication between the Andamans and India was dealt with very fully. The author stated that the territory under the control of the Chief Commissioner of the Andamans and Nicobars consists of a string of islands about 600 miles long, running north and south down the Bay of Bengal. The extreme south point of the Nicobars is about 100 miles from Sumatra, and the extreme north is rather farther from Burma. Between these points, however, are numerous other small islands and reefs. These, it is thought, will enable telegraphic communication to be established between the principal islands and the mainland. The idea of this communication is of great importance, as these islands can then be used as meteorological stations, and warning of the formation, strength, and direction of severe storms or cyclones can be given to the shipping in the Bay of Bengal. It was then pointed out that telegraphic communication could be set up along the whole line of islands, either by wireless telegraphy, or its combination with the ordinary overland wires on the islands. At Diamond Island, just off the coast of Burma, to the north of the map, is an important telegraph station, much used by ships awaiting orders, etc. From Diamond Island to the Alguada Reef, where there is an important lighthouse, is only 10 miles; thence to Preparis Island, the distance is 55 miles; thence to the Cocos Islands, where is another important lighthouse, it is 45 miles; thence to Landfall Island, it is 30 miles. At



Map of Andaman and Nicobar Islands, showing possible Telegraph Stations.

this latter island there is a long, closely-connected string of islands, along which ordinary wires could be stretched to Port Blair, a distance of 150 miles. Communication southwards from this point could be extended to the south of Little Andaman with the help of wireless telegraph stations, these never being more than 25 miles apart. From the Little Andaman to Car Nicobar, the longest sea distance is encountered, this being about 70 miles. The distances onwards are not great, these being: to Chowra, 40 miles; thence to Nancowry, 20 miles; thence to Little Nicobar, another 20 miles, from which place it is only 30 miles to Parsons Point, in the extreme south of the Great Nicobar. The meaning of all this is that the greatest sea distance to Port Blair is 55 miles, and onwards to the Nicobars it is 70 miles. To extend the line of communication across to Sumatra, the distances would be about 60 miles to Pulo Brasse, and then 15 miles to Acheen Head, whence communication should be easy with Singapore.

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Thus it will be seen that the greatest sea distance to be encountered at no time exceeds 70 miles. Colonel Temple states that on conferring with Mr. Marconi and other experts in wireless telegraphy, and also from his own observations, he has found that anything under 100 miles is not impracticable for wireless signals, and that 55 miles is an easily feasible distance. In this way a line of telegraph stations could be run down the whole length of the Andamans and Nicobars, even if Sumatra were not connected, and each of these stations could without difficulty be turned into a meteorological reporting station. The cyclones which at present are such a danger to the shipping in the Bay of Bengal, and which, although very seldom doing any damage on the islands, in the bay make their presence felt there some four or five days before any part of the Indian Coast is touched, could thus be reported, and shipping prepared to meet them, thus saving a large amount of shipwreck and loss of life. The extension of the line to Sumatra and so on, mentioned above, would, of course, involve co-operation with the Government of Dutch East India, but it is very possible that an arrangement might be come to in the matter. The map which we give above shows the proposed positions of the telegraph stations as referred to by the author.

BANBURY ELECTRIC LIGHTING.

At a special meeting of the Town Council of Banbury held before Christmas it was decided to give the Council's consent to the application for a provisional order for electric lighting by the Electrical Power Distribution Company now before the Board of Trade. The rival applicant for a provisional order was the Edmundsons' Electricity Corporation, Limited, who applied on behalf of the Urban Electrical Supply Company, Limited. After an extended debate, however, it was decided to give consent to the first application, on the Electrical Power Distribution Company undertaking to insert the following terms in the order: "That the company will pay all the expenses incurred by the Council in connection with the granting of the order and any necessary agreement with the company. That the prices to be charged by the company shall be as follows: For lighting—The Brighton system of charging to be adopted, and the charge for the first hour to be 7d. per unit and all subsequent supply 2½d. per unit, and the company also to agree that if, after the first complete year of working, it is found that the average price of the supply exceeds 5d. per Board of Trade unit they will, for the following year, make a reduction calculated to bring the price to that figure. For power—The system of charging is to be as above, the charges being 7d. per unit for the first 100 hours and 2d. subsequently, with a provision for reduction in the terms of the last preceding clause substituting 2d. for 5d. The Council are to be entitled to purchase the undertaking upon the expiry of two years' notice, given at the end of 12 years, or of subsequent periods of seven years, at a value to be fixed by independent valuers. Provided that in case the company does not, within the first period of seven years, make a reduction in the tariff equal to 10 per cent. on the average price of the general supply, then the Council shall be entitled to acquire the undertaking on the above terms on the expiry of two years' notice given at the end of the seventh year. The company are to adopt the low-pressure system of supply. Street work in connection with the underground mains is to be carried out to the satisfaction of the Council, or the Council are to have the right to do the necessary replacements at the expense of the company. The same rates to be charged for electric current required for public street lighting as to ordinary consumers for power. The Council, however, are in no way pledged to make use of electricity for street-lighting, the question being simply one of cost and competition."

From the discussion we gather that the other company offer to supply lighting at 6d. per unit, and the two members of the Council who proposed and seconded the amendment made a strong point of this. In doing so they neglected the fact that the average price per unit under the accepted system is guaranteed to be under 5d. per unit. As only two members were in favour of the Council undertaking the supply themselves, we think that they have done well in getting such good terms from a company, as it must be remembered that Banbury is a comparatively small place.

THE ECONOMICAL GENERATION OF STEAM POWER.

BY B. A. TAPP.

The production of steam power has of late years assumed an important position among the multifarious commercial undertakings of municipal bodies, and more especially the economical production and utilisation of heat for conversion into electrical energy. This latter condition will be more readily appreciated when it is stated that some 200 electrical generating stations are in operation for lighting and tramway purposes, employing in round numbers 150,000 i.h.p. The coal consumption estimated approximately would reach a total of about 1,000,000 tons annually. The declining century has witnessed practically the whole of the evolution of the steam boiler and engine, and the thousand and one delicate mechanisms which the age of invention has developed to improve their performances.

It is with some of these more recent devices for improving the efficiency of steam producers that I intend to deal, and make some record of their performances when obtainable. Many engineers have formed their opinions under circumstances which premise dissatisfaction, for after adding to their plant some reputed improvements they have been rewarded with failure, sometimes due to ignorance on the part of the operator, and not infrequently due to insufficient consideration of the circumstances of adoption. The writer is of opinion that satisfactory results could be guaranteed if the latter qualification received more attention. Some of the recorded results will no doubt provoke the customary deprecating smile from the unsatisfied one, but the writer would remind them that expert advice might reveal some flaw in their arrangements. It may be taken, roughly, that the proposed annual economy must somewhat exceed the combined sums of interest on outlay, depreciation, and repairs per annum. But few years ago the Lancashire boiler was practically in possession of this important field of heat conversion, and its still undoubted good qualities enable it to successfully compete at the present day, but of necessity it has been fitted with many extra contrivances to make up for its shortcomings. These contrivances are usually in the form of mechanical stokers, with and without forced-draught attachment, forced or induced draught (produced by means of steam-jet or fan), feed-heaters, circulators, economisers, and superheaters (generally built into the flues in close proximity to the boiler). In competition with the Lancashire boiler and its modern accessories many rivals have appeared, principally taking the form of water-tube and multitubular boilers, having independent firegrates fixed in brickwork underneath them. These are notably rapid steam-raisers, and possess, among many well-known features, those of ease of transport, compactness, and, in the case of water-tube boilers, freedom from serious explosion.

Recently another system of economising fuel has been adopted by several municipalities—*i.e.*, refuse furnaces. The objects to be attained were, however, twofold, as primarily they were introduced to consume refuse for which no use could be found, and which was accumulating in such quantities as to require a large area for storage. The secondary object has been successfully attained: the furnaces worked with forced draught, maintaining full steam pressure. In some cases no coal is used, and the cost of generation of steam is in these cases practically reduced by the amount of the coal bill. In all cases where these furnaces are in operation for the generation of electrical power, provision is made for ordinary coal firing.

As it is intended to devote some space to this subject later, we pass on to a consideration of the conditions in which we find steam plants in general use. For the most part we see all classes of boilers fitted up with one or

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another of the devices mentioned, with a view to increasing fuel consumption per square foot of grate and evaporation per pound of coal. Many tubular boilers are being fitted with mechanical stokers, forced draught, and economisers, although it is doubtful whether forced draught, increasing, as it does, wear and tear at an alarming rate, tends towards economy in the end. Our means of promoting economy do not, however, end here, as supplementary appliances for the handling of fuel, ashes, etc., and for supplanting manual labour are daily gaining favour. Such appliances are bucket, belt, and worm conveyors and elevators, which, if suitably arranged to carry and distribute fuel to any desired point with a minimum of attention, invariably prove a substantial investment.

Having briefly recorded the lines on which many modern steam-producing plants are installed, the writer proposes to give a brief *résumé* of figures, etc., relating to various economies accruing from the adoption of one or other of the devices and arrangements previously mentioned. It will be noted that no attempt is made at detailed description, although general particulars are given and diagrams, where in the author's opinion these were necessary.

Economisers are of various types, some emanating from America, but all more or less following the well-known apparatus of Messrs. Green and Son. The resulting economy from heating feed water in this apparatus is so well known as to hardly call for comment. Yet as the economiser of to-day occupies the premier position among machines for utilising the residual gases from boiler furnaces, over 200,000 boilers having been equipped, some record of its well-tried service is essential. Briefly described, it consists of series of cast-iron pipes arranged in sections of different widths to suit available accommodation, and placed vertically in the flues leading to the chimney. The pipes are usually about 4in. internal diameter and about 9ft. long (depending on available height), and are connected together by top and bottom boxes and branch pipes. The exteriors of these pipes are cleaned of soot by means of scrapers attached to chains, and worked by suitable overhead gearing, the motive power for which can in electric light stations be conveniently obtained from a motor suitably geared. The feed water is forced through the economiser on its way to the boiler, and absorbs heat from the passing gases. The saving in fuel varies from 15 to 25 per cent. Appended is a table (A) showing percentage saving of fuel by heating feed water (steam at 60lb.), also a table (B) showing comparative tests, etc.

It may be taken that an average saving of 1 per cent of fuel results from every 10deg. F. that is added to the temperature of feed water, but the saving is proportionately greater the lower the temperature of the entering feed water. The resulting temperature of feed may be as much as 300deg. in favourable conditions, as the residual gases attain upwards of 700deg. It is not usual to cool the escaping gases below 300deg., as this temperature is necessary to create a chimney draught. Every economiser installation should be provided with an independent by-pass flue, so that in the event of breakdown the gases can be turned straight up the chimney; also in large installations the tubes should be arranged in nests of convenient width for easy manipulation and of moderate size, each nest to be capable of cutting off from the remainder when for any cause it may become necessary. All economisers are fitted with blow-off valves, by which means they rid the feed water of much sediment, etc., also safety valves are fitted to relieve any excessive pressure. From the foregoing it will be seen that a good economiser should at

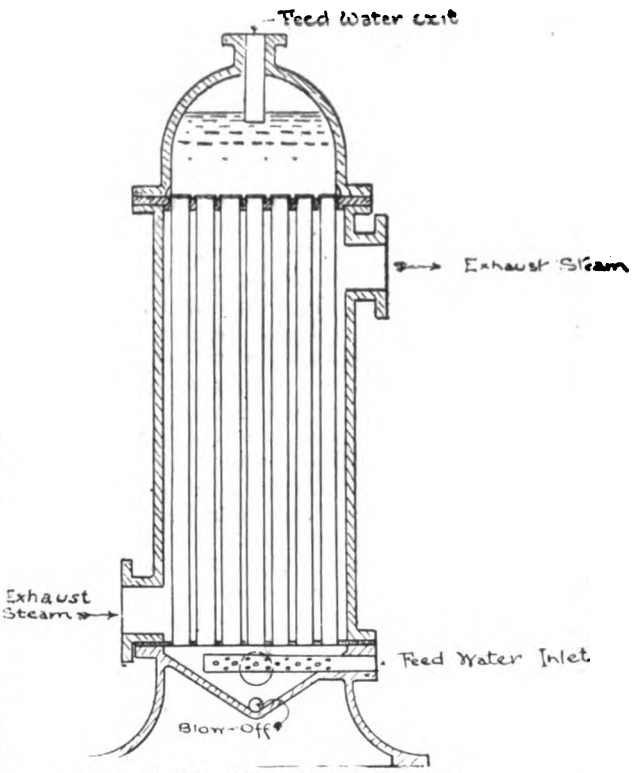

FIG. 1.—An Exhaust Steam Feed-Water Heater.

TABLE A.—Percentage of Saving of Fuel by Heating Feed Water. Steam at 60lb.

Final temp.	Initial temperature of water. 32°	40°	50°	60°	70°	80°	90°	100°	120°	140°	160°	180°	200°
60°	2·39	1 71	0·86	0									
80	4·09	3·43	2·59	1·74	0·88	0							
100	5·79	5·14	4·32	3 49	2·64	1·77	0·90	0					
120	7·50	6·85	6 05	5·23	4·40	3 55	2·68	1·80	0				
140	9·20	8·57	7·77	6·97	6·15	5·32	4·47	3·61	1·84	0			
160	10·90	10 28	9 50	8·72	7·91	7·09	6 26	5 42	3 67	1·87	0		
180	12·60	12·00	11·23	10·46	9·68	8 87	8·06	7·23	5 52	3 75	1·91	0	
200	14·30	13·71	13 00	12·20	11 43	10 65	9·85	9·03	7·36	5 62	3 82	1·96	0
220	16·00	15·42	14·70	14·00	13·19	12·33	11·64	10·84	9 20	7 50	5 73	3 93	1·98
240	17·79	17·13	16·42	15 69	14·96	14 20	13·43	12·65	11·05	9 37	7 64	5·90	3·97
260	19·40	18 85	18·15	17·44	16·71	15 97	15·22	14·45	11·88	11·24	9·56	7·86	5 96
280	21·10	20 56	19 87	19·18	18·47	17 75	17·01	16·26	14·72	13 02	11·40	9 73	7 94
300	22·88	22·27	21 61	20·92	20 23	19·52	18·81	18 07	16·49	14 99	13·37	11·70	9·93

TABLE B.

	Economiser working.	Economiser not working.	Economiser working.	Economiser not working.
1. Duration of test (hours)	11·5	11·5	11·5	11·5
2. Weight of dry coal consumed (lbs.)	8,743	9 694	7 856	10,282
3. Percentage of ash and refuse	7·5	7·7	8·0	8·4
4. Weight of coal consumed per hour per square foot grate surface (lbs.)	15·2	16·8	7·6	9·9
5. Weight of water evaporated (lbs.)	84,078	82,725	72,002	72,959
6. Horse-power developed on basis of 30lb. per horse-power fed at 100deg. and evaporated at 70lb.	247	243 5	210·3	213·6
7. Average boiler pressure (lbs.)	68·2	67·2	58·0	57·4
8. Average temperature of feed water entering economiser (deg. F.)	84·2°	—	88°	—
9. Average temperature of feed water entering boiler	196·2°	82°	225·2°	85·2°
10. Number degrees feed water was heated by economiser	112°	—	137·2°	—
11. Average temperature of flue gases entering economiser	435°	—	818°	—
12. Average temperature of flue gases entering chimney	279°	452°	365°	645°
13. Number of degrees flue gases were cooled by economiser	156°	—	253°	—
14. Pounds of water evaporated per pound of coal	9 617	8·533	9·165	7·096
15. Equivalent evaporation per pound of coal from and at 212deg.	11·204	9·955	10·613	8 235
16. Percentage gained by using the economiser	12·5	—	28·9	—
	The steam in this test contained 1·3 per cent. of moisture.		The steam was superheated about 50deg. in these tests.	

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any time be able to supply a fair volume of water at about evaporation point, and thus, owing to the reduction of range of temperature to which a boiler may be subjected, tends to prolong its days; it also relieves the feed water of sediment and decreases the coal consumption.

Before leaving the subject of feed water we must glance at another form of heater in general use, more especially for small powers and where condensation is out of the question. Such apparatus, under the name of feed-water heater, usually consists of a series of brass tubes, through which the feed water is pumped, the exhaust steam from the engine being made to circulate round these tubes and so deliver up some of its heat to the cooler water. The converse of this arrangement is sometimes adopted. An undoubted advantage of this type of heater is its purifying effect on feed water, especially where it contains chalk and other insoluble impurities, which can be blown off as in the economiser. Experience has proved that every square foot of tube surface raises about seven gallons of water per hour from the normal temperature (about 60deg. F.) to 200deg. F. The appended table gives the approximate amount of water per hour which heaters of various sizes (by a well-known maker) will raise to 200deg. F. from the normal temperature:

Diameter of exhaust pipe.	Gallons per hour.	Approximate square feet of heating surface.
3	140	20
3½	200	28
4	250	40
4½	390	55
5	500	71
6	600	86
7	850	135
8	1,050	150
9	1,300	186
10	1,600	228
11	2,000	286
12	2,600	371
14	3,300	471
16	4,000	571
18	4,800	686
20	6,000	857

A total saving of 15 to 25 per cent. may be expected from a good feed-water heater. This may not appear at first sight, but increased boiler life, purer water, etc., will account for a portion. It must be remembered, however, that a free exhaust is necessary to the economical working of a steam-engine, and the introduction of anything which tends to interrupt the free passage of exhausting steam also tends to increase back pressure in the cylinder and correspondingly diminish the effective pressure. Many feed-water heaters of excellent design are on the market, such as the "Berryman," "Normandy," "Kirkaldy," "Royle's," etc., all of which have special constructional features of their own. A cheap and effective type of heater for small powers is built on the lines of the accompanying diagram (Fig. 1).

(To be continued.)

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

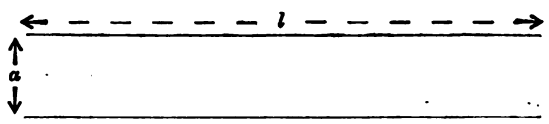
233. Which do you consider best, over or under ground sub-stations for transformer distribution, or single transformers in street boxes?—F. L.

234. Make a list of the causes tending to produce excessive noise or vibration in a dynamo. Name the simplest remedies you know in the various cases.—J. C. R.

ANSWERS.

Question No. 227.—Show how the total inductance in henrys of either a three-wire overhead or a three-core underground cable may be calculated for a triphase current of known periodicity and amperage. State the inductance for each line wire.

Best Answer to No. 227 (*awarded* 10*s.*).—It has been calculated by Maxwell that the values of the coefficients of self and mutual induction for two wires, diameter 2ρ, length l, distance a apart, but not joined to form a closed circuit, is as follows:



(All dimensions in centimetres.)

Coefficient of self-induction—

$$L = 2l\left(\log_e \frac{2l}{\rho} - 0{\cdot}75\right);$$

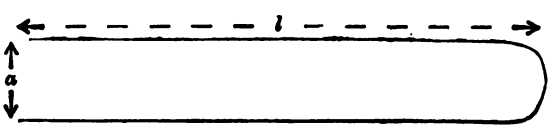
Coefficient of mutual induction—

$$M = 2l\left(\log_e \frac{2l}{a} - 1\right).$$

The total inductance is the algebraic sum of L and M—*i.e.*,

$$L - M = 2l\left(\log_e \frac{a}{\rho} + 0{\cdot}25.\right.$$

If the circuit is closed thus,



then the total inductance is $4l\left(\log_e \frac{a}{\rho} + 0{\cdot}25\right)$.

In determining the value for *each wire of* a three-phase overhead line, where all three wires are equidistant from one another, thus forming an equilateral triangle, the above expression must be multiplied by $\frac{\sqrt{3}}{2}$, thus we have

Inductance of each wire

$$= \sqrt{3} \cdot 2l\left(\log_e \frac{a}{\rho} + 0{\cdot}25\right) \text{ C.G.S. units.}$$

Multiply this formula by 10^{-9} to obtain the result in henrys.

For all practical purposes the above formula will hold good for a three-core cable, though it is more accurate when the ratio of the distance between the wires to the radius of each wire is great. The drop in a three-core cable due to inductance is generally negligible, so that any small inaccuracy in the formula is of no account. On overhead lines for high voltage, where the wires are, say, 5mm. diameter and 300mm. apart, the inductance drop cannot be neglected without serious error. The value of the inductance depends on the length, diameter, and distance apart of the wires, and not upon the amperes and periodicity of the current. If the above formula has a value H in henrys, then $2\pi \sim H$ is the value of the reactance, where $\sim$ is the periodicity of the current. Multiplying this by the current in amperes, we obtain the drop in volts due to the reactance in each wire.—I. E. T.

Answer to No. 227 (*awarded* 5*s.*).—The henry is known as the coefficient of self-induction, and is equal to the total C.G.S. lines of force produced in a circuit by one C.G.S. unit of steady current multiplied by the number of turns and divided by 10^9; if the current is in amperes, the divisor will be 10^8. The relation existing between the henry and the total inductance, etc., of a single current, is shown by the following formulæ:

Where A = virtual amperes = $\sqrt{\text{mean square amperes}}$; E = virtual reactance volts; $\sim$ = periodicity; L = henrys; I = total inductance of circuit; $\pi = 3{\cdot}141$; R = volts lost due to ohmic resistance of circuit; and E_1 = virtual E.M.F. registered to overcome R and E:

$$I = 2\pi \sim L;$$

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$$\therefore L = \frac{I}{2\pi \frown\!\!\!\!\sim};$$

$$E = 2\pi \frown\!\!\!\!\sim L A = I A;$$

$$E_1 = \sqrt{R^2 + (2\pi \frown\!\!\!\!\sim L A)^2} = \sqrt{R^2 + E^2}.$$

It will be seen that the chief difficulty is in calculating the value of L. We will first consider its value for an ordinary alternating-current circuit consisting of an outgoing and returning cable. It is best to take a long length as the unit and calculate the total inductance, etc., in terms of the length chosen. In the following 2,000ft. of cable is taken as the unit—*i.e.*, 1,000ft. of double wire:

$$L = \frac{\cdot 9575 + 8\cdot 82\ K}{10^4 \times \pi}$$

per 2,000ft. of cable,

where K = the common log. of

$$\left(\frac{\text{distance between centres of wires}}{\text{radius of wire}}\right).$$

To make the matter clear, take the following example: Let diameter of copper wire = ·3in.; distance between centres = 12in.; total length of cable, 4,000ft.; virtual amperes = 50; frequency = 60; lost volts due to ohmic resistance = ·461 × 50 = 23; then

$$K = \log\left(\frac{12}{\cdot 15}\right) = 1\cdot 9;$$

$$L = \left(\frac{\cdot 9575 + 8\cdot 82 \times 1\cdot 9}{10^4 \times 3\cdot 141}\right) \times \frac{4{,}000}{2{,}000} = \cdot 00113 \text{ henry.}$$

$I = 2\pi \frown\!\!\!\!\sim L$, $= 2 \times 3\cdot 141 \times 60 \times \cdot 0013$, $= 426$.

$E = I A$, $= \cdot 426 \times 50$, $= 21\cdot 3$ reactance volts.

$E_1 = \sqrt{R^2 + E^2}$, $= \sqrt{23^2 + 21\cdot 3^2}$, $= 31\cdot 3$ volts registered to overcome R and E.

It will be seen from the value chosen for R that in the above example E_1 is the E.M.F. registered to overcome the resistance of the cable and its inductance; it will also be noticed from the formulæ that the reactance E.M.F. is in quadrature of 90 with the E.M.F. due to ohmic resistance.

If the circuit is three-phase with three wires, and they are arranged as an equilateral triangle, the above values will hold good for each of the circuits if same value of current, etc., is taken, and in place of total length of cable two-thirds of its length is taken.

The self-induction of ordinary concentric cable is practically negligible, and, as far as the writer is aware, a three-core concentric cable is the same. To calculate the inductance of a single cable use the same formulæ as for two wires with a very big distance between centres. This, of course, is not quite accurate, but it will be seen from the formulæ that beyond a certain distance the error is practically negligible.—F. W.

Question No. 228.—Boilers and steam-pipes are usually tested by water pressure. What advantage is there in this case over testing with steam pressure?

Best Answer to No. 228 (*awarded* 10*s.*).—To those who have not been used to it, it may appear madness to test boilers or steam-pipes first by steam to ascertain if it is safe at 50 or 25 per cent. lower pressure. To a certain extent this is done, and once was common practice in boiler works. This really means an attempt to explode a boiler in the boiler yard to see whether it will burst then or at the works of the purchaser. In favour of testing by steam, it is argued that it is the only method by which the conditions of strain can possibly be the same as those under which the boiler is worked. This may be so, but the steam test should only be applied after the strength of the boiler has been ascertained by testing with water. There are many who object to hydraulic testing on the ground that it does not tell the actual strength of the boiler after all. But the same objections may be urged against a steam test, and the reply to this objection is twofold: (1) the test is not meant for perfectly sound boilers, but to detect weakness, and for the safety of the boilers at its working pressure; (2) in order to test the actual strength of a boiler we should have to burst it, or to strain it so far as to render it useless, which, of course, no sane person would demand for a boiler he intends working. As to whether a boiler is strained most severely by steam or by water pressure, this will resolve itself almost entirely into a question of construction. A boiler under steam is often strained, especially longitudinally, more by the greater dilation of the tubes compared with the shell, or by the unequal expansion of the top and bottom of the shell than by the actual fluid pressure; in fact, it would not be difficult to design a boiler that would explode with 30lb. or 40lb. steam pressure and not be unduly strained by 200lb. or 300lb. water pressure. The persistent leakage at the shell ring seams is usually ascribed to the difference in temperature of the water and steam at the bottom and top of the boiler, but in some cases the leakage is principally caused by the longitudinal straining of the bottom of the shell due to the greater expansion of the tubes, especially with forced firing in getting up steam after the boiler has been at rest. As this straining would not take place in testing by water in the usual manner, this leakage would not be produced. It follows from the above considerations that a hydraulic test might fail to indicate weakness which would be made apparent by steam pressure. It is often much more difficult to keep a boiler perfectly tight, and free from oozing at the rivets, plate edges, stays, and tube ends under a high water pressure, than under an equal pressure of steam. It is sometimes urged that the severe percussive or dynamic force produced by the sudden raising of steam by hard firing, or by suddenly opening and shutting the valves and cocks, strains a boiler more than the dead static pressure supposed to be exerted in employing the hydraulic test; but instead of the hydraulic test being a mere dead pressure, the rapid working of the pump often produces a severer sudden strain than is produced when there is an elastic cushion of steam in the boiler. Although hundreds and thousands of boilers have successfully passed the steam ordeal, the principle is inherently bad, and no amount of success which hitherto may have attended it can render the practice justifiable.—A. B.

Answer to No. 228 (*awarded* 5*s.*).—The advantage of testing steam boilers and pipes by means of steam pressure is quite apparent, for by doing this we should subject the boiler or pipe to the same strain and under similar conditions to those which would occur in actual working. Thus it appears that steam is the most efficient pressure to employ for the test, but there are practical objections which prevent its use. Briefly stated, it is far too dangerous; a little consideration will render this perfectly clear. In testing boilers it is necessary, if the test is to be of any real value, to make very careful observations of the boiler during the various stages of the test—that is to say, the pressure must be gradually increased up to the required value, and full particulars of any bulging, elongation, or permanent set accurately noted, and in order that this may be accomplished in safety some pressure must be employed that will cause no serious explosion should any sudden failure of the material to stand the strain upon it occur.

The actual pressure which a boiler when under test has to stand above its ordinary working pressure varies considerably. The Board of Trade and some insurance companies require them to be tested to double their working pressure. The disastrous results attending the collapse of a boiler under steam at the pressures now commonly adopted are so great that every precaution must be taken to prevent such an occurrence, and considering that these pressures have to be, say, doubled for testing purposes, it is obvious that the use of steam for testing is far too risky, and that some other power must be found to give, as far as possible, a true indication of the sufficiency of a boiler. Hydraulic pressure is very well adapted for the purpose, as the pressure can be gradually pumped up to the required value without any danger should a defective part give way, and thus all necessary gaugings, etc., can be taken in safety. Owing to this, and the fact that water is generally readily obtainable, hydraulic pressure is almost exclusively used; but while such a test is of the greatest value, it must not be taken as absolutely reliable, as boilers have collapsed soon after being tested to double their working pressure. Consideration must also be given to the fact that with the hydraulic pressure the strain upon the boiler is equal at all parts, whereas when under steam the material will be required to withstand the

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further strain of unequal expansion, due to the different temperature of the water at various parts of the boiler. Finally, the hydraulic test must in no case take the place of a thorough examination at regular intervals.—F. A.

Answer to No. 228 (*awarded* 5*s.*).—A series of tests should always imitate as far as possible actual working conditions. In addition to standing an outward stress due to pressure contained within, a boiler has to be so constructed as to be leak-tight under steam pressure and at the temperature of the steam. A water test certainly does not show this decisively, as water can ooze through where steam does not escape, and the temperature difference between hot steam and cold water allows joints which are apparently dangerously leaky under water pressure to become perfectly steam-tight. Again, a continuous run of, say, six hours of a boiler and pipework under normal steam pressure brings into prominence other points besides resistance to pressure. It shows whether the boilers have a tendency to prime, what parts of the boiler are liable to dangerous heating, whether all joints are properly made and of suitable materials. It enables finishing touches to be put to the work, such as adjusting glands, following up bolts on rubber joints, etc. All fittings (safety valves, high and low water indicators, etc.) are in place, so that the whole system down to the smallest detail is thoroughly tested.

On the other hand, the risks attendant on a steam test with a new boiler or system of pipes are so serious that it seems advisable to have a preliminary water-pressure test. If a boiler or steam-pipe gives way, the room is filled with hot steam (sometimes superheated), scalding attendants and rendering location and manipulation of valves exceedingly difficult. The worst effect of a failure under water pressure is a momentary rush of water at high pressure. For a water-pressure test preceding the steam test the fittings (safety valve, gauge-glass fittings, pressure gauge, etc.) should be removed, and blank flanges screwed to seatings. The pressure should then be forced up to considerably over the normal steam pressure (usually double). The force pump used for this purpose has generally a special pressure gauge attached to it. The boiler or pipes should be kept at this pressure (all air having been removed) for some time, and carefully examined for leaks. The pump should not need more than a stroke or two to maintain the pressure during the whole time of test. The end plates and any stayed surfaces accessible should be gauged for deflection under pressure. If the boiler successfully passes this preliminary test, it can then be subjected to the steam test to determine its actual working behaviour.—J. A. S.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

The following is a complete list of applications for provisional orders deposited with the Board of Trade up to Dec. 21, 1899, under the provisions of the Electric Lighting Acts, 1882 to 1890:

Title of Order and Description of Area.	Name of Promoters.
Allerton, Much Woolton, Little Woolton, Childwall, and Garston Electric Lighting Order.—The Urban Districts of Allerton, Much Woolton, Little Woolton, Childwall, and Garston.	Liverpool District Lighting Company, Limited.
Banbury Electric Lighting Order.—The Municipal Borough of Banbury.	Electrical Power Distribution Company, Limited.
Barmouth Electric Lighting Order.—The Urban District of Barmouth.	The Urban District Council.
Barnard Castle Electric Lighting Order.—The Urban District of Barnard Castle.	Northern Counties Electricity Supply Company.
Barnet Urban District Council Electric Lighting Order.—Portion of the Urban District of Barnet.	The Urban District Council.
Barnstaple Corporation Electric Lighting Order.—The Borough of Barnstaple.	The Corporation.
Basingstoke Electric Lighting Order.—The Borough of Basingstoke.	The Corporation.
Berwick-upon-Tweed Electric Lighting Order.—The Borough of Berwick-upon-Tweed.	Urban Electric Supply Company, Limited.
Birkenhead Corporation Electric Lighting (Extension) Order.—The Townships of Bidston-cum-Ford and Noctorum in the Rural District of Wirral.	The Corporation.
Bishop Auckland Electric Lighting Order.—The Urban District of Bishop Auckland.	Urban Electric Supply Company, Limited.
Bonchurch Electric Lighting Order.—The Parish of Bonchurch, Isle of Wight.	Ventnor Electric Light and Power Company, Limited.
Boston Electric Lighting Order.—The Municipal Borough of Boston.	The Corporation.
Brecon Electric Lighting Order.—The Borough of Brecon.	The Corporation.
Bredbury and Romiley Electric Lighting Order.—The Urban District of Bredbury and Romiley.	The Urban District Council.
Bridge of Allan and Dunblane Electric Lighting Order.—The Burghs of Bridge of Allan and Dunblane.	Urban Electric Supply Company, Limited.
Bridlington Electric Lighting Order.—The Borough of Bridlington.	The Corporation.
Brierfield Electric Lighting Order.—The Urban District of Brierfield.	The Urban District Council.
Brierley Hill Electric Lighting Order.—The Urban District of Brierley Hill.	The Urban District Council.
Broughty Ferry Electric Lighting Order.—The Burgh of Broughty Ferry.	The Commissioners of the Burgh.
Caterham Electric Lighting Order.—The Urban District of Caterham and the Parish of Warlingham in the Godstone Rural District.	Urban Electric Supply Company, Limited.
Cheadle and Gatley Electric Lighting Order.—The Urban District of Cheadle and Gatley.	The Urban District Council.
Cheltenham (Extension) Electric Lighting Order.—The Urban District of Charlton Kings and portions of the Rural Districts of Cheltenham and Winchcombe.	The Corporation of Cheltenham.
Chester le-Street Electric Lighting Order.—The Rural District of Chester-le-Street.	County of Durham Electrical Power Distribution Company, Limited.
Clacton Electric Lighting Order.—The Urban District of Clacton.	The Urban District Council.
Cleckheaton Electric Lighting Order.—The Urban District of Cleckheaton.	The Urban District Council.
Cleethorpes Electric Lighting Order.—The Urban District of Cleethorpes-with-Thrunscoe.	The Urban District Council.
Cobham Electric Lighting Order.—The Parishes of Cobham and Stoke d'Abernon in the Epsom Rural District and part of the Parish of Byfleet in the Chertsey Rural District.	Cobham Gas Company.
Cowpen Electric Lighting Order.—Urban District of Cowpen.	Northern Counties Electricity Supply Company.
Dartmouth Electric Lighting Order.—The Borough of Darmouth.	Urban Electric Supply Company, Limited.
Egremont Electric Lighting Order.—The Urban District of Egremont.	The Urban District Council.
Elland Electric Lighting Order.—The Urban District of Elland.	The Urban District Council.
Enfield Electric Lighting Order.—The Urban District of Enfield.	Urban Electric Supply Company, Limited.
Erdington Electric Lighting Order.—The Urban District of Erdington.	The Urban District Council.
Exmouth Electric Lighting Order.—The Urban District of Exmouth.	The Urban District Council.
Farnham Electric Lighting Order.—The Urban District of Farnham.	The Urban District Council.
Felixstowe and Walton Electric Lighting Order.—The Urban District of Felixstowe and Walton.	The Urban District Council.
Freshwater and Totland (I.W.) Electricity Supply Company, Limited, Electric Lighting Order.—Portion of the Rural District of the Isle of Wight.	Freshwater and Totland (I.W.) Electricity Supply Company, Limited.
Gosforth Electric Lighting Order.—The Urban District of Gosforth.	Newcastle-upon-Tyne Electric Supply Company, Limited.
Gosport and Alverstoke Electric Lighting Order.—Portion of the Urban District of Gosport and Alverstoke.	The Urban District Council.
Grantham Electric Lighting Order.—The Borough of Grantham.	Urban Electric Supply Company, Limited.
Harrow-on-the-Hill Electric Lighting Order.—Portion of the Urban District of Harrow-on-the Hill.	The Urban District Council.
Hebburn Electric Lighting Order.—The Urban District of Hebburn.	The Urban District Council.
Heston and Isleworth Electric Lighting Order.—The Urban District of Heston and Isleworth.	The Urban District Council.
Hyde Electric Lighting Order.—The Borough of Hyde.	The Corporation.

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Title of Order and Description of Area.	Name of Promoters.
Hythe Corporation Electric Lighting Order.—The Borough of Hythe.	The Corporation.
Jarrow, Hebburn, and Felling Electric Lighting Order. — The Municipal Borough of Jarrow and the Urban Districts of Hebburn and Felling.	County of Durham Electrical Power Distribution Company, Limited.
Kendal Electric Supply Order.—The Borough of Kendal.	The Corporation.
Leek Electric Lighting Order.—The Urban District of Leek.	The Urban District Council.
Littleborough Electric Lighting Order. The Urban District of Littleborough.	The Urban District Council.
Liversedge Electric Lighting Order.—The Urban District of Liversedge.	The Urban District Council.
Llandilo Electric Lighting Order.—The Urban District of Llandilo.	The Urban District Council.
Llanrwst Electric Lighting Order.—The Urban District of Llanrwst and portion of the Rural District of Geirionydd.	Llanrwst Electricity Supply Company, Limited.
THE COUNTY OF LONDON.	
Battersea Electric Lighting Order.—Portions of the Parish of St. Mary, Battersea.	County of London and Brush Provincial Electric Lighting Company, Limited.
Lambeth (Part of) Electric Supply Order.—Portion of the Parish of Lambeth.	South London Electric Supply Corporation, Limited.
Limehouse District Electric Lighting Order.—The Limehouse District.	The Board of Works.
Marylebone Electric Lighting Order.—The Parish of Marylebone.	Marylebone Electric Supply Company, Limited.
Mile End Old Town Electric Lighting Order.—The Hamlet of Mile End Old Town.	The Vestry.
St. George-in-the-East Electric Lighting Order.—The Parish of St. George-in-the-East.	The Vestry.
Long Eaton Electric Supply Order.—The Urban District of Long Eaton.	The Urban District Council.
Lytham Urban District Council Electric Lighting Order.—The Urban District of Lytham.	The Urban District Council.
Malton Electric Lighting Order.—The Urban District of Malton.	Northern Counties Electricity Supply Company.
Maryport Electric Lighting Order.—The Urban District of Maryport.	The Urban District Council.
Midland Electric Power Distribution and Lighting (Extension) Order.—The Borough of Smethwick, the Urban Districts of Oldbury, Perry Barr, and Stourbridge, the Township of Upper Penn in the Seisdon Rural District, and the Parish of Bushbury in the Cannock Rural District.	Midland Electric Corporation for Power Distribution, Limited.
Nantwich Electric Lighting Order.—The Urban District of Nantwich.	The Urban District Council.
Neath, Briton Ferry, and Aberavon Electric Lighting Order. — The Municipal Boroughs of Neath and Aberavon, and the Urban District of Briton Ferry.	Electrical Power Distribution Company, Limited.
Newark Electric Lighting Order.—The Borough of Newark.	The Corporation.
Newhaven Electric Lighting Order.—The Urban District of Newhaven.	Rev. H. G. Bonnewell and others.
Nuneaton and Chilvers Coton Electric Lighting Order.—The Urban District of Nuneaton and Chilvers Coton.	The Urban District Council.
Ogmore Valley Electric Lighting Order. Portion of the Urban District of Ogmore and Garw.	Ogmore Valley Electric Light and Power Supply Company, Limited.
Ormesby Electric Lighting Order.—The Urban District of Ormesby.	The Urban District Council.
Ormskirk Electric Lighting Order.—The Urban District of Ormskirk.	The Urban District Council.
Penrith Electric Lighting Order.—The Urban District of Penrith.	The Urban District Council.
Penzance Electric Lighting Order.—The Borough of Penzance.	The Corporation.
Prestwich Electric Lighting Order.—The Urban District of Prestwich.	The Urban District Council.
Pwllheli Electric Supply Order.—The Borough of Pwllheli.	The Corporation.
Ramsgate (Corporation) Electric Lighting Order.—The Borough of Ramsgate.	The Corporation.
Ramsgate Electric Lighting Order.—The Borough of Ramsgate.	Isle of Thanet Electric Tramways and Lighting Company, Limited.
Redcar Electric Lighting Order.—The Urban District of Redcar.	The Urban District Council.
Redruth Electric Lighting Order.—The Urban District of Redruth.	Urban Electric Supply Company, Limited.
Romford Electric Lighting Order.—The Urban District of Romford and the Parish of Romford Rural in the Rural District of Romford.	The Urban District Council.
Royal Leamington Spa Electric Lighting Order.—The Borough of Royal Leamington Spa.	Midland Electric Light and Power Company, Limited.
St. Helens (I.W.) Electric Lighting Order.—The Urban District of St. Helens (I.W.).	Edmund Ironside Bax, Esq.
Sandgate Electric Supply Order.—The Urban District of Sandgate.	The Urban District Council.
Seaford Electric Lighting Order.—The Urban District of Seaford.	Rev. H. G. Bonnewell and others.
Seaham Harbour Electric Lighting Order. — The Urban District of Seaham Harbour.	County of Durham Electrical Power Distribution Company, Limited.
Sevenoaks Electric Lighting Order.—The Urban District of Sevenoaks.	Electrical Power Distribution Company, Limited.
Sheerness Electric Lighting Order.—The Urban District of Sheerness.	Electrical Power Distribution Company, Limited.
Sleaford Electric Lighting Order.—The Urban District of Sleaford.	The Urban District Council.
South Blyth Electric Lighting Order.—The Urban District of South Blyth.	Northern Counties Electricity Supply Company.
Southwold Electric Lighting Order.—The Borough of Southwold.	The Corporation.
Sowerby Bridge Electric Lighting Order.—The Urban District of Sowerby Bridge.	The Urban District Council.
Spennymoor Electric Lighting Order.—The Urban District of Spennymoor.	Northern Counties Electricity Supply Company.
Staines, Egham, and Chertsey Electric Lighting Order.—The Urban Districts of Staines and Chertsey and the Rural District of Egham.	Electrical Power Distribution Company, Limited.
Stamford Electric Lighting Order.—The Borough of Stamford.	Urban Electric Supply Company, Limited.
Sudbury Electric Lighting Order.—The Borough of Sudbury.	The Corporation.
Teddington and Twickenham Electric Lighting Order.—The Urban Districts of Teddington and Twickenham.	Richmond (Surrey) Electric Light and Power Company, Limited.
Thirsk Electric Lighting Order.—The Parishes of Thirsk and Sowerby in the Thirsk Rural District.	Northern Counties Electricity Supply Company.
Totnes Electric Lighting Order.—The Borough of Totnes.	Totnes Electricity Supply Company, Limited.
Tunstall Electric Lighting Order.—The Urban District of Tunstall and the Parishes of Goldenhill and Chell in the Rural District of Wolstanton.	The Urban District Council.
Twickenham and Teddington Electric Lighting Order.—The Urban Districts of Twickenham and Teddington.	Twickenham and Teddington Electric Supply Company, Limited.
Uxbridge and District Electricity Supply Order.—The Urban District of Uxbridge, the Rural District of Uxbridge (except the parish of Northolt), and the Parishes of Iver, Denham, and Gerrards Cross, in the Eton Rural District.	Uxbridge and District Development Syndicate, Limited.
Wallington Electric Lighting Order.—The Parish of Wallington, in the Rural District of Croydon.	County of Surrey Electrical Power Distribution Company, Limited.
Wellingborough Electric Lighting Order.—The Urban District of Wellingborough.	Electrical Power Distribution Company, Limited.
Weybridge Electric Lighting Order.—The Urban District of Weybridge.	Urban Electric Supply Company, Limited.
Whitefield Electric Supply Order.—The Urban District of Whitefield.	The Urban District Council.
Witney Electric Lighting Order.—The Urban District of Witney.	Witney Electric Supply Company, Limited.
Woking Electric Supply Company Electric Lighting Order.—The Parishes of Woking and Horsell and portion of the Parish of Chertsey.	Woking Electric Supply Company, Limited.
Wormit and Woodhaven Electric Lighting Order.—Portions of the Districts of Wormit and Woodhaven in the Parish of Forgan.	Tayside Electric and Gas Light Company, Limited.

DUBLIN ELECTRIC LIGHTING.

We have had forwarded to us a copy of the report prepared by Mr. R. Hammond, consulting electrical engineer, on the proposed extensions of the Dublin electric lighting system and the establishment of a large generating station at the Pigeon House Fort. The report is taken from the *Dublin Evening Mail*, and reads as follows:

I have pleasure in reporting to you upon the cost of (1) laying down an electricity supply works at Pigeon House with capacity sufficient to supply 100,000 lamps of 8 c.p. all alight at one time, or, say, 150,000 lamps fixed on consumers' premises; (2) utilising your present site at Fleet-street as a distributing centre; (3) making an important extension of your distributing mains for private supply; (4) largely extending

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your public arc lighting. I have had the advantage of repeated conferences with Mr. Harty, your city engineer, and with Mr. Ruddle, your electrical superintendent. My first task has been to devise a plan by which the scheme of high-pressure feeding and low-pressure distribution recently designed by Prof. Kennedy shall be completely utilised, and also by which we can avail ourselves to the full of the excellently situated site in Fleet-street as a distributing centre. I have come to the conclusion that the transmission from Pigeon House should be by means of three-phase currents under an E.M.F. of 5,000 volts and with 50 or 60 complete periods per second. I propose three trunk mains of such a section that they could deliver into the distributing centre at Fleet-street an amount of electrical energy sufficient for 100,000 lamps of 8 c.p. all alight at one time, or, say, 150,000 lamps fixed on consumers premises. The system at present in use is the single-phase alternating, the current being supplied to the five sub-stations by five high-pressure feeders at an E.M.F. of 2,000 volts with 83 complete periods per second. I propose to deal with the present system by the conversion at Fleet-street of a portion of the three-phase 5,000 volts alternating to single-phase 2,400 volts alternating. It will be noticed that I raised the pressure from 2,000 volts to 2,400 volts, by which means I increase the carrying capacity of the distributors by 50 per cent., at a cost of about £2,000 for new lamps, etc. The capacity of these distributors is at present 1,695 kw., capable of coping with 56,500 lamps of 8 c.p. alight at one time, or, say, 85,000 fixed on consumers' premises. I deal with the remainder of the energy delivered to Fleet-street from Pigeon House by transmitting it unchanged in phase and E.M.F. to 19 sub-stations. By the plan of running a separate feeder from Fleet-street to each sub-station, the regulation of the pressure at the sub-stations would be rendered extremely simple, and the maximum of safety and efficiency would be ensured. The capacity of the 19 feeders would be 3,681 kw., capable of coping with 126,000 lamps of 8 c.p. alight at one time, or, say, 190,000 fixed on consumers' premises. At the feeding point there would be sub-stations built in convenient spots under the roadway or pathway, and easily accessible therefrom. I propose to build the sub-stations of such a size that they would accommodate additional transformers. I set out the number of transformers that should first be erected therein. Their total capacity would be 2,400 kw., of which 1,800 kw. would be in use and 600 kw. treated as a reserve. I have, in conference with Mr. Harty, settled a list of streets which it is proposed to light with arc lamps. The total number of arc lamps are: north side, 184; south side, 228—412, which, with those at present in use, 81, give a grand total of 493. I have also conferred with Mr. Harty upon the extent to which new distributing mains should be laid. In the city of Dublin, as the committee are aware, the paving and road work have been carried out with exceptional solidity, and, on Mr. Harty's advice, I have taken 10s. per yard run as the cost of breaking up and reinstating. As the outlay on this head will have to be so high, it would seem prudent to adopt the principle of laying distributing mains for private supply wherever a trench is opened for the reception of the arc lighting mains. It is true that the adoption of this principle will lead to the laying of distributing mains, in many cases, in most unpromising positions; yet in view of the certainty of the time arriving when gas as an illuminant will disappear from Dublin, double expense and inconvenience will be avoided if the work be done now. Mr. Hammond then gives details of the estimated capital expenditure on feeding and distribution for private supply as follows: three trunk mains from Pigeon House to Fleet-street, £12,057; apparatus at Fleet-street, £4,425; increasing capacity at present distributing mains by 50 per cent., £2,000; 19 feeders from Fleet-street to sub-stations, £9,645; erecting sub-stations, £4,750; transforming devices, switch gear, etc., in sub-stations, £11,360; distributing mains for private lighting, £19,724—total for materials, £63,961; trenching and reinstating, £29,611—£93,572; add allowance for slack in cables and deviations from straight runs, contingencies, engineering fees, etc., £9,428—£103,000. Details of public arc lighting: Separate mains under control from Fleet-street, connections to lamps, transforming devices, etc., £22,150; trenching and reinstating where no trenches are already made to receive private lighting mains, £3,620; 500 posts, lamps, etc., £11 000; add allowance for slack and deviations of cable from straight runs, contingencies, engineering fees, etc., £3,730—£40,500. The Pigeon House site is admirably adapted for the erection and economical working of an electricity supply works designed on modern lines. At some future time the works may require for condensing purposes as much as 500,000 gallons of water per hour, and the site is so formed that this quantity can be most conveniently handled, it being drawn in cold on one side and discharged hot on the other. Coals can be delivered by ship or steam alongside the wharf and lifted from the ship's hold by mechanical means, and similarly deposited into the coal bunkers, and thence into the mechanical stokers fixed on the boiler fronts. In order to secure economical working, and to leave clear space between the works and the wharf for a 40ft. roadway, the boiler-house will not have sufficient width to accommodate Lancashire boilers. Some form of water-tube boiler, therefore, will be used. I propose to adopt a revolving chain grate, which will automatically convey the ashes to the ashpit when full duty has been extracted from the fuel. The engine-house has a width of 45ft., and is large enough to accommodate Corliss gear slow-speed plant. This class of plant works with the highest economy of coal and with the lowest cost of upkeep. I have accordingly included provision in my estimate for it. As the cost of the four sets would only be about £5,000 more than that of those of the high-speed type, the saving in interest, etc., on capital by their adoption would be more than counterbalanced by the saving in working expenses. I have already stated that the transmission to Fleet-street will be by means of three-phase currents under a potential of 5,000 volts. It will be necessary to decide whether the electrical energy so transmitted will be generated at that voltage, or whether the generation shall be at low pressure, say 500 volts, with transformation in the works by static transformers to the line voltage. High-pressure alternators are obviously subjected to much greater strains than low-pressure ones, but the use of the latter involves the interposition of transformers at a cost of about £6,000, which should be saved if possible. At Pigeon House during tempestuous weather it will be difficult to free the air entirely from salt, which may attack the insulation, and thus militate against the use of the high-pressure machines. I have provided for buildings not only to accommodate the proposed plant, but also to accommodate one more set. When further plant has to be laid down, the buildings are so designed that extensions can be made on easy lines. There is space for a 300ft. engine-house, capable of accommodating plant up to 8,000 kw. I provide for the ultimate use of two chimneys, the one now proposed being similar to the one recently erected by me at Leeds. It will be noticed that I have arranged for two flues, so that either may be cleaned out at any time. Under the head of estimated capital expenditure the following details are given: works at Pigeon House—buildings, foundations for plant, chimney, etc., £20,000; boiler-house plant, £11,670; engine-house plant, £53,900; pipe work and feed tank, £3,500; telephone to Fleet-street, £330—total, £89,400; add contingencies, engineering fees, etc., £6,600—total, £96,000. It will, in addition, be necessary to provide for gradual expenditure, the cost of connecting on new consumers. Meters and house connections—provisional sum, £15,000. Summary of estimated capital expenditure—mains, etc., for private supply, £103,000; public arc lighting, £40,500; works at Pigeon House, £96,000; meters and house connections, £15,000—total, £254,500. The financial results are set out as follows: The proposed plant has a capacity of 3,000 kw., but it would be prudent to treat one set as "reserve." This would leave 2,000 kw. available, or, say, with 10 per cent. extra at top load, 2,200 kw. Of this, 300 kw. would be used for the arc lamps, leaving for the private lighting 1,900 kw., capable of dealing with 63,300 lamps of 8 c.p., all alight at one time, or, say, 95,000 lamps fixed on consumers' premises. Revenue—95,000 lamps, using, say, 16 units each per annum, 1,520,000 units at average price of 4½d., £28,500; meter rents, say, £1,000; 500 arc lamps at £18, £9,000—£38,500 (carbon and trimming being paid by the lighting authority). Expenditure—cost of generation and distribution—private lighting, 1,520,000; public arc lighting, 1,125,000 units—2,645,000 at 1·5d., £16,531; gross profit, £21,969, to provide for interest and sinking fund. The report concludes: When the demand justified the laying down of an additional 1,000-kw. set, the output for private lighting could be increased by 760,000 units. The gross profit arising therefrom would increase the above £21,969 to £31,469.

At a special meeting of the Dublin Corporation held on Thursday, Dec. 28, the report was, after a long discussion, unanimously adopted, with the provision, however, that, if thought fit, any alteration might be made. It was also decided that application should be made immediately to the Local Government Board for sanction to the borrowing of £254,500 for the carrying out of the work.

THE BOLTON ACCIDENT.

We are indebted to the *Bolton Journal and Guardian* for the following interesting account of the recent accident in Newport-street, by which two employés of the Corporation electricity department—William Hazelton, 63, Poplar-street, and Frederick J. Walker, 126, Clarence-street—lost their lives, and of the subsequent enquiry by the borough coroner (Mr. R. Taylor). Walker was a mains superintendent and 41 years of age, and Hazelton an electrical jointer, and aged 26, and both were married. Councillor Dr. Panton (chairman of the Electricity Committee) was present.

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The widows first gave evidence of identification, after which Mr. A. ELLIS (borough electrical engineer) stated that on Thursday evening some of the electric apparatus in the underground transformer chamber in Bradshawgate broke down, with the result that the whole of the lights of the town were extinguished for a quarter of an hour. He was in the town hall at the time and proceeded to the works, where he afterwards saw the deceased Walker, who informed him of the breakdown near the Balmoral Hotel. They had no spare transformers of the same size in stock, and Walker suggested that he might take one from the town hall, where there were three, and replace it with two small ones. This was agreed upon. The next day Walker reported that he had not done the work, as he could not get permission from the town hall to take it away, and the night's work was thus lost. In the absence of the Mayor witness saw the Deputy-Mayor on Friday, and he expressed surprise that Walker had not been allowed to carry out his instructions. Permission being granted, Walker took the transformer from the town hall and put it in the Bradshawgate chamber. It was then found that another transformer in the same chamber was wrong, and on his own authority Walker went to the Newport-street chamber to get a transformer. Witness would not have sanctioned this, as they had already had trouble there, and it was fully loaded up.

Mr. WM. KAY (foreman of the jury) asked how it was that the factory inspector was not present. The enquiry was so important that an inspector ought to have been present.

The CORONER: I believe Mr. Tinker is very ill. They have had three days' notice.

Dr. PANTON: They had an intimation from the Corporation on Saturday morning.

Mr. KAY (to witness): How is it you were short of transformers?

Mr. ELLIS explained that the reason was they intended changing their supply to continuous current, and do away with the transformers altogether. This should have been done in the summer, but the plant they contracted for last year had not yet been fixed for them, and they had had to run overloaded. They had been unable to add fresh customers for some time.

Mr. KAY: How often do these transformers break down?

Mr. ELLIS replied that they had been extremely fortunate in this respect. The committee were spending £30,000 to do away with the sub-stations, which were a source of great danger. Proceeding with his evidence, Mr. Ellis explained at length the interior and workings of the chamber and transformers. In the Newport-street chamber four transformers were at work, two of which were coupled together. It was one of these the men intended to take away. Before doing this they cut off the supply of current by means of a switch in the chamber. After they had got the transformer which they intended to remove isolated, they proceeded to turn a certain switch which they believed would put the current on again to the transformer which had not been disconnected. Instead they put on the wrong switch, with the result that the cables which had been disconnected, and also left lying loose and touching the transformer case, were made alive, as was also the metal case of the transformer, getting the full pressure of the current. The men had hold of the transformer in order to get it out of the sub-station, and they received the full pressure of current through their bodies. There were two mistakes made—leaving the cables lying loose and turning the wrong switch on, this being the fatal mistake. He believed the mistakes were made through the hurry and anxiety of the men to get the current on again. They were perfectly competent, especially Walker. Had the work been done at night time they would not have had the accident, as they would have had the current off at the station.

Replying to Mr. Kay, Mr. ELLIS said the staff at the works were not aware that any work was going on at the Newport-street chamber. The switches were not touched at the works.

In answer to the Coroner, Mr. ELLIS remarked that he could not account for Walker's mistake. He was always anxious to keep the supply right, and that was no doubt the reason why he had of his own accord undertaken the work in the daytime.

JOHN W. SYMONDS, electric jointer, who was working with the deceased, said Walker took him and Hazelton to remove a transformer from Newport-street to Bradshawgate. Walker cut off the current, and after they had prepared for removing the transformer, Walker turned on the wrong switch, and being nearest got the shock first. He reeled against Hazelton, who received the shock, and Hazelton fell against witness, who was powerless to move a muscle. When Hazelton fell off him he got out and ran to the electricity station to get the current off. Being anxious to get the current on as soon as possible they were doing two jobs at once, hence the mistake.

ALBERT EDWARD SIDES, scavenging inspector, spoke to hearing of the accident and going to the rescue of the men. He pulled his coat off and volunteered to go into the chamber. A rope was fastened round his body, and he told Mr. Lloyd, who was helping at the top, to pull him up if he felt a jerk of the rope. The chamber was filled with smoke, but soon he got his sight and found Walker, whom he handed up. Hazelton was lying on his side, and he also handed him up, and was himself also medically treated and then went to his work.

The CORONER observed that Mr. Sides and Mr. Lloyd acted bravely.

Dr. ADAM deposed to being on the scene, and said Sides and Lloyd volunteered to go down, but as Sides looked the stronger the doctor told him to put a handkerchief over his mouth and enter the chamber. Walker was first got out, and animation was restored, but efforts failed in the case of Hazelton. Dr. Robinson and Dr. Panton arrived, and attempts were made in the Wheat Sheaf, to which the men had been carried, to restore consciousness, and Walker was afterwards removed to the infirmary. He examined Hazelton after death, and found that he was burned about the feet and hands, the boots being very much charred. Death was due to electrical shock, and the smoke was caused by the burning.

Mr. ELLIS here rose, and said it was a very risky thing to order anyone down into the chamber. No one should do it without having ascertained that it was absolutely safe. They might have lost a third life.

Dr. ADAM replied that the smoke had diminished.

The CORONER: No doubt the doctor did it with the best intention.

Mr. ELLIS: But if the current had been on it would have been certain death.

Dr. ADAM: The man knew he was running a risk, but wished to render service.

Dr. LIDDELL testified to the death of Walker taking place at the infirmary on Saturday morning from nervous paralysis, the result of an electric shock.

The CORONER expressed the hope that the jury would be satisfied as to cause of death. It was clearly an accident. He could not say anyone was to blame; the men themselves had control of the current and the work.

The jury returned a verdict of accidental death.

Dr. PANTON, speaking on behalf of the Electricity Committee, said they very much deplored this regrettable occurrence. The deceased were capable men, and they were exceedingly sorry to lose them, and they tendered their sympathy to their widows and families. Anything the department could have done to have avoided the accident they would have done. It was an unfortunate accident which had been brought on, it seemed, by the hurry of the men, and the mischance of doing the wrong thing instead of the right one.

Mr. KAY intimated that the jury wished to commend the rescuers.

The CORONER: They behaved with true courage; they are both noble fellows.

LEGAL INTELLIGENCE.

MARYLEBONE VESTRY AND GUARDIANS AND THE METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

The Metropolitan Electric Supply Company, Limited, of 29, Baker-street, were summoned before Mr. Plowden on the 29th ult. at Marylebone, at the instance of the Marylebone Board of Guardians and the Marylebone Vestry, for on Dec. 7, 9, 11, 12, and 14 last having made default in the supply of electric energy to the workhouse and the vestry premises. Mr. Herbert Manisty was counsel for the parochial authorities. The following report appeared in the *Morning Post*:

Mr. Muir, who defended the company, said he must admit the default, which, of course, was a plea of guilty. He hoped, however, to show that the company had done all that human foresight could devise to prevent the breach, which was an accident, and that as to the future measures had been taken by which, humanly speaking, it would be impossible for this cause of complaint to recur. The company, which was the oldest of its kind, was started in 1888, and commenced to supply the public with electricity in the following year. That the demands made on the company had exceeded their most sanguine expectations would be seen when he stated that, whereas the number of lamps supplied in 1892 was 78,000, in 1897 it had increased to 187,000. Acting under experienced advice, the company laid down engine power to the extent of hundreds of horse-power, and it afterwards turned out it should have been thousands of horse-power. In the February of 1898 a site was secured in Willesden on which to build a generating station so as to increase the supply. Contracts were entered into for the erection of works on an unprecedented scale. But unfortunately difficulties cropped up in connection with the execution of the works, and from various causes the time limits in various contracts were broken. Owing to these delays the defendant company went to another electric supply company and got some assistance, but that soon failed, as the company borrowed from needed all the electricity produced for their own customers. When that supply was cut off, the troubles of this company commenced. There was a difficulty in securing Welsh coal for the furnaces, because of the Government demand for steam coal needed by transports being sent to South Africa. Other coal had to be used by the defendants, and that reduced the engine power. To show the provision the company had made, counsel stated that the whole of their

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works, apart from those at Willesden, provided for 8,500 kw., or half a million lamps. The addition by the Willesden works would be an increase of over 50 per cent. to the existing supply, and as the increased demand in 1899 was only 20 per cent., provision had been made for 2½ times more than was required. In consequence of the high pressure at which their works at Manchester-square were carried on in order to keep faith with the public, damage was done which necessitated the stoppage of the works for repairs for at least a week, and it was during that period that their customers made so many complaints. The first engine began to work at Willesden on Nov. 11, and a month later it had to be stopped for the setting right of defects commonly experienced in new machinery. Since then a second engine had been started, and in the course of 10 days a third one would be ready, and the three engines would provide a supply for 270,000 lamps. The object of this prosecution being to ensure the fulfilment of the company's contract, he hoped, after the statement he had made, that the magistrate would not inflict any penalty at this period, but adjourn the summons for a period until after the dark days had passed. If no more stoppages took place, he hoped the penalties would be minimised to the last degree, but if there should be several stoppages, which he did not anticipate, then, of course, his worship would inflict a heavy penalty. He assured the magistrate that the deficiencies had not happened as the result of any niggardly or cheeseparing policy on the part of the company in order to increase dividends. The St. Pancras Vestry controlled their own electric lighting, and they had experienced similar difficulties as this company.

Mr. Plowden, having referred to the lucid, interesting, though somewhat pathetic statement made by counsel, said it seemed clear that the company never contemplated its future greatness, and when that became clear it made frantic and praiseworthy efforts to meet the emergency, efforts which had not been a complete success. As Mr. Manisty had agreed to the suggestions made by Mr. Muir, the summons would be adjourned for three months. Mr. Plowden added that the statements made by Mr. Muir would be very gratifying to many people outside the Court.

PENAL SERVITUDE FOR FALSE PRETENCES.

Ernest John Thomas, 30, electrical engineer, was indicted at Devonshire Quarter Sessions, at Exeter, on Tuesday, for obtaining by false pretences a quantity of copper wire from Messrs. Heaton and Gard, of Birmingham. There were other charges of a similar nature.

It transpired that at Devon Sessions in April, 1897, prisoner was prosecuted on four charges of obtaining goods by false pretences, pleaded guilty to obtaining credit by fraud, and was sentenced to three months' hard labour. In November, 1898, the Treasury prosecuted prisoner on five charges of a similar kind, and he was sentenced to 12 months' imprisonment on each indictment. He came out of prison on Sept. 26 last. Two days later he started writing letters to firms in the name of "J. J. Thomas, C.E.," ordering goods. He then transferred to Plympton, and traded as "Dr. Morris Parr," obtaining a considerable quantity of goods. The police had received a large number of complaints from firms from whom prisoner had obtained goods since he came out of prison.

Mr. Pridham Wippell said the prisoner had assured him that he had no intention of not paying for the goods. Early in October last the prisoner met an American gentleman, who suggested they should start a business at Plympton as surgical electricians, and apparatus was fitted up for the purpose at a house taken by the American. It was agreed that prisoner should eventually go into partnership, but meanwhile he was to be paid 30s. a week, and that sum was actually paid for a week or two. After a while, however, the American disappeared, owing prisoner £4. 15s.

The **Chairman** said prisoner, notwithstanding his superior education and knowledge of an honourable profession, had systematically endeavoured to live by his wits at the expense of the public. The sentence of the Court was that he be sent to penal servitude for three years.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Berga (Province Barcelona, Spain).—The Municipality will on Jan. 18 receive tenders for the electric lighting of the town and suburbs for 20 years.

Tunbridge Wells.—The Corporation invite tenders for a 400-kw. steam alternator. Tenders by Jan. 25. Full particulars in our advertisement columns.

Barnes.—The Urban District Council invite tenders for the supply and erection of boilers, steam dynamos, switchboard, storage batteries, cables, etc. Tenders by Jan. 9.

St. Pancras.—The Vestry invite tenders for condensing plant. Specification, etc., can be obtained at the Electricity Department Offices, 57, Pratt-street, Camden Town, N.W. Tenders by Jan. 9.

Newcastle-upon-Tyne.—The New Tramways Committee of the Corporation invite tenders for one 2,000-h.p. generator required early in 1901. Tenders by Jan. 16. Particulars in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for the supply of one 420-kw. direct coupled continuous-current dynamo. Tenders by 22nd inst. Particulars in our advertisement columns.

Ferrol (Province Coruna, Spain).—The Municipality will on Jan. 16 receive tenders for the electric lighting of the town for 15 years. Specifications may be inspected at the office of the Electrical Engineer.

Utrera (Province Seville, Spain).—The Municipality will on Jan. 16 receive tenders for the electric lighting of the town and suburbs. Specifications may be inspected at the office of the Electrical Engineer.

Barking Town.—The Urban District Council invite tenders for the supply and erection of two continuous-current transformers and switch gear and underground cables and roadwork. Tenders by Jan. 23. Full particulars appear in our advertising columns.

Bermondsey.—The Vestry invite tenders for the construction, supply, and erection of a dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced-draught appliances Tenders by Jan. 13. Particulars in our advertising columns.

Salford.—The School Board invite tenders for the electric lighting of their new schools in Grecian-street North, Lower Broughton. Specification, etc., may be obtained from Mr. Ogilvie Duthie, Chapel-street, Salford. Tenders by Jan. 8.

Yarmouth.—The Town Council invite tenders for the supply of about 800 tons, or thereabouts, of steel girder tramway rails, of from 80lb. to 90lb. per yard, deliveries to commence not later than June 1, and the whole to be delivered on or before Sept. 1, 1900. Tenders by Jan. 30.

Glasgow.—The Corporation invite tenders for cast-iron cable tunnel, water-storage tanks, travelling crane for outside coal storage, mechanical stokers, coal and ash conveyors, and steel flues for the Corporation tramways. Tenders by Jan. 8. Full particulars in our advertisement columns.

Tunbridge Wells.—The Corporation invite tenders for the enlargement of their central electric lighting station, adjoining the South-Eastern Railway Goods Station, at Tunbridge Wells, to be carried out under the superintendence of and in accordance with drawings prepared by Mr. C. H. Strange, A.R.I.B.A., of Tunbridge Wells. Tenders by Jan. 15. Specification, etc., may be inspected at the Town Clerk's Office at the Town Hall.

Birkenhead.—The Corporation invite tenders for constructing and erecting a new electricity generating station in connection with the electric tramways in Craven-street, Birkenhead. Plans, etc., may be obtained from Mr. C. Brownridge, A.M.I.C.E., borough engineer and surveyor, Town Hall, Birkenhead, upon deposit of a sum of £3. 3s., which will be returned upon receipt by the Corporation of a bona fide tender. Tenders by Jan. 16.

Plymouth.—The Plymouth Corporation is prepared to receive tenders for 500-kw. high-speed steam dynamo and motor-generator; 500-kw. high-speed steam alternator (disc armature); 200 accumulator cells for 1,680 ampere-hours capacity; four Lancashire boilers, with mechanical stokers, piping, ejector condensers, valves, economiser; high and low pressure paper-insulated and lead-covered mains, etc. Tenders by Jan. 31. Full particulars in our advertisement columns.

Beira (Portuguese East Africa).—The Companhia de Mocambique invite tenders for laying down the necessary plant for lighting and supplying with electricity the town of Beira (Portuguese East Africa), including the monopoly for the working of same for a period of 25 years from the date of the signing of the contract. Full particulars with regard to terms, etc., may be obtained at the offices of the Company, 12, Austinfriars, London, 45, Rua do Alecrim, Lisbon, and 7, Rue Lafayette, Paris.

Ilford.—The Urban District Council invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, etc; pipework, etc., in engine and boiler house; two 200-kw. and one 100-kw. steam dynamos and motor boosters (vertical enclosed high-speed engines); storage batteries; main switchboard and connections; overhead 15-ton engine-room travelling crane; underground mains, conduits, and roadwork for private and public lighting; arc lamps and posts; and station lighting. Tenders by Jan. 20. Full particulars in our advertisement columns.

Melbourne (Victoria).—The Corporation invite tenders for the supply and delivery of the necessary plant, and the superintendence of its erection, and of the carrying out of the work in connection with the electric lighting of the city, to specifications as follows: (1) boilers (dry-back or water-tube type, with superheaters) and economiser; (2) steam-engines, dynamos, equaliser, booster, and switchboard; (3) feeders, mains, and arc light leads, with all bitumen or insulating material; (4) accumulators. Specifications, etc., can be obtained from the Agent-General for Victoria, 15, Victoria-street, Westminster, London, S.W., on and after the 28th instant, on payment of £1. 1s. for each specification, to be returned on receipt by the Corporation of a bona fide tender. The specifications and drawings may be seen at (but not obtained from) the office of Dr. Alex. B W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders by March 1. Full particulars appear in our advertising columns.

RESULTS OF TENDERS.

Hammersmith.—The Vestry have accepted the tender of Mr. T. L. Hellyar, King-street, Hammersmith, for wiring and installing the Vestry's stables and depôt in Fulham Palace-road for electric light.

Grays.—The Grays Thurrock Urban District Council have accepted the tender of Messrs. Meldrum Bros., Manchester, at

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£1,936, for the construction of a refuse destructor in connection with their proposed electricity works.

Halifax.—The Council have accepted the following tenders: Isaac Storey and Sons, Manchester, for the supply of three condensers and the necessary pumps for the electricity works, at a total cost of £2,025; Callender and Co., London, for the supply of 5,000 yards of 1in. square section cable, at £3,500.

Hull.—The Tramway Sub-Committee have accepted the following tenders: Messrs. Siemens Bros. and Co., for additions to the switchboard required for the motor pumps at the power station £28, for the electrical equipment of the Holderness car shed and the line leading thereto £136, and for the electrical equipment of the connecting line between Saville-street and St. John-street, £132. 10s.; the Westinghouse Company, the fitting of the sprinkling cars as snow-ploughs, this necessitating an additional motor and head lights on each car, amounting to £138. 10s. per car.

BUSINESS NOTES.

TRACTION.

Leeds.—The service of electric cars between Headingley and Chapeltown was inaugurated on Wednesday.

Renhill.—The Glasgow District Tramway Company intend applying for powers to lay a line of tramways in the district.

Manchester.—Mr. J. M. M'Elroy, now secretary to the Tramways Committee, has been appointed general manager of the tramways.

Kidderminster.—The application of the British Electric Traction Company asking the Council to approve of the proposed tramway to Bewdley, has been agreed to.

Keady.—At the meeting of the Town Commissioners on the 1st inst., a resolution was unanimously passed pledging support to the proposed light railway from Newry to Tynan.

Southport.—Plans and sections of the proposed Southport and Lytham tramroad, together with the surveyor's report thereon, have been approved by the Fylde Rural District Council.

Hertfordshire.—The Middlesex County Council have resolved to oppose the county of Hertford light railways provisional order with a view to the protection of the county interests.

Bradford.—The traffic receipts for the week ended Dec. 31 were £353, being, as compared with the corresponding week in 1898, of £291, an increase of £62. The total receipts for 1899 were £13,932.

Cambridge.—A town's meeting has rejected, by a large majority, the proposal of the Town Council to promote a Bill in Parliament to acquire the local tramways and waterworks company. A poll has been demanded.

Levenshulme.—The Manchester Corporation Tramways Bill, to enable the Corporation to construct additional tramways both within and beyond the city, has been deferred to the Parliamentary Committee of the Urban District Council.

Illogan.—The Parish Council have decided to consent to the application for a provisional order by the Urban Electric Supply Company, Limited, to the Board of Trade of a tramway to be constructed between Camborne and Redruth.

Lincoln.—At a meeting of the City Council on Wednesday the resolution to promote a Bill in the next session of Parliament to confer further powers on the Corporation with respect to tramways, and to authorise the borrowing of money for electric tramways, was confirmed.

Leamington.—The proposal of the Leamington and Warwick Tramways Company to extend their line in the direction of Whitnash by the overhead electric system was discussed on Wednesday by the Parish Council. After discussion it was decided not to oppose the scheme.

Liverpool.—The traffic receipts of the Corporation tramways for the week ended Dec. 23 were £7,213, as compared with £6,671 in the corresponding week of 1898, being an increase of £542. The total receipts were £351,154, as compared with £309,680 in 1898, showing an increase of £41,474 for the year.

South Lancashire.—The combined applications of several tramway companies who intend, with the consent of nearly 30 local authorities, to construct about 120 miles of electrical tramways, will practically cover the whole of South Lancashire. The cost of construction and equipment will be about 1½ million sterling.

Halifax.—The Tramways Committee have been authorised to purchase two single-deck cars at a cost not exceeding £400. A motion that the construction of a branch tramline to Wheatley be included in the list of lines which the committee proposed should be next constructed, was defeated at Wednesday's meeting of the Town Council.

Huddersfield.—Thirteen applications have been received for the post of resident engineer and clerk of the works for the Corporation's steam tramways, which are to be converted to electric traction. The Tramways Committee have recommended Mr. H. N. Thomas, of Douglas, superintendent engineer to the Isle of Man Tramways Company, at a salary of £300 a year.

Aberdeen.—A notice from the Town Council of application to be made to Parliament for an Act authorising the construction of new tramways affecting, *inter alia*, the Bridge of Don and the Ellon-road, have been remitted to the Road Sub-Committee. The only drawback to the scheme, so far as the Ellon-road is concerned, appears to be the narrowness of the road.

Aston.—At the last meeting of the Urban District Council, the promotion of the Bill to enable the Council to work the tramways belonging to the Birmingham and Aston and Birmingham City Tramway Companies, and to construct such other tramways within the district as may be desirable, was agreed to.

Glasgow.—Mr. John Young, the general manager of the tramways, has reported, with reference to the proposed extension along Alexandra-parade, that in view of the conversion of the main routes now proceeding, and to be finished before the opening of the exhibition in 1901, it is impracticable to undertake the Alexandra Park extensions at the present time.

Sunderland.—The Sunderland tramways have ceased to be controlled by the local tramway company, the Town Council having taken possession on Jan. 1. The purchase price was £35,000. It is expected that the electric cars will be started in June. The old servants of the company have been retained on the same terms, Mr. Morrison continuing to act as traffic manager.

Tipton.—At a recent meeting of the District Council the Tramway Committee reported negotiations with the Midland Electric Supply Corporation and with the British Electric Traction Company, and recommended that the Council take the necessary steps to promote a Bill in Parliament to empower the Council to acquire the tramways and work them. The resolution was adopted.

Mansfield.—At a special meeting of the Town Council on the 3rd inst., a report of the Council in committee as to the application of a syndicate for an order under the Light Railways Act was discussed. The committee recommended that the draft objections to the syndicate's scheme should be accepted and forwarded to the solicitors of the promoters. The report was confirmed. The Council have arranged to meet the representatives of the syndicate on the 10th inst.

Withington.—The District Council, in their proposed Bill, seek powers to construct several short tramways for the purpose of forming junctions with their existing system. It also provides for 14 sections of street widenings, and the construction of a footbridge across the River Mersey, connecting Ford-lane on the northern and southern sides. The Council ask for powers to borrow £106,114 for the construction of the tramways, £12,000 for tramway purposes, £42,454 for street improvements, and such a sum as may be requisite for passing the Bill through Parliament.

Bournemouth.—The Town Council have sealed their application to the Board of Trade for the provisional tramway order. With regard to the Christchurch, Bournemouth, and Winton tramways, and the intention of the Poole and District Electric Traction Company, Limited, to apply to Parliament for an Act to empower them to construct tramways, the town clerk has been instructed to reply that the Council dissent from the undertaking. At the same time a letter from the company, suggesting that the matter be arranged, has been referred to the General Purposes Committee.

Cardiff.—At Tuesday's meeting of the Parliamentary Committee it was decided to oppose the Rhondda Light Railway Bill. The committee also decided to ask the Parliamentary Committee of the Glamorgan County Council to meet them for a friendly conference upon the Penarth-road question, the proposed Great Western Railway bridge at Ely, electric lighting proposals, and other matters affecting the borough extension. A meeting will be held at Penarth next Monday for the purpose of raising opposition to the proposal to include Penarth in the Cardiff scheme. The committee have also decided to oppose the South Wales Electrical Power Distribution Company's Bill.

Hendon.—At the meeting of the Rural District Council last week the following resolution passed by the Harrow Weald ratepayers was read: "That this parish meeting of residents in Harrow Weald earnestly protest against the light railway proposals of the Middlesex Council from Wealdstone to Stanmore, through Harrow Weald, as contrary to the spirit of the Act, unnecessary, and likely to spoil the residential character of this rural district." A similar resolution had been forwarded by the Stanmore Parish Council, and the Chairman said that those resolutions would be used by the Council at their next meeting, when Sir Richard Nicholson would be in attendance.

South Staffordshire.—The Bill which has been deposited on behalf of the South Staffordshire Tramways Company, and to which we have already referred, proposes not only to confirm an agreement for the sale to the Corporation of Walsall of all the tramway undertaking belonging to the company within that borough for the sum of £18,500, and to reconstruct and adopt other tramways, but power is also sought to enable the company to sell to any local authority the whole or any portion of the undertaking within the district of such local authority upon such terms and conditions as may be agreed upon, provided that no sale shall be made unless it be one of the terms that a lease of the undertaking purchased shall be granted to the company's lessees.

Portsmouth.—The tramways should have been taken over by the Corporation on Dec. 31 last. A deadlock, however, has occurred on account of the demand of the tramways company that the Corporation should take over the hearses, wedding coaches, etc., as forming part of their undertaking. The Corporation claim that they are only required to take over the parliamentary undertakings of the company. The question will probably have to be fought out in the law courts. Anticipating the futile attempt made by the mayor and town clerk at midnight on Sunday, the Town Council recorded the following resolutions;

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(1) "That the Tramway Committee be instructed to refuse to take over the omnibuses, carriages, and hearses belonging to the tramway company, and the depôts and plant used in connection with them, but that the company be informed that the Corporation require the tramway undertaking to be handed over on Dec. 31." (2) "That in the event of the tramway company refusing to hand over their tramway undertaking, the committee be instructed to report to the Council."

Hammersmith.—At the meeting of the Hammersmith Vestry on Wednesday, a letter from the County Council was read, with a resolution passed by the Council sanctioning the plans submitted by the London United Tramways Company for the overhead or trolley system of electrical traction on the company's lines in Uxbridge-road and Goldhawk-road. The sanction, however, was given without prejudice to any action which the Council might decide to take in regard to the proposal of the company for the amendment of their Act of last year relating to the equipment for an underground system of electrical traction on their lines between Young's-corner and the Broadway. The conditions accompanying the sanction are that the trolley wires be not attached to the electric lighting standards; that the company furnish the Vestry with detailed drawings of the inspection chambers and boxes to be placed in the carriageways or footways; and that the "Bristol" designs for the side and centre traction posts be used, but the cut-out circuits be of such length as shall be approved by the Council's chief engineer. The matter was referred to the Electricity and Lighting Committee.

Blackburn.—The tramway statistics for the week ending Dec. 22 show, according to the *Blackburn Weekly Standard*, that there were carried on the various sections during that period 74,096 passengers, as compared with 50,275 in the corresponding week in 1898, an advance for the past seven days of 23,828 passengers. The loss on weekly tickets was 7s., so that the total increase is 23,821. The amount collected reached £349. 6s. 9d., which, compared with the £288. 8s. 2½d. obtained last year, gives an increase for the week in question of £61. 12s. 6½d., or a total advance, deducting 14s. loss on weekly tickets, of £60. 18s. 6½d. A comparison of the returns for the 356 days' running in each year up to and including Dec. 22 shows that the amount collected in 1897 was £15,660. 11s. 6½d., in 1898 £16,297. 19s. 8d., in 1899 £20,582. 5s. 1d. Thus the increase over 1897 is £4,921. 13s. 6½d., and over 1898 £4,284. 5s. 5d. On the Darwen section there were carried last week 56,529 passengers, the receipts amounted to £247. 13s. 2d., as compared with 32,356 passengers in the corresponding week of 1898, and £221. 2s. 2d., the increase being £26. 11s. A comparison of the returns for the 356 days' running shows that in 1898 £11,208. 9s. 2d. was obtained, and in 1899 £13,094. 10s. 1½d., or an increase for the current year of £1,886. 0s. 11½d.

Light Railways.—In the list issued by the Light Railway Commissioners 43 applications are enumerated. On 30 of these projected light railways it is proposed to use electricity as the motive power, and on 11 of them steam; of the remaining two, one is to be run by mechanical power, and the other by either steam or electric power. The total length is 441½ miles, made up as follows: electric, 242½ miles; steam, 141½ miles; steam or electric, 39¾ miles; mechanical, 18 miles. Six are being promoted by the British Electric Traction Company, Limited (31½ miles), four by the Hertford County Council and the Metropolitan Tramways and Omnibus Company, Limited (20¼ miles), and four by the London County Council (15¾ miles). The longest of these projected lines is the Cinque Ports, an electric railway which is to be 67¾ miles long. We annex the following figures from the *Railway News*, showing details of the applications made since the Light Railways Act, 1896, came into force: total applications, 258; total mileage, 2,646½; steam, number 123; steam, 1,598½ miles; electric, number 129; electric, 1,008½ miles; hydraulic, etc., number four; hydraulic, etc., 39½ miles; gauge 4ft. 8½in., number 171; ditto, 1,881¼ miles; gauge 4ft., number five; ditto, 65¾ miles; gauge 3ft. 6in., number 69; ditto, 573¼ miles; other gauges, number 12; ditto, 126¼ miles.

Somerset.—At Tuesday's meeting of the County Council the following reports were received on the various railway and tramway schemes. The General Purposes Committee reported the deposit of plans in reference to the following projects: Light railway from Bridgwater to Storgursey—In regard to this scheme, the committee recommended that notice of opposition be given and not withdrawn until the Council were satisfied that the main roads would not be injuriously affected. Light railways to various parts of Bath and neighbourhood—The committee recommended that, as this application was on the same lines as last year, the clerk be instructed to oppose. Taunton tramways—The committee recommended that this scheme be not opposed, provided the promoters undertook to satisfy the requirements set out in the report of the county surveyor. Weston-super-Mare tramways—The committee recommended that notice of opposition be given to this scheme, but that the same be withdrawn provided that the requirements of the county surveyor were complied with. With the exception of the first named the recommendations were agreed to. In the case of the Bridgwater-to-Stogursey Railway opposition was withdrawn, provided terms contained in the letter of the promoters' solicitors were embodied in the provisional order of the Board of Trade. The committee were satisfied that the roads would not be injuriously affected.

Middlesex.—The following is an extract from the county engineer's report on the Ealing tramways order: "The District Council of Ealing give notice of their intention to apply to the Board of Trade for authority to lay down, work, and maintain a double line of tramways along the whole length of the Uxbridge main road within their district. It will be remembered that the London United Tramways Company recently promoted an order which included this length, but this was not allowed by the Light Railway Commissioners, owing, I believe, to the Ealing opposition. Lines are at present authorised up to the boundaries of the district with Hanwell and Acton. The line is proposed to be double along its whole length, but for some reason not altogether clear portions of it are to be worked as single lines. The whole of this scheme is upon the county main road, except Tramway No. 2 single line from the main road to the depôt." In view of the fact that the Council has resolved to become the light railway authority in the county, and is already promoting schemes, the committee think it will be obviously undesirable that district councils or private companies should obtain powers for the construction of tramways or light railways along the main arteries in the county, and so interfere with any comprehensive schemes arranged by the Council for light railway communication. The County Council, of course, desires so far as possible to further the wishes of district councils, and not to oppose, unless it is absolutely necessary, any scheme which they may promote as regards their respective districts. Considering that the County Council itself are dealing with the light railway question, they have decided to oppose the scheme. A joint committee, consisting of members from the Finance, Highways, and Parliamentary Committees, is to be formed to consider matters affecting the interests of the county and its districts with regard to the proposed agreement and schemes connected with the light railway enterprise in Middlesex.

Hull.—The Tramways Committee of the Corporation have resolved to recommend the Council to continue the running of the steam-cars on the Hedon-road until the Corporation are in a position to reconstruct the tramways. The Chairman hopes they will be in a position to begin to reconstruct the road in the early summer. The *Eastern Morning News* publishes the following review of the first six months' work of the city electric tramways: "A survey of the brief period of six months which have elapsed since the first electric car in Hull commenced its historic journey from St. John-street reveals a great many things on which the city and the Tramways Committee are entitled to congratulation. There will be very few, for instance, in the face of the figures we are about to present, who will dare to take up an attitude of opposition to the system on the ground of finance. The service was inaugurated on July 5, and from that date to Dec. 30 4,086,876 passengers were carried, the receipts being £17,028. 12s. 2d. Deducting the first four days to July 8 inclusive—which cannot be said to represent a full week—and dividing, therefore, by 25 weeks, an average is obtained of 160,804 passengers carried and £670 taken per week, or 22,972 passengers and £95. 14s. 3d. respectively per day. The highest weekly receipts were returned from Oct. 8 to 14, during which Hull Fair drew thousands of people within its limits, and increased enormously the traffic on the Anlaby-road. During that week 323,612 patronised the trams, and £1,348. 7s. 8d. was taken in fares. The next highest total was attained during the Yorkshire Show week (July 16 to 27), when 204,917 passengers were carried and the receipts were £853. 16s. 5d. It will be observed that on both these occasions there were special causes for the magnitude of the figures. The highest receipts during any ordinary week were from Dec. 17 to 23, when 170,414 passengers and £710. 1s. 2d. in receipts were reported. Christmas week was higher, but, including as it does Bank Holiday, and considering its other points of significance, one can hardly regard it as an 'ordinary week.' The highest totals for any one day were 72,500 passengers and £302. 1s. 2d. respectively, on Oct. 11 (Hull Fair Day). Then comes 52,780 passengers and £219. 18s. 4d. on July 29 (the second day of the Yorkshire Agricultural Show), and 41,354 passengers and £172. 6s. 2d. on August Bank Holiday. The highest total for any ordinary day was reached on Dec. 23, when 39,670 passengers were carried and £165. 5s. 10d. taken in fares. Those figures, of course, simply represent six months' working. It can be assumed, therefore, that in a year on two routes 8 000,000 passengers will be carried, and something like £34,000 taken. There are four routes yet to open out, and when the whole system is in working order there will, therefore, on a rough estimate be 24 000,000 passengers per year, and annual receipts amounting to £102,000. That should be a comforting statement for the contemplation of the chairman of the Finance Committee."

LIGHTING AND GENERAL.

Derby.—The Electric Lighting Committee have decided to let out motors on hire.

Poplar.—The District Board have decided to oppose by petition the Charing Cross and Strand Electricity Supply Bill.

Torquay.—The transformer sub-station under the Strand band-stand is to be constructed larger than originally proposed.

Inverness.—The amended scheme of Mr. Craven is estimated to cost £25,000, and it has been decided to proceed on the same.

Eastbourne.—Application is to be made to the Postmaster-General to make the present post office in Grove-road a telegraph office.

Electric Construction Co.—The transfer books for the 4 per cent. perpetual first mortgage debenture stock will be closed from 1st to 13th prox.

Dublin.—The Corporation have adopted a large scheme for extending the electric lighting of the city, details of which appear in another column.

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North Devon.—It is stated that the National Telephone Company have arranged for an immediate extension of the trunk system to North Devon.

Sutton Coldfield.—The Post Office authorities have intimated to the Town Council their inability to undertake the establishment of a telephone service in Sutton Coldfield.

Greenock.—The Public Works Loan Commissioners have agreed to the application of the electricity department of the Greenock Police Board for a loan of £50,000 at 3 per cent.

Appointments Vacant.—Elsewhere will be found particulars referring to vacancies for electrical assistants, a works manager, a meter inspector, a traffic superintendent, travellers etc.

Govan.—The First Ward Committee have decided to send a memorial to the Commissioners asking them to take steps to have the closes and stairs in the burgh lighted with electricity.

Manchester.—The City Council on Wednesday decided to refer the application of the Mutual Telephone Company to the committee which is considering the municipalisation of the telephones.

Hull.—The Sculcoates Guardians have approved the minutes of the Engineering Sub-Committee, suggesting certain improvements in connection with the scheme for providing electric lighting installation at the workhouse.

St. Annes.—The Electric Lighting Committee have received the Board of Trade's formal consent to the system of supply to be adopted. Tenders have been invited for mains, arc lamps, and incandescent street lamps,

Whitechapel.—The District Board have sealed a contract with Mr. W. Griffiths for the construction of a portion of the new electricity supply station at Osborn-street. The parish church is to be lighted by electricity.

West Bromwich.—A previous resolution of the Council for the promotion of a Bill in Parliament to confer power upon the Corporation with respect to tramways, electric lighting, and other undertakings was confirmed on Wednesday.

Coal.—The scarcity of coal is making itself known in the various electricity stations in London and elsewhere. We understand that Shoreditch Vestry, among others, cannot obtain any coal under their existing contract, and have decided to advertise for a supply for the next three months.

Islington.—With regard to the various electric lighting loans to this parish, the following resolution will come before the Vestry at its meeting to-day: "That in future no contract be entered into for works proposed to be paid for out of loans until the consent of the sanctioning authority has been obtained."

Gateshead.—At Wednesday's meeting of the Town Council complaints were made with regard to the insufficient lighting supplied to the streets of the town by the Newcastle and Gateshead Gas Company, and it was decided that the Town Improvement Committee take the matter in hand at their next meeting.

Brighouse.—The Corporation have decided to approve of a large scheme for dealing with the refuse in the borough by means of a destructor, the heat from which is to be used in the generation of electricity. The project is one that will involve a large capital outlay, but it is believed that it can be made profitable to the Corporation.

St. Marylebone.—At a Vestry meeting held yesterday (Thursday) the Parliamentary Committee presented a report recommending that the Vestry of St. Marylebone should protest in the strongest possible manner to the Board of Trade that the Metropolitan Electric Supply Company have failed utterly to supply an efficient light in the Vestry's area, and to state that continual and repeated complaints are being received by the Vestry daily.

New York.—The New York correspondent of the *Yorkshire Post* telegraphs on Wednesday as follows: "The Consolidated Gaslight Company announced to-day that it had absorbed the New York Electric Lighting and Heating Company. This will make the Consolidated the most powerful illuminating company in New York, and will put it in a position to make a strenuous attempt to unite all the gas and electric light companies in the city."

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to St. James's and Pall Mall Electric Light Company, Limited (further issue of 8,020 shares of £5 each fully paid, Nos. 52,081 to 60,100), and to allow to be quoted in the official list Western Telegraph Company. Limited (further issue of 565 shares of £10 each fully paid, Nos. 205,894 to 206,558).

Boiler Seatings.—We have received from Mr. W. Stokes, of Queen's-road, Reading, his list of special fireclay blocks, covers, and special work for boilers. These are the outcome of long experience in the work, and the arrangements made for locking the various blocks and covers to the brickwork seem to be exceedingly serviceable. Chimney and flue linings, also with the interlocking joints, are also listed, and can be supplied to meet special requirements.

Calendars.—The Rugby Portland Cement Company's calendar for 1900 is illustrated with fancy pictures of life in the various pre-human geological formations, which are contrasted with some views of the company's works in 1899. The calendar part proper is large and serviceable.—Messrs. Shand, Mason, and Co., makers of steam fire-engines, Upper Ground-street, Blackfriars, London, S.E., have issued what they call a fire brigade wall calendar for the year 1900, in which prominence is given to a record of historical fires, with the damage done, etc. A telling picture of the Cripplegate site after the fire occupies part of the sheet, and the corners are occupied by types of the engines manufactured by the firm.

Salford.—The following letter has been received by the Town Council from the Postmaster-General: "With reference to the resolution of the Council of the borough of Salford in favour of the application of the Mutual Telephone Company, Limited, for a license to carry on a telephone exchange business, I am directed to inform you that a license, terminating in 1911, to transact such business in the borough of Salford and in the urban districts of Moss Side, Wilmslow, Stretford, Audenshaw, Gorton, Altrincham, Sale, and Swinton and Pendlebury was granted to the company on the 30th ult."

Grantham.—The Town Council on Wednesday adopted a report of the Electric Lighting Committee recommending the Council to consent to the provisional order submitted to the Board of Trade by the Urban Electric Supply Company, Limited, provided the company entered into an agreement with the Council by which they will not be allowed to make a charge exceeding: for street-lighting or other public purposes, 7d. per unit for the first hour, 2d. per unit after the first hour; for motor power, 4d. per unit for the first hour, and 1d. per unit after the first hour. Further, the company will have to adopt a system of free wiring to be approved by the Council, and the site of the installation station will also have to receive the approval of the Council.

Cable Rates to West Africa.—At the last meeting of the committee of the African Trade Section of the Liverpool Chamber of Commerce the Chairman called attention to the prohibitive rates charged for cabling to and from West Africa, and pointed out that a substantial reduction in the rates in question would be followed by a large increase in the traffic. It was resolved that the committee should make a representation to the cable companies interested, and ask that the rates per word be reduced by one-half; and that, for that end, they should, as on a previous occasion, undertake to make arrangements for guaranteeing these companies in return a revenue equal in amount to that received by the companies in 1899 from the interests concerned.—*Financial Times.*

Personal.—We congratulate Mr. C. P. Sparks on his appointment as chief engineer to the County of London and Brush Provincial Electric Lighting Company, Limited, and note that he has also been appointed consulting engineer to the Richmond (Surrey) Electric Light and Power Company, Limited.—On the occasion of the transference of Mr. Leigh Robinson to Prof. Robinson's staff, the King's Lynn Electricity Committee recorded their high appreciation of the valuable services rendered by him in connection with the installation of the electric light in the town.—Mr. J. Moss, of Derby, has been appointed borough electrical engineer at Eccles. Mr. H. N. Thomas has been recommended by the committee, out of 13 applicants, as resident engineer and clerk of works for the proposed electrical tramways.

Grays.—At the last meeting of the Urban District Council a letter was read from the Local Government Board with reference to the report by Colonel Durnford on the application of the Council for a loan of £13,000. The Board required to be furnished with further and more detailed evidence to show that there was such a demand as justified the District Council in constructing the proposed lighting works, and with calculations showing how the estimated results were arrived at. In the meantime, in view of the fact that the Council were required to complete the purchase of the land by Christmas, and they proposed to erect a dust destructor on part of it, the Board had decided to sanction a loan of £6,000 for the purchase of the land as required for purposes of a dust destructor, and such sanction was forwarded. Mr. Preece has been asked to take the matter in hand.

Tyneside Power Scheme.—The Bill of the Tyneside Electric Power Company seeks power for the purpose of supplying electricity within an area comprising the city of Newcastle, the boroughs of Tynemouth, South Shields, and Jarrow, the urban districts of Willington Quay, Gosforth, Wallsend, Walker, Newburn, Benwell and Fenham, and Westslade, Blaydon, Whickham, Felling, Hebburn, and Ryton, and the rural districts of Tynemouth and South Shields. There is a clause in the Bill excluding a general supply of electricity within the city of Newcastle-on-Tyne, and another stipulating that the powers granted to the company shall not confer upon them the exclusive right to supply electrical energy within the area of supply, nor hinder or restrict any other body from supplying or increasing their present supply of energy within that area. It is intended to erect three generating stations, at Wallsend, Hebburn, and Whickham respectively. The capital is £500,000.

Yorkshire Bills.—The Huddersfield Corporation Tramways Bill proposes to authorise the adaptation of the existing Corporation tramways for electrical power, and to construct additional tramways in the borough and in Brighouse, Mirfield, Marsden, Slaithwaite, Linthwaite, Lepton, Kirkburton, Honley, Thurstonland, New Mill, Netherthong, Holmfirth, Fixby, Clifton, and Hartshead, the Corporation being empowered to purchase or take on lease tramways without the borough. The Bill seeks to raise £261 203 for the construction of tramways, and £138,147 for general tramway purposes, and the total length of new lines to be authorised is about 23 miles.—The Morley Corporation Bill makes further provision in regard to the electrical undertaking.—The Scarborough Corporation Bill, among other matters, asks for power to borrow £32,000 for tramways, and such sum as may be required for the purchase of the undertaking of the Scarborough Electric Supply Company.—The Halifax Corporation seek power to construct additional tramways, and to borrow £326,000 for tramway purposes and £100,000 for the purposes of the electric lighting undertaking.

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Malton.—The Urban Council have sealed the draft agreement under which the Northern Counties Electric Supply Company are seeking to obtain a provisional order from the Board of Trade to supply electricity within the district.

Partnership.—Mr. Bernard P. Scattergood, late head of the electrical testing department of Messrs. John Fowler and Co., of Leeds, and Mr. Claude Johnson, jun., late of Messrs. Johnson and Phillips, Charlton, S.E., have entered into partnership as electrical engineers. Their offices are at Westminster-buildings, East-parade, Leeds.

Dornoch Light Railway.—The Government grant in aid of the construction of the line between the Mound and Dornoch has been increased from £9,000 to £14,000, which is one-half the estimated cost. The offers for construction will probably come before the directors this week, and the work is expected to be proceeded with almost immediately.

Unwin's Chap-Book, 1899-1900.—This year's chap-book, published by T. Fisher Unwin, London (1s.), is well got up and beautifully illustrated, and contains, as usual, extracts from the best books published by the firm during the past 12 months—just enough to whet your appetite—and biographical and anecdotal sketches of their authors.

Douglas.—At a special meeting of the Town Council last week a proposal was made to purchase a site containing half an acre almost adjoining the gas company's works for the erection of electrical works to light the public lamps and supply private consumers. Another site at Belle Vue was also suggested. The matter was adjourned for a month.

West Ham.—At a recent meeting of the Guardians it was proposed that an electrophone instrument be obtained and fixed to the present telephone connection on approbation for the Board to consider the advisability of connecting the same with the infirmary and workhouse. The cost would be £10 and 10s. for each room supplied. The motion was referred to committee.

Canterbury.—At the last meeting of the Council it was stated that measures were still under the consideration of the Lighting Committee with regard to the better illumination of the streets by means of the incandescent lights. They hoped that a remedy would be found in the course of a few days. They had been waiting for additional cable and plant, which was now being delivered.

Durham.—The Corporation (the undertakers for the purpose of the Durham Corporation Electric Lighting Order, 1899) have published the statutory advertisement notifying that with the consent of the Board of Trade they propose by deed to be approved by the Board of Trade to transfer their powers, duties, liabilities, and works to the County of Durham Electrical Power Distribution Company, Limited.

St. Olave's.—The application of the London Electric Supply Corporation for permission to lay additional mains with inspection boxes in Tooley-street, across Queen Elizabeth-street, and the Tower Bridge Approach has been granted by the Board of Works, subject to the mains being placed at a depth of not less than 4ft. below the surface, and to the company altering them at their own cost in case of any public improvement being made.

Southwark.—The Vestry have decided not to object to the London Electric Supply Corporation's application to lay high-tension distributing mains along New Kent-road, Paragon-mews, and Searles-road, also to construct surface boxes of the usual pattern in positions indicated on the plan submitted, providing the works are carried out to the satisfaction of the surveyor, and they have informed the London County Council to this effect.

Birmingham. — The Corporation on Jan. 1 effected the purchase of the undertaking of the Birmingham Electric Supply Company. The formal transaction took place at the London and Midland Bank's Birmingham office, when a cheque for £420,000, the amount of the purchase price, was handed over by the deputy town clerk and the acting city treasurer to the representatives of the company. The Corporation will take over the staff and the workmen in the company's employ, and acquire all the rights for the manufacture and supply of the electric light hitherto possessed by the company.

Bath.—The Local Government Board have intimated to the Corporation that the report of Colonel Durnford on the enquiry he recently held in Bath had been brought before the Board, who had sanctioned a loan of the amount of £25,900 instead of £26,000 as applied for. In arriving at this amount the Board had deducted £100 in respect of the provision of switching, as they considered the cost of this should not come out of the loan. The Board also required that no part of the money should be expended on incandescent lamps or in salaries. The permission was for a loan not exceeding 25 years.

Henley.—Mr. Wilkinson has reported on the electric lighting, and is meeting the Electric Lighting Committee this week to discuss the same. The probable expenditure will be about £14,000, exclusive of the additional work of supplying the connections with the compressed-air mains, which will bring the total just under £20,000. Mr. Hare, the architect, has been instructed to accept the lowest tender for the wiring of the town hall. The amount is estimated at £125. A petition from the owners and occupiers of houses in Hamilton-avenue, asking for extra lighting, has been deferred until such time as the road is taken over.

Great Malvern.—At a recent meeting of the Urban District Council the special committee appointed to consider the question of establishing electric lighting in the town advised the Council to adopt a scheme prepared by Mr. R. Hammond, upon which the initial outlay would be £30,000. Mr. Hammond anticipated a loss of £200 a year for three years, and a profit in the fourth year of £355, which would be increased as the demand for the light grew. There was strong opposition to the proposal. After a long discussion, it was decided to convene a town's meeting, in order to ascertain the views of the ratepayers with regard to the outlay.

Accident.—The hitherto clean record of the Glasgow electric tramways has at last been broken. The accident does not seem, however, to be in any way connected with the electrical apparatus on the cars, but mainly through the carelessness of a driver. Two cars, one a double-decker and the other a single-decker, left the Mitchell-street station for Springburn, the double-deck car being in advance. The cars proceeded a certain distance when the double-deck car stopped to set down passengers. There seems to have been no effort on the part of the driver of the single deck car behind to slacken speed, and it dashed with full force into the rear end of the double-deck car, with the result that a girl was killed and three men injured. This is the first death which has occurred from accident on the Glasgow car system.

London Gazette.—The first meeting in the estate of W. Dalzell, Newcastle-on-Tyne, was held on Dec. 29, 1899, at 11.30 a.m., at the office of official receiver, 3, Mosley-street, Newcastle-on-Tyne. The public examination will take place on Jan. 11, at 11 a.m., at the Court House, Westgate-road, Newcastle-on-Tyne.—The first meeting in the estate of F. Beville de Foe Paynter, Middlesex, will be held on Jan. 10, at 12.30 p.m., at 24, Railway-approach, London Bridge, S.E. The public examination will take place on Jan. 30, at 1 p.m., at the Court House, Burney-street, Greenwich.—An adjudication order was made out against W. Rowbotham, Teddington, at Kingston Court. Mr. H. C. Howard, 17, Coleman-street, E.C., has been appointed trustee.

Todmorden.—At the last meeting of the Town Council it was mentioned that at the last meeting of the Finance Committee it had been decided to refer to the Gas Committee the resolution adopted by the Council some months ago in reference to the proposed construction of electricity works. At the time when the resolution was carried it was understood that the committee should consider the advisability of working the tramways by electricity as well as supplying it for lighting and other purposes. It was now suggested that the Council appoint a special committee to deal with the matter. The Mayor ruled that the proposal must be considered by the Gas Committee in the first instance, but that that committee might ask the Council to appoint a special committee to deal with the subject.

Chelmsford.—At a meeting of the Town Council held last week, the Road and Lighting Committee jointly reported that the town clerk having written to the Chelmsford Electric Lighting Company, Limited, forwarding them a copy of the surveyor's report in reference to the condition of the roads and footpaths broken up by the company in laying new cables and doing other work, had received a letter in reply, stating that instructions had been given that in future everything possible was to be done to satisfy the surveyor. The Council agreed to receive £272 as due to them from the Chelmsford Electric Lighting Company for repairs of roads and footpaths. The electric lighting company have also obtained the consent of the Town Council in reference to their application to lay water-pipes from their boiler-house at the Arc Works to a well on land near Seymour-street.

Crompton's Baby Show.—The annual entertainment given by Messrs. Crompton and Co. to the employés at the Arc Works, Chelmsford, took place last Saturday. The entertainment was a complete success, and the 800 guests were not dull for a moment during the five hours the entertainment lasted. A great feature of the entertainment was a baby show. The entries consisted of one and two years old, 20 entering in the one-year class and rather fewer in the two-year class. After the babies had been inspected and the prizes awarded we have it on record that the Mayor complimented the firm generally on the production of such a fine show, and said it was firms like Messrs. Crompton and Co. which had made Chelmsford and similar towns successful. Mr. R. E. B. Crompton was unable to be present at the gathering owing to work in connection with the Electrical Engineers' Volunteers Corps.

St. Luke's.—At the last meeting of the Vestry a letter was received from the London County Council stating that their attention had been called to the fact that the National Telephone Company had carried out works in several parts of the Metropolis without having first obtained the consent of the Council as required by the Telegraphs Act. The Council had for some time been endeavouring to come to some arrangement with the Telephone Company, but hitherto the negotiations had proved abortive. In the meantime the company had carried out certain works, and the Council were advised that there was no provision in the Act for the imposition of penalties. They asked to be immediately informed by the Vestry when the company commenced new works in the district. It was eventually decided to inform the County Council if the Telephone Company commenced any new works in the district.

George Schultz and Co.—We are informed that the partnership between Mr. Charles Jennings and Mr. George Schultz, formerly Charles Jennings and Co., has been dissolved under date of Jan. 1 by mutual consent. Mr. Schultz has purchased Mr. Jennings's share in the goodwill of the business, which will be continued under the style of George Schultz and Co. The following agencies carried on by the late firm will likewise be continued by the new firm—viz.: Etablissements Mouchel, Paris and Boisthorel, etc., manufacturers in all forms of high-class copper, brass, and alloys for electrical and other purposes; Hawthorn and Co., Leith, N.B., iron and steel forgings of every description; W. Shaw and Co.,

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Middlesbrough, manufacturers of steel castings up to 10 tons—speciality, dynamo castings; Gebr. van der Zypen, Cologne-Deutz, sectional steel of all kinds—angles, bars, round, square, and flat, etc.

Worthing.—The Town Council on Tuesday confirmed a report of the Electric Lighting Committee acknowledging the receipt of a letter from the Local Government Board with reference to the application of the Council for sanction to borrow the sum of £36,900 for electric lighting purposes, stating that the Board had decided to comply with the application so far as relates to the sum of £32,500 required for immediate outlay upon the scheme, such sum to be repaid with interest within a period of 25 years from the date of the borrowing thereof. The report added that the engineers, Messrs. Burstall and Monkhouse, have been accordingly instructed to prepare the necessary working plans, drawings, and specifications, and such other information as may be requisite to admit of tenders being invited for the execution of so much of the works which form part of the scheme adopted by the Council as is comprised within the stated sum of £32,500.

Annual Festival.—The employés of Messrs. Lowdon Bros. and Co., Dundee, Edinburgh, and Glasgow, held their annual festival in the City Assembly Rooms, Dundee, on Friday last. Mr. E. J. B. Lowdon, the senior partner, presided, and was supported by Messrs. K. Lowdon and G. Balfour, the other members of the firm. About 200 sat down to tea, after which the chairman, in an address, congratulated the employés on the representative turn-out, and also on the cheerful and successful manner in which they had got through a very busy year's work. Mr. G. Balfour said that contracts had been fixed which would keep the employés busy for a good part of the ensuing year, and though not fully fixed for the whole of 1900, the firm were at present in negotiation in connection with contracts which he had every confidence in announcing, and which would not only keep the whole staff busy, but would entail still further extensions of their already large premises in Dundee and elsewhere.

Rochdale.—There were 64 applications for the position of electrical engineer and clerk of works in connection with the installation of the electric light at the workhouse. The number was reduced to four—William Barnes, Manchester; L. Ellison, Morecambe; Robert Senior, Dewsbury; and William Stirzaker, Rochdale. Mr. Senior, who has for six years been in charge of the workhouse electric plant at Dewsbury, has been appointed. At the last meeting of the Guardians resolutions were passed consenting to the erection of an engine-house, boiler-house, and chimney at the workhouse in connection with the proposed lighting of the workhouse cottage homes and new infirmary by electricity, to the provision of the necessary machinery and plant for the above purpose, and to the borrowing of £9,876 for carrying out the work, £1,876 of this to be repaid within 30 years by equal annual instalments of principal and interest, and the remaining £8,000 to be similarly repaid within 15 years.

Wireless Telegraph and Signal Co.—The third ordinary general meeting of the Wireless Telegraph and Signal Company, Limited, was held on Friday last at 28, Mark-lane, E.C. The report stated that the past year must be considered as another year of experiment, but the foundation had now been laid on which a sound commercial business might be expected to be built up at an early date. After alluding to the experiments which had been made, some of which at the last naval manœuvres reached 70 miles, the report stated that six assistants with apparatus sailed under agreement with her Majesty's War Office for South Africa. Naturally, the experience of the Company's assistants, under Mr. Bullock, with the Marconi system for the first time in the field during active warfare was of very great interest. The directors recommended that the name of the Company should be changed to "Marconi's Wireless Telegraph Company, Limited." Major Flood Page, the managing director, proposed that the meeting be adjourned till some day in January or February, 1900, to be appointed by the directors. This was agreed to.

Bristol.—The Town Council on Monday adopted the following report of the Electrical Committee on the extension of the electrical undertaking: "Your committee report that they have had under their consideration the sum necessary to be expended in making provision for the probable increase in the demand for electricity during the next two or three years. Your committee find that the following capital expenditure will be required: high and low pressure mains, feeders, meters, and connections to consumers, £60,389; foundations, buildings, engine-room plant, and boiler plant at Avonbank, £71,397; provision of additional plant at Temple Back, £12,229—total, £144,015. Your committee are of opinion that the sum to be borrowed should consist of: expenditure on new works as above mentioned, £144,015; purchase money of property at Temple Back already acquired with the consent of the Council, £933; cost of obtaining loan, stamp duty on mortgage, and incidental expenses, £202—total, £145,150. Your committee recommend the Council to authorise them to carry out the foregoing works, and to obtain the sanction of the Local Government Board to a loan of £145,150."

Aberdeen.—At the last meeting of the Electric Lighting Committee a report was submitted concerning the additional demand probable to arise in the near future as to electric lighting and energy, and after some conversation it was decided to leave consideration of it over until a future meeting. It was, however, agreed to recommend to the Council at their first meeting to authorise the erection of an additional engine and dynamo complete, with spare armature, suitable for lighting and traction, in view of the absolute necessity of what would be required in this direction early in the autumn of 1900. The other portions of the report were left over for consideration. Tenders were submitted for furnishings for the department for 1900, when the following were declared the successful offerers: cast-iron work, Messrs. Abernethy and Co.; malleable iron, Messrs. Glegg and Thomson; brasswork, Messrs. Blaikie and Sons and Messrs. Wm. V. B. Cowan; lead, Messrs. J. Blaikie and Sons; rope yarn, etc., Messrs. Duthie Bros.; timber, Messrs. George Gordon and Co.; painter and glazier's work, Messrs. Geo. Donald and Sons; dry-salteries, etc., Messrs. W. Riddell and Co.; fireclay goods, Bonnybridge Fireclay Company; retorts, Messrs. P. and M. Hurl, Glasgow; and carting, Messrs. J. M'Adam and Co.

Calendars Received.—We have received from the Electrical Power Storage Company, Limited, of 4, Great Winchester-street, E.C., their blotting pad and diary for the year 1900. This is a useful article for office use, containing as it does ample space for memoranda for each day of the year. In addition to this, postal information is given, and also particulars of the numerous kinds of batteries and accumulators supplied by the firm. A list of the E.P.S. regulating switches and switchboards and other instruments is also given. On the inside of the cover of the diary is also found a railway accident insurance coupon, which, on being signed, entitles the holder to £200 on disablement, and the next-of-kin is entitled to £500 if the owner of the coupon be killed on the railway.—We have also received from Messrs. Julius Sax and Co., Limited, of 119, Coldharbour-lane, S.E., one of their New Year's calendars. This firm being very old-established manufacturers of electric bells, it is very appropriate that the calendar should be in the form of one of these instruments. Messrs. Sax and Co. also inform us that, owing to the large and increasing amount of Government work which they have in hand, they are putting further machinery in their works. Messrs. Sax and Co. intimate that they will be pleased to forward copies of the calendar to any of our readers who might wish to possess them.

PROVISIONAL PATENTS, 1899.

DEC. 18.

25032. Improvements in electric driving mechanism for geared machines generally. Frederick Samuel Carter, 4, Corporation-street, Manchester.

25053. Improvements in connecters for electrical wires or cables. Thomas Ridley Sowerbutts, 44, West hill, Wandsworth, London.

25054. An improved method for connecting tubular conduits with rectangular casings for electric conductors. George Henry Congdon and Frederick McCullum, 47, Hitherfield-road, Streatham, London.

25057. Electric light magnifying bulbs or burners. Octavius Dixie Deacon, 150, Leadenhall-street, London.

25072. Electrolytic interrupter. Frederic de Mare, 70, Chancery-lane, London. (Complete specification.)

DEC. 19.

25164. Improvements in electric igniting devices for lighting gas and like lamps. Ernest Schmidt, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25177. Improvements in and relating to electrical illuminated advertisements. Count Henry Robert de Lambertye-Tornielle, 18, Buckingham-street, Strand, London.

25186. Improvements in apparatus employed in wireless telegraphy. Guglielmo Marconi and the Wireless Telegraph and Signal Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

25200. Improvements in electricity meters. William Henry Johnson, 46, Lincoln's-inn-fields, London.

DEC. 20.

25216. Improvements in electric cable conduits. George Edward Heyl-Dia, 55, Market-street, Manchester.

25254. Improvements in the construction of reflectors or shades for electric or other lights. Oliver Holt, 8, Quality-court, Chancery-lane, London.

25274. Process for clearing the bulbs of electric incandescent lamps. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Johann Lux, Austria.)

25275. Improvements in or relating to clock-controlled electric switches. Ernest Webster, 46, Lincoln's-inn-fields, London.

25281. Improvements in or relating to electrical traction particularly applicable for tramways and railways. Howard Lane, 11, Burlington-chambers, New-street, Birmingham.

25282. Improvements in earthing devices and safety fuses for electrical circuits. Louis John Steele, 11, Burlington-chambers, New-street, Birmingham.

25295. Improvements in electrical resistance measuring instruments. John Ambrose Fleming, 36, Chancery-lane, London. (Complete specification.)

DEC. 21.

25348. Improvements in or connected with incandescent electric lamps. George Davis, 38, Margravine-gardens, West Kensington, London.

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25346. Improvements in perforators for use in connection with automatic telegraph transmitters. Anthony Stephen Frampton and Muirhead and Co., 323, High Holborn, London.

25347. A new or improved method of measuring the difference of electric pressure between points of a circuit which may be distant from the observer and apparatus therefor. Michael Birt Field, 1, Handenroad, Lee, Kent.

25350. Improvements in electric incandescent lamps. Victor Scholz, 45, Southampton-buildings, Chancery-lane, London.

25353. Improvements in liquid resistances for electrical circuits. Ernest Francis Moy, Percy Henry Bastie, and Ernest F. Moy, Limited, 37, Essex-street, Strand, London.

25362. Improved method of telegraphing on telephone lines and telegraphic recorders for use in connection therewith. William Phillips Thompson, 322, High Holborn, London. (Alf. Sinding-Larsen, Norway.) (Complete specification.)

25366. Improvements in electric incandescent lamp fittings or fasteners. Serge Berditschewsky Apostoloff, 53, Chancery-lane, London.

DEC. 22.

25391. Improvements in electrical measuring instruments. George Keith Buller Elphinstone and Arthur Cecil Heap, Century Works, Lewisham, London.

25396. Electric trackway train. Arthur St. Vincent Burnaby, 67, The Drive, Hove, Brighton, Sussex.

25403. An improved electric low-water alarm for steam generators. Stephen Martin Mathews, 28, New Bridge-street, London. (Complete specification.)

25407. Improvements in holders for electric incandescent lamps. John Pullar Phibbs, 15, King's-square, Bristol.

25413. Improved means for insulating electric conductors. Walter William Colley, 37, Cursitor-street, Chancery-lane, London.

25415. Improvements in and relating to perforators for use in connection with automatic telegraph transmitters. George Draper, Kenwrick Cecil Cox, and John Jeffrey, 323, High Holborn, London.

25417. Improvements in and relating to electromagnets. Leon Jules Delaveau, 70, Chancery-lane, London.

25420. Improvements in alternating-current inductor motors. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 24, 1899, being date of application in United States.)

25421. Improvements in alternating-current generators. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 24, 1899, being date of application in United States.)

25422. Improvements in systems of electrical distribution and circuit breakers for use therein. Lewis Buckley Stillwell, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 24, 1899, being date of application in United States.)

25423. Improvements in electrical resistances. Julien Dulait and Otto Garbe, 322, High Holborn, London.

25426. Improvements in or relating to electric arc lamps. David Jackson Bissell, 6, Lord-street, Liverpool.

25432. New or improved electrically-actuated air-douche apparatus. August Emil Thiergärtner, 115, Cannon-street, London. (Complete specification.)

25439. A new or improved electrical contact apparatus. Eugene Cadet and Charles Chevallier, 18, Buckingham street, Strand, London.

25446. Improvements in electric railway motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward D. Priest, United States.) (Complete specification.)

25447. Improvements in electric brakes. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (Frank E. Case, United States.) (Complete specification.)

25448. Improvements in safety devices for electric vehicles. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Frank E. Case, United States.) (Complete specification.)

25449. Improvements in means for controlling electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert G. Davis and William B. Potter, United States.) (Complete specification.)

25450. Improvements in systems of electric train control. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

25451. Improvements in electric switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Eustace Oxley, United States.) (Complete specification.)

25452. Improvements in means for cooling electric brake shoes. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Axel Ekstrom, United States.) (Complete specification.)

25453. Improvements in alternating-current motor systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert G. Davis, United States.) (Complete specification.)

DEC. 23.

25464. Improvements in electric alarms. Max Weecher and Paul Wollenhaupt, 12 Salomonsgasse, Cologne. (Complete specification.)

25490. Improvements in secondary batteries. Michel Auguste Philippe Monnier, 6, Bream's-buildings, Chancery-lane, London.

25491. Improvements in accumulator batteries. Pascal Marino, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25494. An improvement in the manufacture of guttapercha. Siemens Bros. and Co., Limited, and Wilhelm Dieselhorst, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

25509. Improvements in methods or means of insulating electric wires. Benjamin George Hodges, Henry Smith, and William Arthur Ager Burrows, Imperial-chambers, Albert-street, Derby.

25513. Improvements in electric arc lamps. Arthur Freemore Spooner, 323, High Holborn, London. (Pierre Vassia, France.)

25514. Improvements in telegraph relays. Angus Fraser and George Draper, 323, High Holborn, London.

DEC. 27.

25553. A quality attachment or loner and sound distributer and augmenter of "phonograph" musical sounds, speech, etc. William Samuel How and George Lindsay Johnson, 36, Finsbury-pavement, London.

25576. Improvements in resistance switches and automatic cut-outs for starting, regulating, and protecting electric motors and their circuits. Veritys, Limited, and Louis John Steele, 11, Burlington-chambers, New-street, Birmingham.

25591. Repeater for wireless telegraphy. Emile Guarini, 33, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, May 27, 1899, being date of application in Belgium. (Complete specification.)

DEC. 28.

25601. Improvements in inspection and junction pieces for electric wire conduits. Andrew Weston Prentice, 100, Wellington-street, Glasgow.

25621. Improvements in electric light switches. Andreas Peter Lundberg and Gustaf Charles Lundberg, Bradbury-street, Kingsland, London.

25622. Improved method of fitting the covers of electric light fittings to their base parts. Andreas Peter Lundberg and Gustaf Charles Lundberg, Bradbury-street, Kingsland, London.

25628. Improvements in electric fishing apparatus. Ivan Werner Johannes Lindbohm, 53, Chancery-lane, London.

25641. Improvements in electro-mechanical accumulators. Henry W. Schlomann and Angel de Castro, 322, High Holborn, London.

DEC. 29.

25681. Improvements in and connected with electro-dynamo-motors. Victor Isidore Feeny, 60, Queen Victoria-street, London. Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

25683. Improved apparatus for electro-therapeutic treatment. Johann Jakob Stanger, 322, High Holborn, London.

25688. Improved apparatus for automatically controlling the light of electric, gas, and other lamps. Clarence Edgar Romaine Keddie and Eugene Solmersitz, 53, Chancery-lane, London.

DEC. 30.

25699. Improvements in or appertaining to electromotors. George James Gibbs, 2, Market-street, Bradford.

25701. An improved controlling apparatus for electric motors John Alexander Steven and William Rylance Haigh, 6, Elmwood-gardens, Broomhill, Glasgow.

25709. Improvements in electrically-driven cranes. Frederick Henry Royce, Cooke-street, Hulme, Manchester.

25710. Improvements in electrical apparatus for opening gas-cocks from a distance. Ridley James Urquhart, 57, Barton-arcade, Manchester. (The Aktien-Gesellschaft für Fabrikation von Bronce-waren und Zinkguss, vormals Spinn and Sohn, Germany.)

25721. Improvements in plates for storage batteries. Alexander Pallavicini, 160, Friedrichstrasse, Berlin. (Complete specification.)

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25730. An improved electrical commutator. Joseph Byrant, Henry Smallman, and Alfred Howard Elsom, 70, Finsbury-pavement, London.

25736. Improved electrical igniting apparatus for internal-combustion engines. Ernst Schaeffer, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

25738. Improved reversing mechanism for phonographs. Philipp Richard, 322, High Holborn, London. (Complete specification.)

25740. Improvements in current collectors for electrical machines. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 5, 1899, being date of application in United States.)

25741. Improvements in and relating to lightning arresters. Alexander Jay Wurts, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 8, 1899, being date of application in United States.)

25744. Improvements in dynamo-electric machines. British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry G. Reist, United States.) (Complete specification.)

25745. Improved method of regulating dynamo-electric machines. British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

25746. Improvements in alternating-current electric motors. British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

25747. Improvements in safety devices for dynamo-electric machines. British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Harold W. Buck, United States.) (Complete specification.)

25748. Improvements in electric railway systems. British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Albert H. Armstrong, United States.) (Complete specification.)

25749. Improvements in electric railway systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

25750. Improvements in controlling electric motors. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Maxwell W. Day, United States.) (Complete specification.)

25751. Improvements in electric time switches. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles H. Van Slycke, United States.) (Complete specification.)

25752. Improvements in electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. Caryl D. Haskins, United States.) (Complete specification.)

25767. Improvements in or relating to electric motors. Harold Rowntree, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

25768. Improvements in and relating to electric lifts or elevators. Harold Rowntree, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1898.

21043. Electric meter systems British Thomson-Houston Company, Limited. (Rice.)

25764. Devices for making and breaking surface contact on electrical tramways. Stamp.

1899.

1487. Electric light wire casing. Davidson.

2742. Electric floats for theatrical purposes. Bowles.

6687. Porous diaphragms for electrolytic cells and methods of producing the same. Dow.

7523. Clip for shades for electric lamps, candles, or other illuminating devices. Dunand.

13008. Apparatus for converting alternating currents into continuous current. Déri.

17337. Battery cells with double case, applicable also as a Leyden jar. Vogt.

21329. Means of maintaining and renewing the charge of electric accumulators working motors for carriages, boats, balloons, and other vehicles. Placet. (Date applied for under International Convention, May 27, 1899.)

21354. Apparatus for electrically winding up or giving tension to driving springs. Aron and Aron Electricity Meter, Limited.

21652. Method of and means for synchronising electric motors. The British Thomson-Houston Company, Limited. (Case.)

22384. Chemical electrical excitants. Post.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1899.	1898.	Increase or decrease.	Total receipts for half-year. 1899.	1898.
		£	£	£	£	£ c
Birmingham Tramways Co.	Dec. 30	3,709	3,823	- 114	215,764	197,211
Blackpool-Fleetwood	,, 31	213	216	- 3	20,297	14,476
Bradford City Trams	,, 10	335	247	+ 88	22,969	—
Bristol Tramways Co.	,, 29	3,048	3,194	- 146	—	—
City & South London	,, 31	966	1,036	- 70	26,961	27,002
Dover Tramways ...	,, 30	158	193	- 35	1,0044	8,549
Dublin U.T., elec. cars	,, 29	2,987	648	+2,339	—	—
Dublin S.D. Electric	,, 29	664	785	- 121	—	—
Halifax Corporation	,, 31	514	265	+ 249	23,308a	7,118b
Hull Corporat'n E.S.	,, 30	771	—	—	17,028c	— c
Liverpool Corporat'n	,, 9d	6,801	6,028	+ 773	337,897	296,957
Liverpool Overhead	,, 17	1,432	1,324	+ 108	40,370c	38,379c
Sheffield Corporation	,, 31	2,090	—	—	—	—
South Staffordshire	,, 31	1,021	954	+ 67	34,822c	33,142

a Since April 1, 1899. *b* Since June 29. *c* Since Jan. 1.
d Partly electrical. *e* Since July 5.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Tuesday.
Aron Electricity Meter, Ld., 6 p.c. Cum. Pref. Shs., 1-125,000	1	¾-⅞
Blackheath & Greenwich. District Elec. Lt., Ord. 1,201-101,200	1	¾-1
Blackpool and Fleetwood Tramroad Shares	10	17-19
Bournemouth and Poole Electric Supply, Limited, Ord.	10	12-13
—— 4½ per cent. Cum. Pref.	10	10-11
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	15-16
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12½-13
—— 5 per cent. Perpetual Debenture Stock	100	125-128
British Insulated Wire, Ord., No. 1 to 40,000	5	11½-12½
—— 6 per cent. Cum. Pref., No. 1 to 27,500	5	6½ 6¾
Brompton and Kensington Electric Supply Co., Ordinary	5	7⅞-8⅛
—— 7 per cent. Preference	5	9-10
Brush Electrical Engineering, Limited, Ordinary	2	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	110-115
—— 4½ per cent. 2nd Debenture Stock	100	102-105 xd
Callender's Cable Company, Debentures	100	110-115 xd
—— Ordinary	5	12½-13½
—— 5 per cent. Pref.	5	5½-5¾ xd
Central London Railway, Ordinary	10	9½-10 xd
—— Pref. Half-Shares	5	4½-5 xd
—— ,, ,, deferred	5	4⅜-5 xd
Charing Cross and Strand	5	9⅞-10⅛
—— 30,001-50,000	5	9⅞-10⅛
—— 4½ per cent. Cum. Pref.	5	5½-6
Chelsea Electricity Company	5	7⅛-8⅛
—— 4½ per cent. Debentures	100	109-111
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	13-14
—— 5 per cent. Debenture Stock	100	122-127 xd
City and South London Railway, Consolidated Ordinary	100	59-62
—— ,, ,,	4½	3½-4½
—— 4 per cent. Debenture Stock	100	127-133
—— 5 per cent. Pref. Stock '91	100	143-148
—— ,, ,, '96	100	135-140
County of London and Brush Prov. Elec. Light Co., Ord.	10	10-11
—— 6 per cent. Cum. Pref.	10	13-14
—— 4½ per cent. Debentures Prov. Certs. All pd. Ed.	—	107-110 xd
Crompton and Co.	3	3½ 4
—— 5 per cent. Debentures	—	98-101 xd
Edison and Swan United Ordinary	3	2-2½
—— 5 per cent. Debentures	5	3½-4½
—— 4 per cent. Deb. Stock, Red.	100	93-96 xd
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	4½-5½
Electric Construction, Limited	3	1⅞-2⅛
—— 7 per cent. Cumulative Pref.	3	2⅞-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	104-107
W. T. Henley's Telegraph Works, Ordinary	5	12-13
—— 4½ per cent. Preference	5	5-5½
—— 4½ per cent. Debentures	100	111-114
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21½ xd
—— 4 per cent. Debentures	100	100-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	8	8-8½
London Electric Supply, Ordinary	3	2½-2⅞
—— 6 per cent. Pref.	5	5⅞-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	102-104
Metropolitan Electric Supply, Limited, Ord.	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	116-118 xd
—— 3½ per cent. Mortgage Debenture, Red.	100	96-97 xd
National Telephone, Ordinary	5	4⅞-5⅛
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Non. Cum. Third Pref.	5	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100	98-100 xd
New General Traction, Limited, Ordinary	5	3½-4
—— 6 per cent. Cum. Pref.	5	5-5½
Notting Hill Electric Lighting Company, Limited	10	15½-16½
Oldham, Aston, and Hyde Electric Tramway, Ordinary	10	18-19
—— Preference	10	10⅞-10⅞
Oriental, Limited, 1879	1	1⅛-1⅜
—— £5 Shares	5	7-7½
—— £4½ Shares, New	4½	6½-6¾
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7½
Potteries Electric Traction, Ld., Ord., Nos. 26,667-40,000	10	11-12½
—— 5 per cent. Cum. Pref., Nos. 1-20,000	10	10-11
Royal Electrical Company of Montreal	1⅛	150-170 xd
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	4-4½
St. James's and Pall Mall, Limited, Ordinary	5	15-16
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	34-38
—— 5 per cent. Bonds	100	102-105 xd
Telegraph Manufacturing, Ordinary	5	9-10
—— 5 per cent. Cum. Pref.	5	5½-6
Waterloo and City Railway, Ordinary	100	101-104
Westminster Electric Supply, Ordinary	5	13½-14½

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NOTES.

Electric Light Breakdowns.—We understand that the President of the Board of Trade has consented to receive a deputation at Whitehall-gardens on the 17th inst., at 2.30 p.m., of those who have suffered from the failures of the Metropolitan Electric Supply Company to supply them with current.

Personal.—We are informed that Mr. R. A. Dawbarn has resigned the position of superintending engineer to the Brush Electrical Engineering Company in order to take up consulting practice. Mr. Dawbarn has been connected with the Brush Company for many years, and those who have met him in his capacity of superintending engineer will wish him every success in the consulting field.

Calcutta.—A definite agreement has now been made between the Calcutta Corporation and the Calcutta Tramways Company, by which the latter is bound to introduce a system of electric traction into the city within three years. In the event of this not being done, the company will have to pay a heavy fine per day till the work is completed. Under the agreement the tramway undertaking can be purchased by the Corporation at the beginning of 1931.

An Irish Water-Power Scheme.—The Fishery Board of the Shannon are again considering the Bill of the Shannon Water and Electrical Power Company. The great objection raised to the Bill by the Board is that it is proposed to lower the water-level of the Shannon lakes by 7ft. at times, and it is stated that this will seriously injure the fisheries of the district. We think the promoters of the Bill would do well to meet the Fishery Board on this point, if possible, before their Bill comes up for discussion in Parliament.

Lightning.—In the current number of *Knowledge*, Mr. H. B. Little gathers up the fragments of the controversy of the past 12 months on "Trees struck by Lightning." It would be well to suggest that writers on the subject of the action of lightning make themselves acquainted with the work of Prof. O. Lodge on the matter; they would then be less surprised at what they deem the vagaries of the action of lightning, and it would also, we fancy, tend to inculcate more widely the view that electrical action possesses many of the characteristics of the action of an entity.

Telegraphs in India. — We learn from *Indian Engineering* that a new telegraph line between Madras and Calcutta has now been practically finished, and that it will be ready for use in a short time. Copper conductors are used entirely for the new line so as to increase its working capacity. The route chosen is *vid* Dhoud and Mannad. A third line will also be constructed to connect up Bombay to these lines. The copper wires along the new route are supported on oil insulators of the Johnson and Phillips type, so as to minimise the effect of the saline atmosphere along the coast.

An Interesting Experiment.—Mr. I. J. Kavanagh, of St. Mary's College, Montreal, has designed an interesting experiment to show the great difference in the conducting power of carbon as it is heated. For this purpose he took a stick of wood charcoal connected between terminals at 110 volts. He then drew slowly along a zigzag path on the charcoal a carbon connected to one of the poles. He commenced the path by an arc which was gradually drawn out, heating the zigzag path between the two poles. Sufficient current then passed between the electrodes on the ends of the charcoal stick to keep the path luminous showing that the bulk of the current passed along it in spite of the much shorter road through cool carbon.

An Electric Transporter Bridge.—Amongst the Bills to be considered at the next session of Parliament is one for the incorporation of a company to construct a transporter bridge to connect Widnes with the urban district of Runcorn. The proposed bridge will cross both the River Mersey and the Manchester Ship Canal. It is proposed that carriages, heavy carts, and passengers will be carried across the river and canal by means of a platform suspended from the bridge itself. This moving platform will be propelled by electricity. Sir John F. Bruner, M.P., will be the chairman of the undertaking, which will have a capital of £75,000.

Patent Office Reform.—We learn from the Press Association that Mr. Ritchie, the President of the Board of Trade, has appointed a Departmental Committee upon the subject of patent facilities, and that the following are the official terms of the reference: "To consider various suggestions which have been made for developing the benefits afforded by the Patent Office to inventors, and report." The committee will comprise Mr. F. J. S. Hopwood, chairman; Mr. Edward Carpmael, president of the Chartered Institute of Patent Agents; Mr. C. N. Dalton, C.B., Controller-General of Patents; Mr. J. A. Kempe, deputy-chairman of the Board of Customs; Mr. S. E. Spring Rice, C.B., of H.M. Treasury; and Mr. Arthur Neeves, of the Board of Trade, who will act as secretary.

Duty on Electricity.—The Niagara Falls Power Company have petitioned the Treasury Department of the United States of America to levy a tariff on the electricity generated in Canada and transmitted across the border into the United States. This course is being taken in order that the Ontario Power Company shall not compete in the United States with the petitioning concern, and it is stated that insomuch as electricity is a thing of value and can be bought and sold, it should be subject to duty. After the recent decisions of the German law courts and also common sense refute the statement that the electric current is a thing, still there is no doubt that it does compete with an American industry in the above case, and we should not be surprised to find that, following out the protective policy of that country, a tariff is imposed. In fact, we know that in Russia certain towns, such as St. Petersburg, even propose to levy a tax on all electricity delivered into the town from generating stations outside the municipal boundary.

Locomotion. — Thursday last week Mr. Scotter delivered a lecture at the Drill Hall, Northwich, on "Locomotion — Past, Present, and Future." In this lecture Mr. Scotter went back to the earliest methods of travelling, and traced the gradual development of the improvement in means of locomotion from the old Roman carriages up to the railways of to-day. He stated his opinion that electricity was fast superseding steam as a means for supplying energy for traction, and proceeded to call the attention of his audience to an application now before the Light Railway Commission for a line between Northwich and Warrington. These places, although only nine miles apart by road, necessitate a journey by rail of an hour and a half. The scheme includes an electric line which, in most places, will be constructed along the side of the highways. Connections with the railways are to be provided at either end of the line, which should in this way be of great service to the neighbourhood. The lecture seems to have aroused a considerable amount of local interest.

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A Question of Authority.—The editor of the *Barnet Press*, in proving that the local electric light company is about to charge rather more than it should do for electrical energy, has gone considerably astray on the question of authority. For instance, we are told that Major Miller, one of the Urban District Council, is responsible for the statement that "electricity is the poor man's light." We are quite sure that the gallant major would not wish to deprive Sir W. H. Preece of the honour of inaugurating the above quotation. The editor of our contemporary goes on to state that "no authority on electric lighting has ventured to assert that, light for light, electricity is as cheap as gas." Seeing that gas at Barnet costs 3s. 11d. per 1,000ft., and that the electric lighting company are giving substantial discounts to regular consumers, local evidence will soon convince the editor of the falseness of his reasoning, and he may even refer back to numerous authorities on electric lighting who have proved from practical experience that electricity is really the cheaper illuminant.

Sky Colours.—On Monday last, Dr. A. H. Fison delivered a lecture before the London Institution on "Sky Colours and London Fogs." The first part of the lecture was devoted to a brief consideration of colour photography based on the three-colour system. He pointed out in this respect that at present a method of printing colour photographs in the same way that ordinary photographs are printed has not been discovered. Proceeding to deal with the sky colours, the lecturer followed fairly closely in the footsteps of Prof. Tyndall when treating the same subject. Thus Dr. Fison explained that the reason that the normal colour of the sky was blue was on account of minute particles of matter which affected particularly the blue rays of the spectrum. The penetrating power of red light in the fog is due to the fact that red light is not much affected by such particles. In conclusion, the author showed experimentally how the blue coloration could be produced from fine particles by depositing sulphur from a weak solution of hyposulphite of soda by decomposing it with hydrochloric acid. The rays from an arc lamp passed through such a solution coloured it blue, while the issuing rays were of an orange tinge.

Ruskin Hall, Oxford.—We have been asked to call attention to the work being done in Ruskin Hall at Oxford in providing an education which should be within reach of the working classes, by combining self-help with education. The object of the institution being to broaden a man's mind, special emphasis is laid on subjects such as English history, sociology, political economy, psychology, etc. The work is carried on in two ways, by residence at Oxford and by correspondence. Every student at Ruskin Hall is expected to work two hours a day at cooking, cleaning, etc., no servants being kept. By this means the cost of board and lodging is reduced to 10s. per week, in addition to which the fees for tuition are 2s. 6d. per week. The correspondence course is intended for those who are unable to reside at Ruskin Hall, and follows the usual lines of correspondence colleges. For this the charges are 1s. entrance fee and 1s. per month. The authors of the scheme seem very sanguine of the success of this new method of raising the working-man, but we think that, even with the object of broadening his views, subjects of rather a different kind to those enumerated above will be required to benefit the ordinary working-man.

Wireless Telegraphy. — The *Daily Mail* correspondent at Cape Town states that experiments have been tried with the Marconi system between De Aar and Modder River, with intermediate receiving stations as well. Messages have been successfully sent between Orange River and Enslin, but it is stated that the large amount of iron in the neighbouring hills has interfered with experiments over greater distances. In the meantime, the Wheatstone system of ordinary telegraphy is being used between De Aar and Modder River with a speed of 220 words per minute each way on a single wire. This is said to be a record speed for a military line. The most recent application of the Marconi system at home is the proposal to maintain constant communication between the steamers of the South-Eastern and Chatham Railways from Dover to Calais and Folkestone to Boulogne. The signalling station is to be at Dover, and the range will include the two ports on the French coast. We are informed, however, that the telegraph will only be used for service purposes, and that no private messages will be transmitted. In rough and foggy weather this system should be of great advantage to the company.

Electrolytic Gas Development.—The following is an abstract appearing in the *Journal* of the Chemical Society of a paper published by Mr. W. A. Caspari in the *Zeitschrift fuer Physikalische Chemie*: At ordinary temperatures hydrogen is liberated at 1·55 to 1·56 volts, and with higher E.M.F.'s a mixture of oxygen with excess of hydrogen is obtained, whilst at a temperature of 98deg. to 100deg. hydrogen production occurs at 1·33 volts. After long electrolysis hydrogen peroxide or persulphuric acid is present in the liquid. With electrodes of spongy platinum the cathodic electrolysis is completely reversible; with bright platinum a slight excess of tension was necessary for the liberation of hydrogen, whilst with other metals this excess of tension is considerable, and the electrolysis is hence non-reversible; it is least for those metals which possess the greatest occlusion capability. Experiments on the electrolysis of solutions of potassium bromide or potassium iodide in N sulphuric acid proved that the precipitation of the bromine or iodine on platinum electrodes is reversible; this is also found to be the case for the precipitation of silver on silver electrodes in solution of silver nitrate, or of double cyanides.

Rail-Bond Resistances.—From the *Street Railway Journal* we learn of a new method of testing the resistances of rail bonds, which has been invented by Mr. R. W. Conaut, of Boston. The method is based on the balancing of the resistance of two circuits against each other, and determining when they and the other resistances are equal by telephonic means. This Conaut rail-testing instrument utilises the current already on the track, and it does not matter how variable this current may be. The operator, having the instrument case slung across his shoulder, gets the assistant to strike two connecting poles, which have point contacts, into the rails spanning the joint, with about 3ft. between the poles. He himself then strikes another pole into the rail at about, say, 4ft. from the centre pole. He then listens at the telephone attached to the box, which has a continuous interrupter in circuit. He then moves a switch alternately to the right and left, and compares the two sounds heard from the joint and from the 4ft. of rail. He moves his pole up or down until silence is found in the telephone, thus giving the length of rail the resistance of which equals that of the joint. To allow of the use of the instrument with a very weak current an intensifier may be attached, which allows of such currents being utilised.

A Simplified Beckmann's Boiling-Point Apparatus.—We notice in the *Journal* of the Chemical Society an abstract of a paper published by Mr. S. L. Bigelow in the *American Chemical Journal*. To obviate the danger of superheating, and to secure a constant heating effect

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independent of changes of gas pressure, the author adopts as the source of heat a spiral of thin platinum wire immersed in the solvent and heated by means of an electric current of constant strength; the boiling vessel adopted is the same as in Beckmann's method, but is surrounded by a layer of felt to avoid cooling by radiation and convection. The electric connection to the heating wire is furnished by two glass tubes filled with mercury, passing through the cork and reaching nearly to the bottom of the vessel; through the lower ends of these are fused platinum hooks on which the heating spiral is suspended. The beads which are necessary in Beckmann's method to ensure uniformity of temperature and avoid superheating are not required with the new apparatus. Although in general with electric heating the results are normal, remarkably low values are obtained with very dilute solutions, which point to dissociation occurring "under the conditions of the experiment of non-electrolytes in solvents to which it is not usual to ascribe dissociating power." The author intends investigating this question.

Steam-Pipes.—At the December meeting of the Ipswich Engineering Society, Mr. Arnold A. Arnold read a paper on the arrangement of steam-pipes, in which he drew special attention to the many essential details to be observed in the design of a good system of steam-piping. After dealing with the case in which only one large engine has to be supplied from a number of boilers, the author took up the design of steam-pipes for central-station working where a number of units are required. After describing the ring system and the various loop main systems with duplicate service of boilers and engines, and also with duplicate mains, Mr. Arnold proceeded to call attention to the advantages of the cross-connected system in which each engine is supplied by one boiler or by one group of boilers. In this case the pipes from the boiler-house to the engine-house are also cross connected. The first cost of this system is low and it keeps down the diameter of the steam-pipe required, as the cross connecting main need not, as a rule, be large. The author also advised that after steam-pipes had been erected they should be blown through with the engine valve-chest cover removed so as to get out any foreign substances inadvertently left in the pipes during erection. The author advocated the use of wrought-steel pipes with flanges screwed and brazed on.

Selenium.—We have now received further details of the experiments carried out by M. Perreau on the influence of the Röntgen rays on selenium. He experimented with a thin strip of selenium which had under normal conditions a resistance of 40,000 ohms. It was contained in a zinc box which could be closed by an aluminium lid. The resistance of the strip when exposed to the diffused light from a gas-burner placed about 5ft. away rapidly fell to 33,000 ohms. When the light was withdrawn, the resistance returned to its original value very quickly. The strip was then exposed to the rays coming from a Crookes tube placed at a distance of about 2in. from it. The resistance rapidly diminished till it reached 34,000 ohms, small variations of the same taking place, which the author attributes to the variation of the intensity of the rays given off by the tube. When the tube was shut off the resistance of the strip gradually returned to the first value, it being remarked that this return was much slower than after the exposure to gaslight. The reduction of the resistance, of course, diminished as the Crookes tube was removed further away from the strip, but it was still appreciable when the tube was some 7in. away from the strip. The interposition of substances more or less transparent to the cathode rays sensibly affected the reduction in resistance. The experiments were made in the physical laboratory of the university at Nancy.

Street Explosions.—On Friday last much excitement was caused in the neighbourhood of the Royal Exchange, Manchester, by an explosion in connection with the electrical mains. We gather from the *Manchester Guardian* that the explosion was caused by one of the men of the waterworks department driving his hammer through to some cables at the corner of Princes-street and Great George-street. The short-circuit which occurred was between indiarubber-covered mains drawn into pipes. Simultaneously with this another main in Bank-street broke down. It is stated by the *Manchester Guardian* that the fumes given off by the indiarubber passed along the pipes as far as the junction of Bank-street and Cross-street. An explosion then took place under a culvert in Cross-street, which lifted about 10 yards of flags and blew up the lid of the box. The city electrical engineer, Mr. Wordingham, was quickly on the spot, and the work of repairing the damage was at once proceeded with. We are glad to note that the supply of electricity in the city was not affected to any considerable extent, as only those consumers immediately around the breakdown were without light. These india-rubber-covered mains are being replaced throughout Manchester, and we trust that we shall hear of no more breakdowns from the above cause. It is not clear to us, however, that there was not an accumulation of coal gas in the conduit which exploded, or that the short-circuit did more than ignite the mixture of gas and air.

Electric Shocks.—In the *Revue de l'Electricité* of Berne is published an article by Messrs. Prevost and Botelli on some experiments they have made in the University of Geneva on dogs, rabbits, and fowls. The novelty in the experiments consists in the using of a discharge from a condenser in giving shocks to the various animals experimented upon, instead of an E.M.F. from either a battery or a dynamo. The condensers in question had a capacity of ·16 microfarad, so that the energy available was limited. The authors' conclusions are that the mortal effect of an electric discharge is not proportional to the quantity of electricity passed through the animal, but that the effect is proportional to the energy of the discharge within the limits of their experiments. Within certain limits the increase in the sparking distance of the larger condensers does not correspond to equal augmentation in the mortal effects produced. For instance, with a capacity equal to 1 and a sparking distance of 4cm., approximately the same effects were obtained as when the capacity of the condensers was equal to 4 and the sparking distance 1cm. The authors proceed to give the results of their experiments as to the effect of a discharge of a certain number of joules through the different animals experimented with. For instance, 1,000 joules were not sufficient to kill a dog weighing from 12lb. to 14lb. A discharge of the same strength, however, seriously affected a rabbit, while a much smaller amount was sufficient to stop respiration in a chicken. We presume that these experiments are of interest to medical men, but to us the subject of the effect of a discharge from a condenser does not seem of much value when one wishes to estimate the probable effect of handling high-tension apparatus.

An Electric Swingbridge.—There has recently been completed and opened for traffic a new bridge across the Charles River in America, connecting Boston and Charlestown. The bridge in question has a total length with approaches of 1,920ft., of which 1,020ft. is over the water. The width of the bridge is 100ft. The central section, which is made to revolve, is 240ft. long and weighs no less than 1,200 tons. It is supported when turning by 70

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wheels of steel, 26in. in diameter, which run on a circular track 54ft. in diameter. The whole of the apparatus for operating this part of the bridge is contained in a spacious room beneath the centre of the moving portion. Electricity is used throughout for working the bridge, and even actuated the hydraulic machinery for lifting the weight of the centre portion off the running wheels when it is at rest. The bridge is moved by means of two standard General Electric railway motors, each of 28 h.p. capacity. These are placed outside the power-house, one on each side and above the circular track. They are connected to this by means of bevel gearing and vertical shafts, so as to equalise the moving power. We gather from the description of this bridge by Mr. W. S. Key in the *Electrical World* that the whole of the bridge is well lighted by electricity, and that electrical signals are provided to show the man in the power-house exactly the position of the bridge when he is moving it at night-time. The electrical current required for lighting and for the power to work the bridge is taken from a cable laid under the bed of the river.

Electric Lighting at Marylebone.—As we recently stated, the negotiations for the purchase of the works of the Metropolitan Electric Light Company within the parish of Marylebone by the Vestry are practically at a deadlock, in consequence of the great discrepancy between the valuation of the undertaking by the opposite parties. In the meantime the Marylebone Electric Supply Company has applied to the Vestry for its consent to a provisional order being granted by the Board of Trade to enable it to supply electricity in competition with the Metropolitan Company. The application of the Marylebone Electric Supply Company was fully discussed at the last meeting of the Vestry, and it was ultimately determined that consent should not be given. The secretary of the company had written explaining in full the system under which they proposed to work, and undertaking that, if the consent were given, a real and effective competition in the supply of electricity would be undertaken. He also stated that direct-current plant would be used, and that the same liberal charges which are given to the consumers of the St. James's and Pall Mall Company would be adopted. While we quite agree with the Vestry that they do not want to buy out two undertakings at the expiration of the present company's provisional order, we think that the Vestry should press forward the matter of purchasing at once the works of the Metropolitan Company, or else allow competition from other sources. There is little doubt that if a competing supply were to be had in the parish at present, the interruptions which have been felt this winter would have been considerably minimised.

The Liberty of Submarine Cables.—While the electrical Press of France is quite willing to concede to the English nation due credit for the invention and development of the submarine cable, they are by no means satisfied with the way in which the censorship of telegrams to and from South Africa is now being enforced by us. In this, they, of course, echo the views expressed in the untechnical papers. For instance, we are informed that the English companies are so powerful that even the French Government has to approach them when it wishes to attach new cables to the present networks from the French settlements in Africa, Madagascar, and Cochin China. Apart from the indignity of the French Government being obliged to approach the English companies to ask for concessions, the present tariffs are described as exorbitant, and in this repect we do not disagree with our French contemporaries. Still, they go on to say that it is impossible to admit that the submarine telegraphs should be considered as the exclusive property of Great Britain, or that the Great Powers of Europe will allow the members of the English Foreign Office to report entirely the commercial relations between Europe and other parts of the world. The whole complaint turns round the refusal of the Government to allow code messages to pass over lines to South Africa, and we are told that England is trying to obtain the commercial and political secrets of the world by this method. Of course, the solution to the matter is that a system of French submarine cables should be established, or else that a number of European nations should unite in the establishment of cables which should be independent of "perfidious Albion." In the meanwhile, we are sure that the insinuations brought against the Government can be treated with the contempt they deserve, and that British interests should continue to be safeguarded by the prevention of code messages to any point in Cape Colony and Natal. As our French contemporaries state, the solution of the matter is the establishment of an independent line, and it would be interesting to see whether they consider the cost of this solution worth the advantages derived from it.

Vibration in Rifles.—Captain John P. Wisser contributes to the *Electrical Review* of New York an interesting *résumé* of some recent work carried out in Germany by Profs. Cranz and Koch on the determination of the jump in guns at the instant of their being fired It is obvious that if the explosion of the charge causes a vibration in the barrel of the gun which moves it appreciably before the bullet has left the muzzle, the angle of elevation of the rifle will not be the same as the angle of projection of the bullet. This subject was investigated in 1895 by Prof. Crehore and Lieutenant Squier, who used a photographic method for determining the complete motion of the gun during recoil. These gentlemen concluded that the Springfield rifle did not move appreciably before the bullet left the muzzle, and that the first motion of the gun was parallel to the axis, which, therefore, would not affect the direction of the bullet even if the same were still in the muzzle. The two German experimenters have also used a photographic method for determining the motion of any point on the barrel of the gun during the act of firing. Time ordinates are obtained on a moving photographic plate by means of light refracted from an electrically-driven tuning-fork. In the same way a ray of light is also refracted from a small point on the barrel of the gun, and in this way the curve of the motion of this point is obtained. From the photographic records reproduced by our contemporary we see that a very slight motion of the end of the barrel took place before the bullet had actually left it. A point near the stock of the gun had moved considerably in the same time. It is curious to note that the vibration of the muzzle is increased with the decreased quantity of powder, and at the same time the vibration naturally becomes more effective in altering the course of the bullet. The whole question appears to us to be largely dependent on the method of supporting the rifle, and on the balance of the same. The subject is one which should be carefully gone into for every type of rifle before its adoption, as the distribution of weight round the barrel may considerably affect the accuracy of the fire. The ideal arrangement would be one in which the centre of gravity of the whole rifle coincided with the axis of the barrel.

A New Telephone Exchange.—The *Electrical World* gives a fully illustrated description of a new common battery telephone exchange just opened by the Bell Company in Brooklyn, New York. The details of this exchange have been most carefully gone into, and it is interesting to note the complete disappearance of the drop

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indicator, signal lamps being used instead. This naturally results in a great diminution of the noise in the exchange. To quote the poetic language of one of the superintendents, "One wonders at the absence of noise. Soft light, like stars in the Milky Way, come and go over the surface of the switchboard, and only a quiet murmur of sweet feminine voices is heard." The board is equipped at the present time for 3,500 subscribers' circuits and 500 trunk circuits, and has an ultimate capacity through the addition of other sections and equipment of over 5,000 circuits. The whole of the current required to light these indicating lamps, and also to provide speaking current, is furnished by accumulators of the Chloride type, which are charged on the premises by means of direct-current transformers from the public mains. The capacity of the accumulators used is 1,250 ampere-hours. A considerable amount of complication is introduced in this exchange from the fact that there are eight distinct kinds of subscribers connected to the exchange, and all of which have to be discriminated by the girl in charge of the line. In order to simplify this, one class of subscriber is grouped as far as possible together. Further than this, there are signals placed in front of the lamps, so that they are lighted up when a call is made. These eight distinct classes of subscribers are as follows: message rate, direct line; message rate, party line; flat rate, direct line; flat rate, party line; pay station, direct line; pay station, party line; automatic pay station line; and message rate and pay station party line. All these different classes naturally require different methods in handling, and distinguishing between them must add considerably to the labour of the exchange. We are not told, however, of any automatic apparatus used to save the operators. In order to prevent delay the number of subscribers per operator is kept down as much as possible, some girls having only 30 lines to look after.

Steam-Boilers and Refuse Destructors. — We have received from Mr. F. W. Brookman, hon. secretary of the Association of Cleansing Superintendents of Great Britain, a copy of the papers read before that association at its second annual meeting, which was held at Glasgow in September. The papers chiefly deal with sanitary questions, but the paper by Mr. W. Bamford on "Steam-Boilers, with special reference to Destructors," is interesting to electrical as well as sanitary engineers. The author begins his remarks by speaking of the high pressures used at the present time, and compares them with those of 60 years ago. The various forms of boilers are then described, from the very early spherical-shaped cast-iron boiler to the multitubular and such like boilers used to day. The water-tube boiler of any type is stated, roughly, to consist of a steam-drum fixed horizontally over a number of water-tubes, set at a considerable inclination, and connected at each end to the steam-drum above. The advantages claimed for these boilers are thinner metal, but ample strength, better circulation, ease of transport, and ease in repairing, and long life. The multitubular boiler is then described in detail, as are also the Lancashire and water-tube types. With regard to the management of boilers, the author states that plenty of room should be allowed in the flues in the case of the destructor, this being of special importance, as if the flues are cramped the cleaning cannot be properly carried out, and a slight deposit on the fire side of the plates, causing retardation of the steaming of the boiler, is the result. He also states that a thorough inspection of the fittings should very often be made. In a comparison of the results obtained from the three kinds of boilers mentioned above, when working with dust destructors, we are given to understand in only two cases have multitubular boilers given reasonable results—namely, at Birmingham and Bradford. The author had not the Birmingham figures, but at a test at Bradford ·725lb. of water was evaporated per pound of refuse. With water-tube boilers at Warrington the quantity of water evaporated per pound of refuse was 1·14lb. At Torquay, with a multitubular boiler, ·334lb. of water was evaporated per pound of refuse. With a Lancashire boiler internally fired, at Salford, the figure was 1·9lb., while with the same type of boiler with cells in front of the boiler an average of about 1·67lb. was obtained. The better results obtained by the Lancashire boilers are, the author thinks, an argument in favour of their use with destructor plants.

Phosphorescence.—The first juvenile lecture by Mr H. Jackson at the Society of Arts was delivered on Jan. 3, his subject being "The Phenomena of Phosphorescence." In the issue of the *Journal* of the Society of Arts for Jan. 5 is given an abstract of the lecture, which we take the liberty of reproducing. The abstract reads as follows: The lecturer commenced by a reference to the natural sources of phosphorescence as seen in the sea, and in some cases of animal decay, etc. Phosphorescence and fluorescence might be treated as identical terms. They were illustrated by the exhibition of a phosphorescent jet of steam from a vessel containing water and phosphorus, and of the effect produced by sprinkling fluor-spar on a heated plate. He then proceeded to show how there were certain substances which showed light, generally of a yellowish or greenish colour, when exposed to the more refrangible rays—the rays at the violet end of the spectrum—and showed how the visible spectrum was apparently extended in length when the violet and ultra-violet rays fell on a surface prepared with such materials as sulphate of quinine or thallene. On passing a slab of uranium glass along the spectrum, it was made manifest that no effect was produced on the glass by the red end, whereas, as soon as it was placed in the violet rays, it glowed with its characteristic greenish-yellow colour. The phosphorescence of quinine and of fluorescein when the solution was dropped into a tall jar of water was also shown, and further illustrated by burning sulphur in oxygen in a jar immersed within a larger jar filled with the phosphorescent solution. The phosphorescence of such materials only lasted while the exciting cause was present, but there were other materials which continued to emit light after the exciting light had been withdrawn; of these, possibly the best known was Balmain's luminous paint. A card coated with this was exhibited, and it was shown how the brightness of the phosphorescence was temporarily increased by heat and diminished by cold. It was, however, possible to make other similar substances which acted in the same way, but showed light of different colours, and Mr. Jackson exhibited a fine series of phosphorescent bodies, principally lime salts, which, when excited by the brilliant discharge from a large induction coil, glowed for a certain time with various tints, blue, yellowish green, and pinkish red. Phosphorescence could be produced in a block of lime, such as that used for the limelight, but it was of very short duration. If, however, such a block were rapidly rotated in the close neighbourhood of the induction discharge, the phosphorescence produced by the discharge lasted long enough to be perceived on the side of the lime turned away from the spark as it rotated. After this the lecturer passed to the phosphorescent effects produced by the electrical discharge in vacuous tubes, and showed the very beautiful results in a long tube, in which a spark from an induction coil was passed, as the air and the various gases with which the tube was filled were gradually exhausted.

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CAMBRIDGE ELECTRICITY SUPPLY WORKS.

Surveying the university towns of Great Britain in the mind's eye, a certain trio, or possibly quartet, stand out very prominently—to such a degree, in fact, as to almost obscure the others—and of these three or four favoured centres of learning Cambridge, the town with which we are now concerned, is certainly not the least important. The town takes its name from the more modern appellation of the river on which it is situated, the ancient name of which (according to some historians) was Granta. The word Cam signifies crooked, and in its application here evidently has reference to the winding nature of the river.

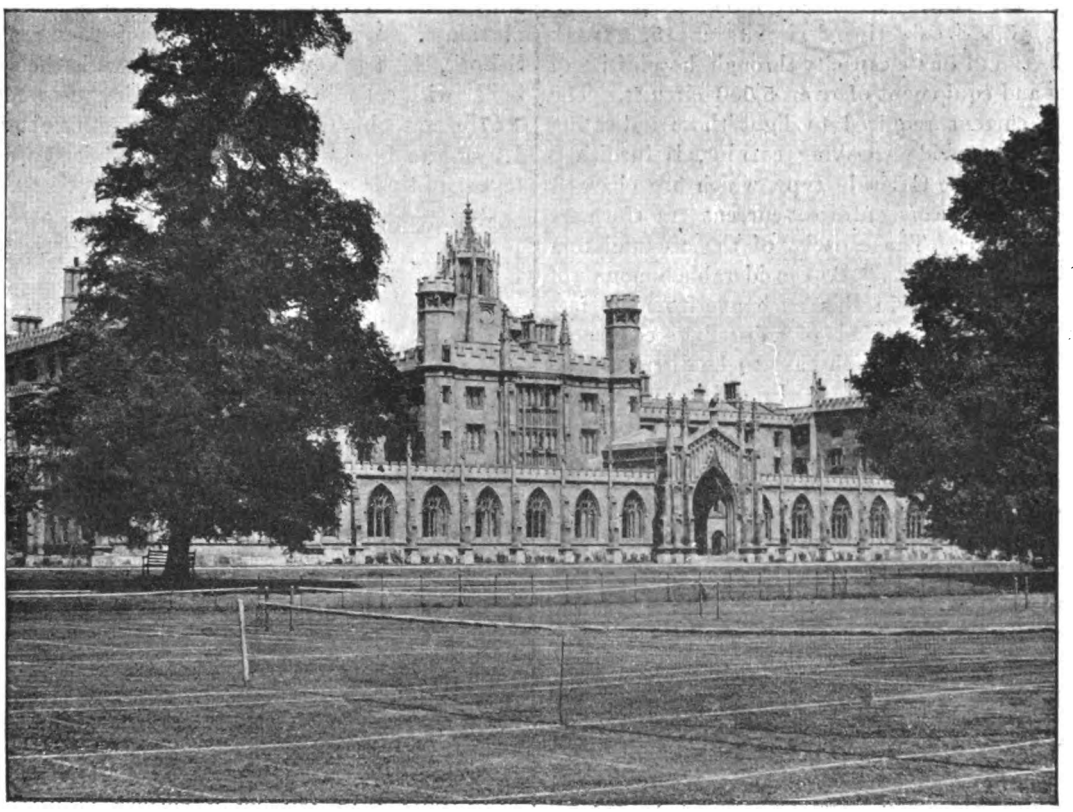

FIG. 1.—St. John's College, Cambridge.

Much obscurity envelopes the foundation of the university, not to mention that of the town itself. Legend says the university was founded by Cantaber, a Spaniard, 375 years before the advent of Christ, but there seems greater reason to believe that Cambridge first became the seat of learning in the seventh century, under the government of Sigebert, King of East Anglia. But however this may be, it is

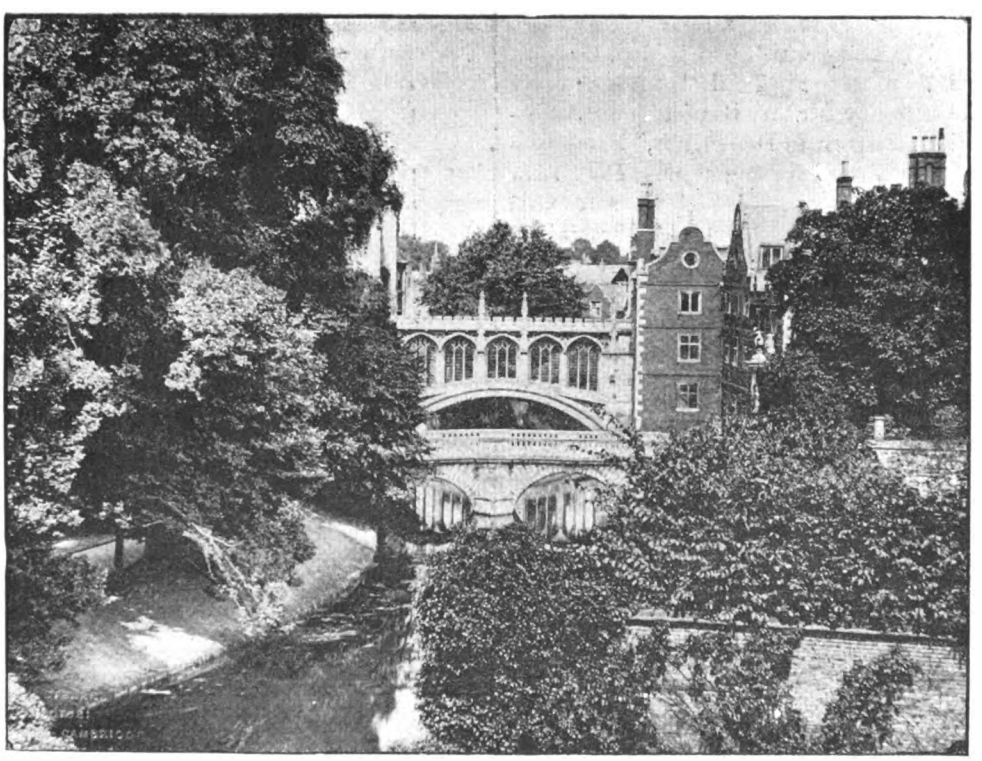

FIG. 2.—Bridge, St. John's College, Cambridge.

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certain that from a very early period the town was the abode of numerous students. The first college—called Peter

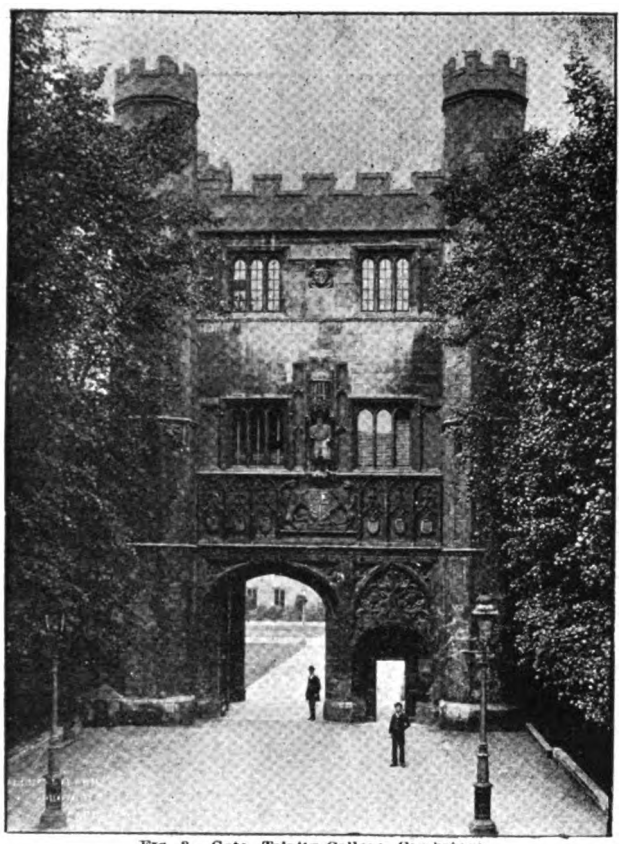

FIG 3.—Gate, Trinity College, Cambridge.

House—of which we possess any authentic record, was founded and endowed by Hugh Balsham, Bishop of Ely, in the year 1284, since when the university has enjoyed a course of practically uninterrupted extension and prosperity. It is only natural under these circumstances that Cambridge should have become a veritable paradise to the student of archæology. Its numerous colleges and other university buildings representing many centuries of steady development, and characterised by as many or more different styles of architecture, form a group which it would indeed be difficult to match, some of the buildings being of exceptional beauty—masterpieces, in fact, of their respective orders. The town, too, possesses a certain charm inherent to narrow winding streets and architectural traces of mediæval times. But modern requirements have been responsible for the destruction of a great many picturesque properties during recent years, and present-day architecture ill becomes the narrow streets of Cambridge. So it is that the town no longer continues to improve from an æsthetic point of view, rather the contrary being unfortunately the case. The main and most picturesque thoroughfare represents the Roman Viâ Devana. Nor is this street by any means the sole evidence left of the former occupation of these parts by the Romans, for the immediate vicinity, if not Cambridge itself, abounds in unmistakable traces of Roman fortifications, earthworks, etc.

According to history it would not seem that university towns are, as a rule, endowed with any superabundant degree of enterprise outside university matters pure and simple; nor does tradition point to Cambridge as an exception in this respect. Therefore it is not surprising to find that the water supply, gas supply, trams, and electricity supply of the town are at present in the hands of private companies. True the Corporation have recently moved in the matter of acquiring the waterworks and tramways undertakings—indeed, going so far as to prepare and approve a Bill for promotion in the forthcoming session of Parliament to this end, but we understand that a meeting of the ratepayers has since rejected the whole scheme by an overwhelming majority. As matters now stand, the lease of the tramways to the company at present working them shortly expires, and unless a canvass of the town shows a majority in favour of the Corporation's original proposal it is difficult to foresee what will be the outcome of the present deadlock. The existing company possess no powers to work the lines other than by horse traction. It is, therefore, possible in the event of a definite abandonment of the Corporation's scheme that the British Electric Traction Company might come to the rescue, taking

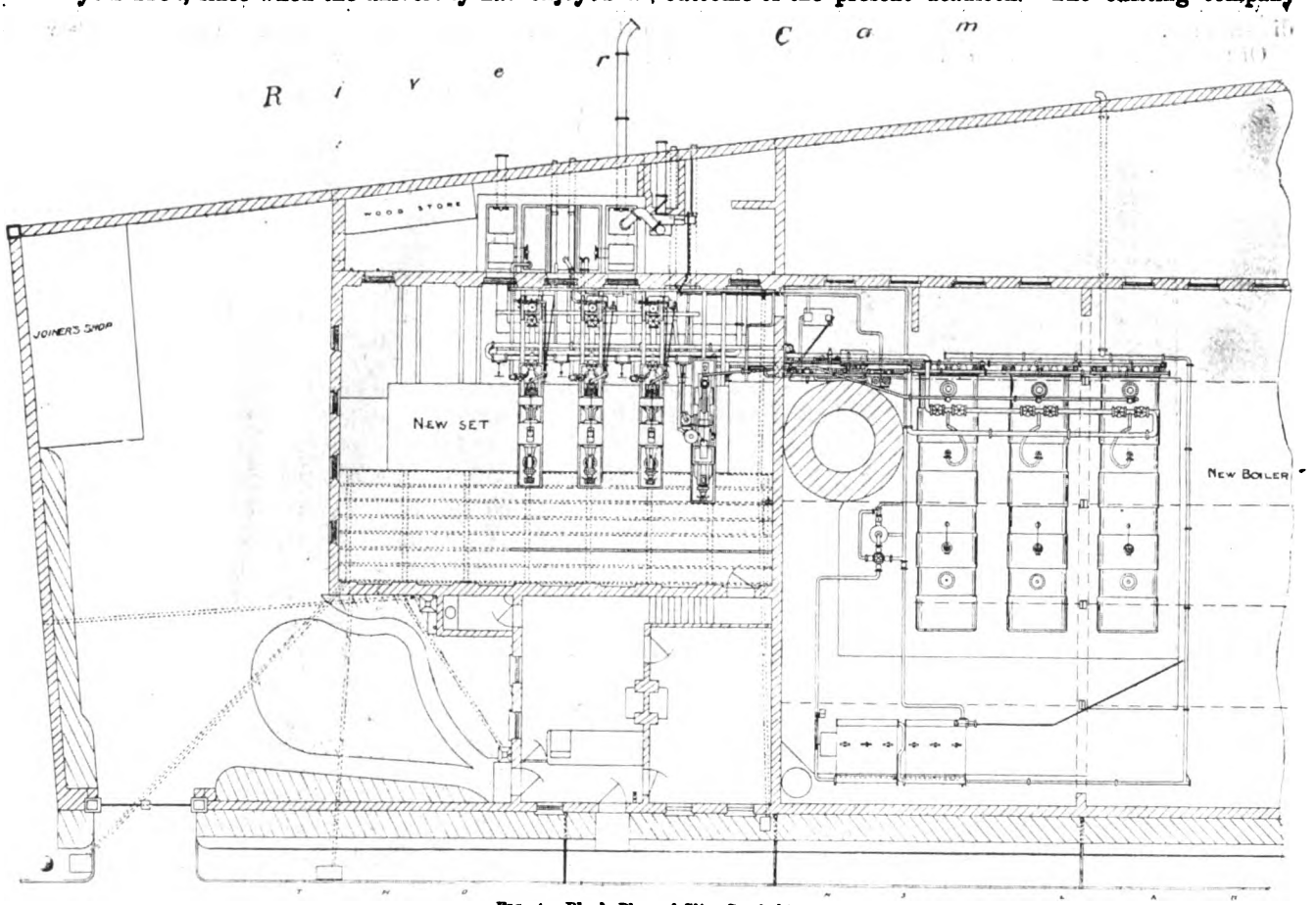

FIG. 4.—Block Plan of Site, Cambridge

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the supply of current necessary to work the lines by means of electric traction from the existing supply station. However, this is mere conjecture. Time alone will show in what manner the question will be finally settled, though one thing seems certain: horse traction is destined to give way to electric traction on the Cambridge system at no very distant date.

Of the accompanying illustrations, Figs. 1, 2, and 3 will suffice to confirm the foregoing remarks with regard to the architectural riches of Cambridge. Fig. 1 gives a view of St. John's College, which was founded in 1511, while Fig. 2 depicts the bridge commonly called the Bridge of Sighs, which forms a connection between certain courts of the same college. In Fig. 3, the great gate of Trinity College is shown. The prosperity of Cambridge is now almost entirely dependent upon its university, its importance as an agricultural centre and market town having sadly depreciated of late years. With the students in house the population amounts to some 33,000, the ratable value of the town being £230,359.

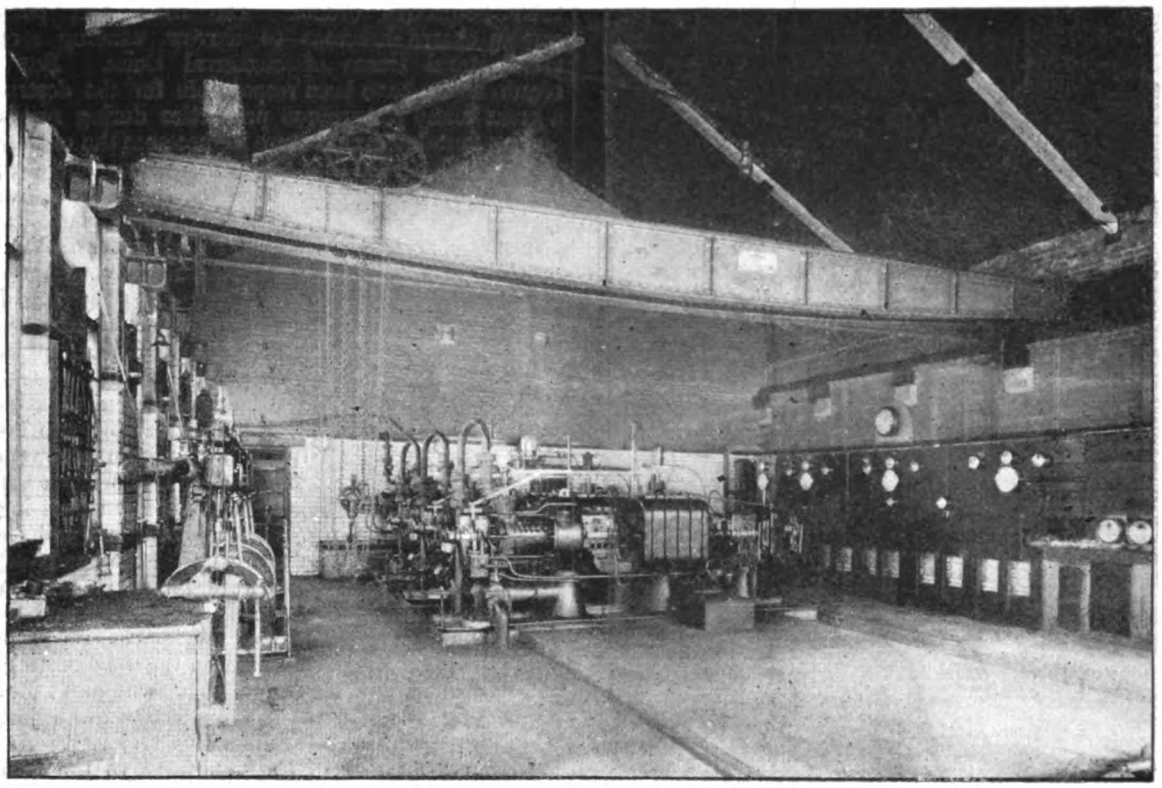

FIG. 5.—Original Plant, Cambridge.

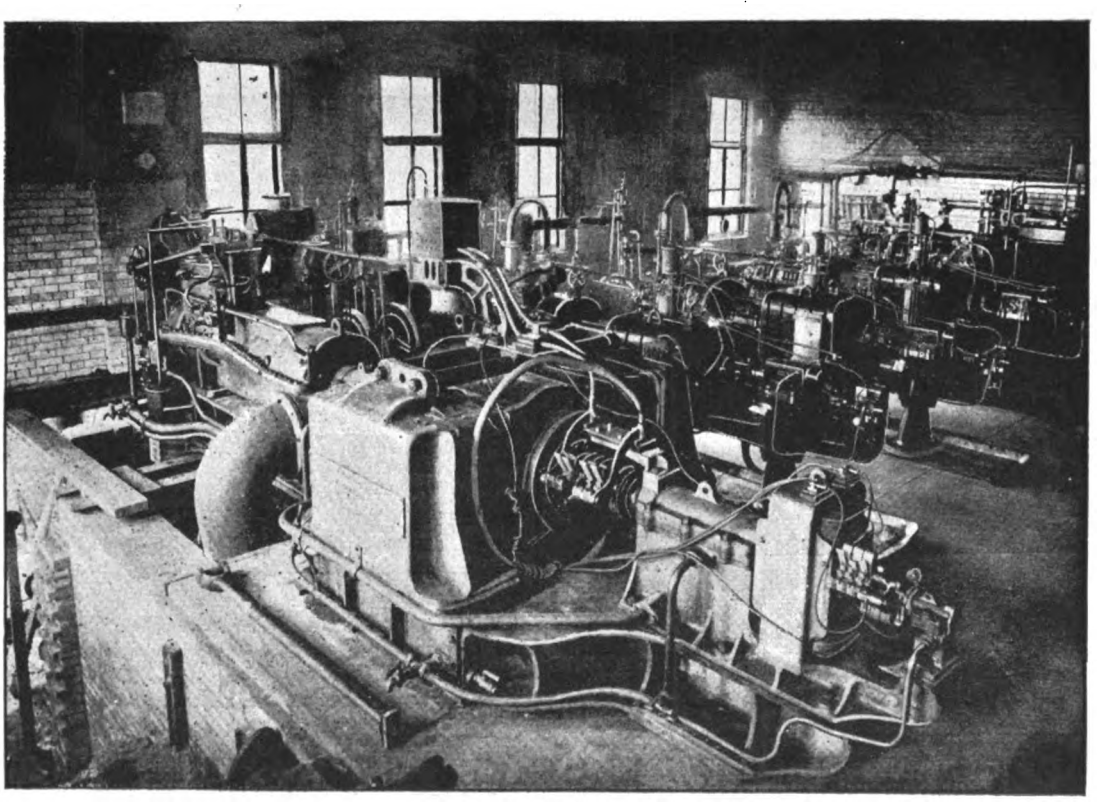

FIG. 6.—Present Plant, Cambridge.

We may now proceed to describe the undertaking of the Cambridge Electric Supply Company, Limited, into whose hands the supply of current for lighting and power purposes in the town has devolved. The existing order was

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originally applied for and obtained by the Corporation, but in 1892 was acquired by the Hon. C. A. Parsons for a round £1,000. No time was subsequently lost in getting to work, a company being promoted, building operations commenced, and the supply of current to consumers

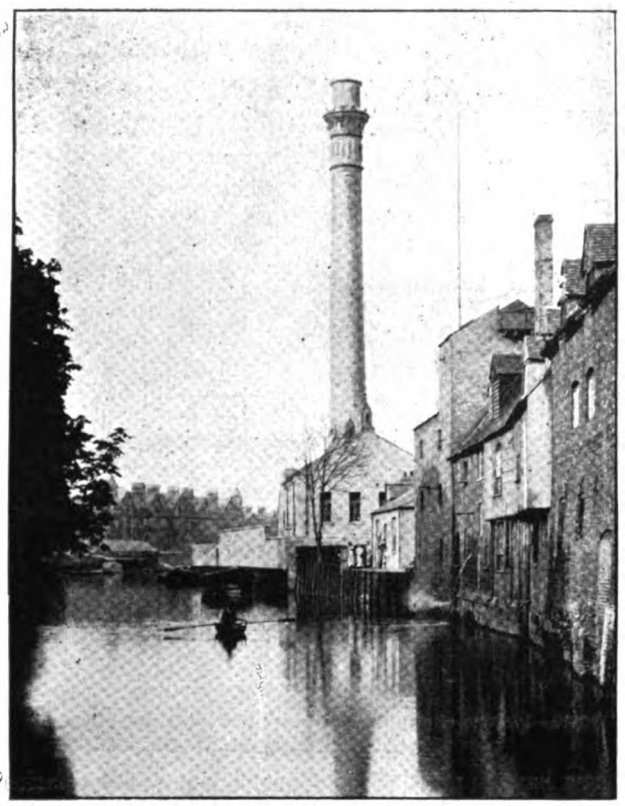

FIG. 7.—Central Station, Cambridge.

inaugurated well within the same year. The capital of the company is set down at £100,000, of which amount about half only has been called up. Messrs. D. Munsey (chairman), Hon. C. A. Parsons (managing director), Sir B. C. Browne, P. W. Latham, and John B. Simpson are the directors, while Mr. John H. Barker, A.M.I.C.E., M.I.E.E., is the resident manager and engineer to the company. Having regard to the scattered nature of the town, the directors decided to put down a high-pressure alternate-current generating plant with transformers. Plans, for which the managing director was alone responsible, were accordingly drawn up and a Parsons steam-turbine plant resolved upon. The site selected for the generating station is situated as shown in Fig. 11. The chief factor governing the selection of this particular spot was undoubtedly the excellent facilities for condensing and boiler feed water which it offered, being situated immediately on the banks of the River Cam. But sites for generating stations

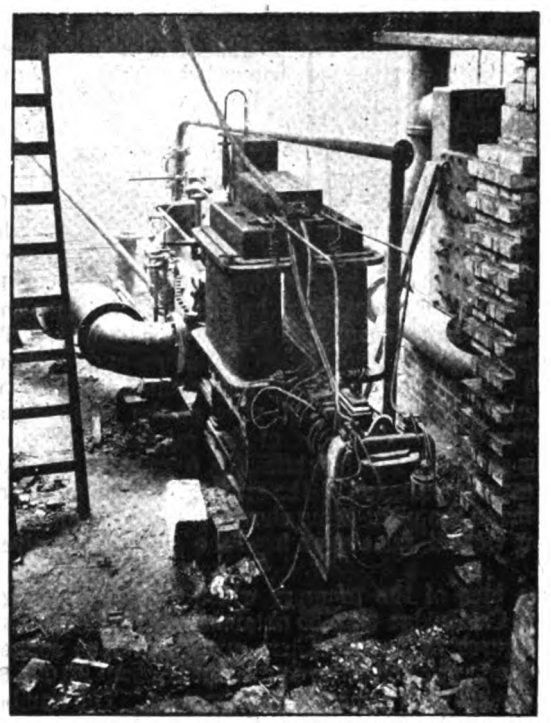

FIG. 8.—Temporary Plant, Cambridge.

are, like battleships, always more or less of a compromise, and in the case under notice the unusual advantages with regard to water supply were obtained partly at the expense of coaling facilities. Coal has, in fact, to be carted some distance, since the river is not available for its transport. It cannot be delivered at the station yard under 13s. 3d. per ton, which represents the actual price being paid at the present moment for slack. The cost of carriage from the pit's mouth accounts for about 8s. of this amount.

Some difficulty was also experienced with regard to the

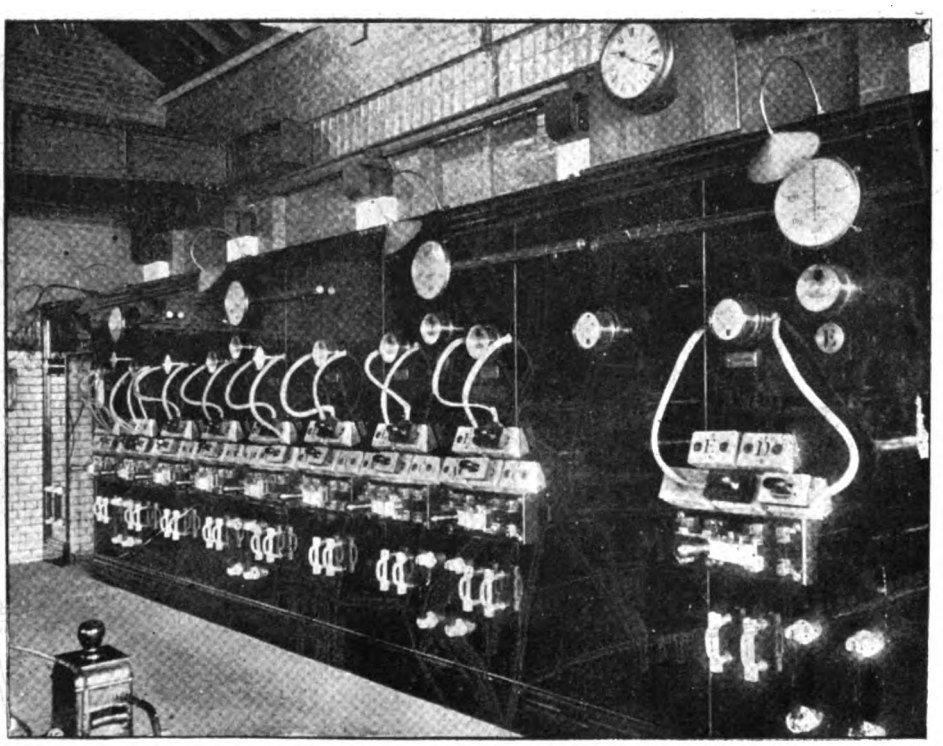

FIG. 9.—Switchboard, Cambridge.

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foundations of the generating station buildings, owing to the nature of the site, nothing more secure than stiff mud being met with for a considerable depth. For this reason the foundations of the chimney shaft, which is carried to a height of 150ft. above the ground-level, had to be sunk to a depth of 30ft. in order to reach the solid clay. In the case of the engine and boiler room foundations it was not considered necessary to adopt the same precaution, a sufficiently firm foundation being obtained by footing the walls, etc., with a substantial area of solid concrete. So far as the walls and engine-room foundations are concerned, the latter plan succeeded admirably, but did not entirely succeed in the case of the boilers, one of which settled down so much as to necessitate the underpinning of its foundations. Within six months of actually starting building operations the supply of current to consumers was commenced—an extremely creditable performance, especially when the difficulties initially met with are taken into account. Various extensions and alterations have been carried out since the station started in 1892. These have been necessitated by the rapid increase in the number of lamps connected to the mains. Fig. 4 shows the disposition of the station buildings and equipment, though the most recent and important additions to the plant are not marked in. A view of the engine-room as it appeared on completion of the original instalment of plant is shown in Fig. 5, while Fig. 6 conveys an idea of the present appearance of the same room, the most recent additions to the plant being shown in the foreground. An exterior view of the station from the riverside is given in Fig. 7.

Some idea of the progress which electric lighting has made in Cambridge may be obtained from a glance at the latest figures to hand. There are at present connected to the company's mains the equivalent of about 28,000 8-c.p. lamps, exclusive of some 8 h.p. in motors. The number of units supplied to consumers during 1899 amounted to 298,392, an increase of 38,085 as compared with the total of the previous year. The colleges have not been slow to adopt the light, and now constitute the company's principal source of revenue. The demand in a university town must naturally be a fluctuating one, since during the vacation very little artificial illumination is needed in the colleges, and for this reason those in charge of the Cambridge supply are enjoying a very quiet time just when the majority of

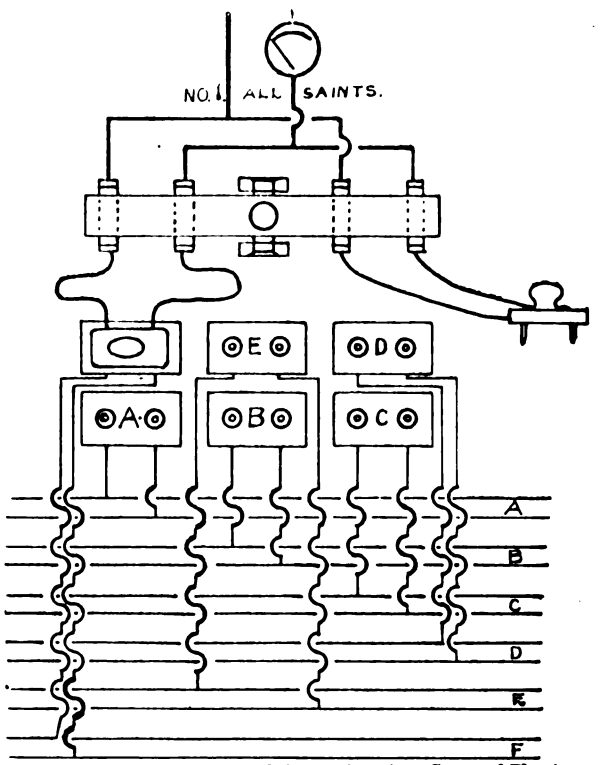

FIG. 10.—Diagram of Switchboard Connections (one Group of Plugs), Cambridge.

stations have to meet the maximum demand. Mr. Barker is one of the few central-station engineers in a position to rely with certainty upon an undisturbed Christmas holiday.

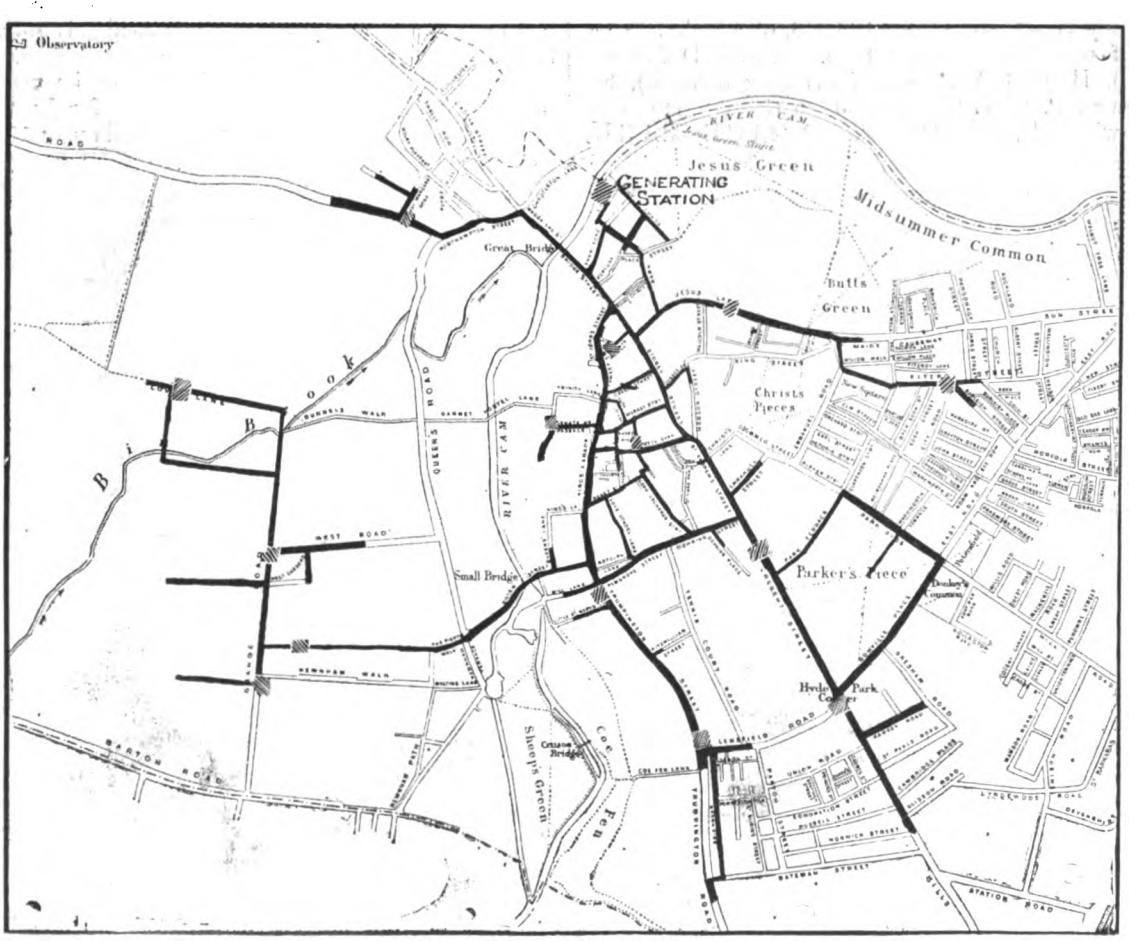

FIG. 11.—Mains as laid at Cambridge.

Although the colleges are the company's best customers, the residents, hotels, and shop proprietors of the town have also taken to the electric light very well, as may be judged from the fact that out of 10,000 houses of all kinds in Cam-

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bridge, over 400 are connected to the mains. It is probable that a system of free wiring may be adopted in Cambridge at no distant date, whereby the number of consumers might be largely increased. Hitherto the price charged to consumers per unit for lighting purposes has been 7d. with discounts, but the maximum demand system of charging is about to be adopted in the town, whereby 7d. will be charged per unit for the first hour and 3½d. afterwards. Special rates are conceded to large consumers. It may be mentioned here that the prevailing price of gas is 3s. per 1,000 cubic feet. The maximum demand which the generating plant has so far been called upon to meet was 400 kw., while as much as 77 per cent. of the units generated has been accounted for as actually sold. The works lighting includes the supply of current to a row of cottages inhabited by workmen in the company's employ and also to the engineer's residence, all in close proximity to the works. There is no public street-lighting in Cambridge at present.

We may now enter into a more detailed description of the plant installed. The boiler-house contains four boilers at present, three of which suffice to take the heavy load, with one standing in reserve. The boilers are of the Lancashire type by Adamson, and supply steam at 140lb.

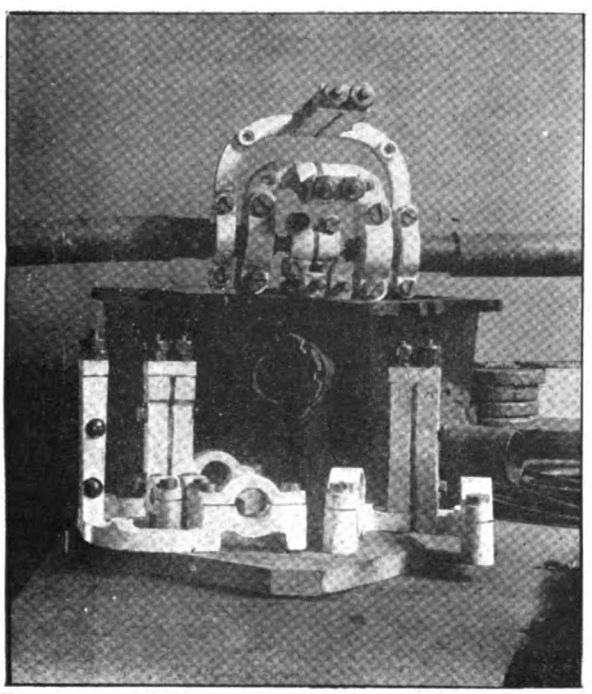

FIG. 12.—Low-Pressure Triple-Concentric Mouse Connection, Cambridge.

pressure to the square inch. They each measure 30ft. long by 7ft. 6in. diameter, and are worked with forced draught, being, however, stoked by hand. A Green's economiser is fitted in the main flue, by means of which the feed water is heated up to about 300deg. F. before entering the boilers. Its scrapers are driven by a motor, which also serves to drive the repairing-shop machinery, including lathes, etc., for the station is practically self-contained, and provided with the necessary equipment for executing its own repairs. The steam-piping from the boilers to the turbines is in duplicate throughout, and its arrangements will be seen on reference to Fig. 4. This piping is placed in a tunnel below the engine-room, the branches to the several turbines being carried up through the floor.

Coming to the engine-room, it may be mentioned that this is 50ft. long by 34ft. wide. The plant at present installed comprises six steam-turbine sets of the following capacities respectively: one 35-kw., one 60-kw., three 120-kw., one 500-kw. Each of the five smaller turbines is direct coupled to its respective alternator, and runs at a speed of 5,400 revolutions per minute. The exciters are coupled to the alternator shafts, and the supply of steam to the turbines is electrically governed. Each turbine is provided with a separate condenser of the surface type, the necessary circulating water being drawn from the river by the pumps attached to the condensers for that purpose. The alternators generate at 2,000 volts terminal potential. The bearings are provided with forced lubrication throughout.

The larger and most recently installed turbine set combines all the latest improvements introduced by Messrs. Parsons and Co., and may therefore be dealt with at some length. When the directors of the Cambridge Electric Supply Company, Limited, decided to put down the new plant, they invited tenders from five leading English firms for a direct-coupled high-speed engine and a 500-kw. dynamo, and in reply they received tenders from each at the figures given below:

A	£4,100	without condenser and pumps.
B	5,456	
C	4,880	
D	5,010	
E Messrs. Parsons and Co. ...	4,824	with condenser and pumps.

In accepting the tender of Messrs. Parsons and Co., the directors were guided by the following circumstances. The cost of a condenser and pumps, with an independent engine to drive them, was about £1,025, which fact reduced the tender of Messrs. Parsons to £3,799. A more serious consideration was that the space available in the present engine-room would not accommodate a single set offered by the first four contractors, whilst it is possible to instal two 500-kw. sets of the accepted design—as a matter of fact the second set has since been ordered for delivery during the present year—and in addition to the other advantages of turbine-driven plant, their guaranteed consumption of steam per kilowatt-hour for this size was lower than that of other makers. The figures in this case are given below:

	25 per cent. overload.	Full load.	Half-load.
A	—	28lb.	34lb.
B	—	28lb.	34lb.
C	25·51lb.	27lb.	32lb.
D	—	26 6lb.	31·2lb.
E (Parsons and Co.).. ...	—	27lb.	30lb.

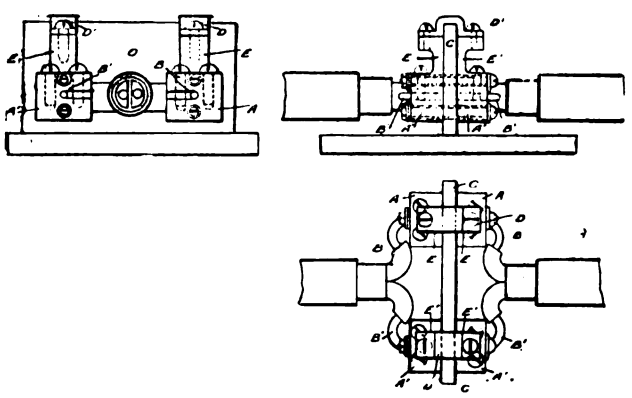

FIG. 13.—Primary Cable Joints.

All were to have 140lb. pressure of steam, and to be condensing. The last figures included the power absorbed by the air and circulating pump, and are without the 5 per cent. margin claimed in the other four (which is equal to another 1¼ of steam).

The plant was tested at the makers' works, Newcastle-on-Tyne, in October last by the company's engineer, Mr. John H. Barker. It was impossible to attach its own condenser, as this had already been delivered and was built in position at Cambridge. As regards steam consumption, the figures are comparable with the guarantees of the other four, excepting the margin of 1¼lb.; the condenser and pumps attached to the test-house were used. The tests extended over a period of four hours, and gave the results tabulated below:

Boiler pressure.....	127	139	145	140
Vacuum	24·75	24·5	26·5	27·5
Barometer	29·6	—	—	—
Water per hour, lbs.....	13.400	12.675	7,029	4,180
Output in kilowatts	598	526·4	256·1	124
Water per kilowatt-hour...	22·4	24·1	27·5	33·7
Exciting current, kilowatts	3·5	3·3	3·1	3·0

When in position with its own condenser it is hoped to get even better results, as a higher vacuum will be maintained than is possible with a condenser so far away from the engine, as is necessary in a test-house, and without the many branches on a trunk pipe. So far as is known, the figure of 22·4lb. of steam per kilowatt-hour at only 127lb. pressure has not been previously attained with a high-speed

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engine of this size, and a maintained efficiency down to one quarter full load of only 33·7lb. is a remarkably good performance. Fig. 6 shows the set erected in position at Cambridge. The engine is of the usual parallel-flow turbine type, and runs at a speed of 2,700 revolutions per minute. It is electrically governed, and can run in parallel

FIG. 14.—Laying Mains, Cambridge.

with the other alternators. Below the floor, in a tunnel, is a surface condenser, which is connected by a pipe on either side. The air and circulating pumps are on the same level as the condenser, and are driven from a worm and wheel, which worm is of three threads, and is connected to an extension of the engine shaft at the high-pressure end. This arrangement of driving air-pumps has been found satisfactory during the last four years. An engine with a similar attachment has run almost daily with

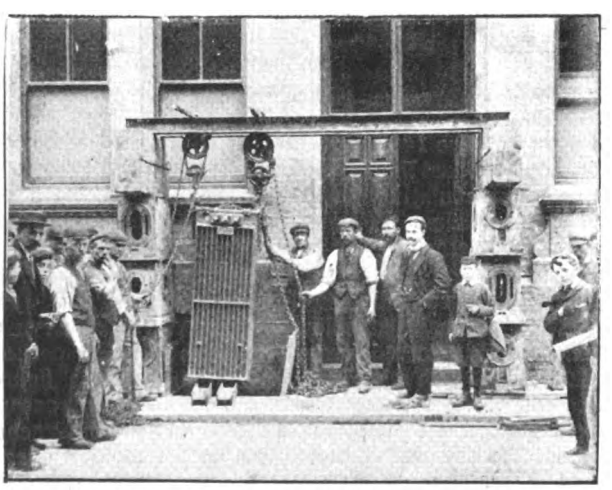

FIG. 15.—Getting in Transformer, Cambridge.

the same worm-wheel, which is still in excellent condition. The alternator is coupled direct to the engine; it is four-polar with rotating armature, and delivers current at 2,000 volts of 90 periods per second. To the same shaft is coupled the exciter dynamo; it has a capacity of 5 kw., though only 3·5 are required at full load, or about 0·7 per cent. of the output. It was impossible to deliver the engine in time for the winter of 1899, and the plant at the disposal of the company was not powerful enough to carry through without dangerously overloading. Messrs. Parsons and Co. therefore lent a 100-kw. non-condensing set to run until delivery of the larger machine. Fig. 8 shows this engine and dynamo as it stood working in the basement of the engine-room. It rests only on four blocks of timber laid on the bare earth; three connections only were required: a 3in. steam-pipe, a 10in. exhaust, and a pair of cables to the switchboard. The total cost of erection was something under £5. It is safe to say that no other class of plant can be so readily adapted in urgent cases, nor could a 200-i.h.p. engine of other build run under such simple conditions of foundations. In actual running the engine was the most silent in the place, and was quite as good in all other respects. In 1898 the directors let one of their engines and alternators to a town whose heavy season was in the summer, to help them until they could obtain plant, and the engine was in a few days after returned to work and ready for the winter season.

A few further remarks remain to be made respecting the alternators. A very ingenious method has been adopted by their makers, Messrs. Parsons and Co., whereby the balance of the armature may be readjusted should it be necessary. The core of each armature is provided with threaded bolt-holes at either end drilled parallel to the armature shaft near the outer circumference of the core. Should the balance of the armature require readjust-

FIG. 16.—Use of Doulton Conduits, Cambridge.

ment, its heavier side is ascertained by holding a pencil against the revolving shaft, a screw bolt being then inserted in the core on that side found to be the lighter. The centrifugal balance of the armature is thus effectively adjusted in a very simple manner without dismounting the machine.

The switchboard (Fig. 9) was erected by the works' own staff. Its arrangement is exceedingly simple, though at first sight somewhat cumbersome. The alternators are not run in parallel, Mr. Barker having a personal prejudice against such method of working, although we understand that the type of alternator in question will run quite satisfactorily so. The method of working which Mr. Barker has adopted consists in running the alternators on separate circuits or individual groups of circuits. In fact, the switchboard arrangement admits of one machine being run on all the circuits simultaneously or on any number of them as circumstances may require. There are nine feeders run from the switchboard to different points in the distributing network of mains, or, more correctly speaking, we should say 10, since one feeder is divided into two portions

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behind the board. The leads from each generator run the entire length of the board, and constitute the 'bus bars, as it were. But the groups of plugging points are governed by the number of feeders, and since there are nine of the latter, consequently nine sets of plugging points are entailed by the arrangement adoped. A diagram of the connections of one of these sets is shown in Fig. 10, from which it is readily apparent how the changes are made. A change-over switch, situated immediately below each of the groups of plugs, enables the load on any one machine to be shifted over to another as the load increases or decreases. Before changing over, the machine to be substituted for the one already on load is run up on a water resistance until it is doing approximately the amount of work which it will be called upon to do when switched on to the actual load. A flickering of the lamps is thus avoided. The arrangement is very simple, and with judicious management does not entail more manipulation at the switchboard than parallel running.

The feeders originally laid are of the Silvertown india-rubber-covered type, but for recent extensions of the mains the British Insulated Wire Company's paper-insulated type of cable has been exclusively employed. A new feeder of the latter type capable of taking the whole of the load, has been recently run. This is a concentric lead-covered cable, while

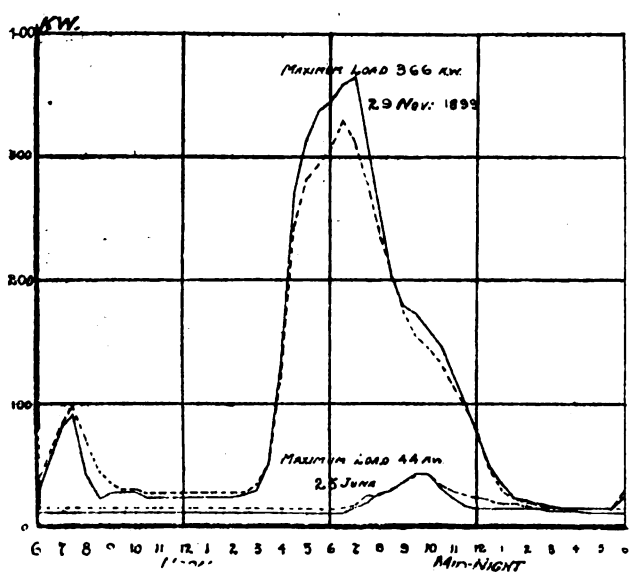

FIG. 17.—Maximum Load Curve, Cambridge.

the older feeders are twin cables. It is drawn through iron piping, together with a low-pressure triple-concentric main, but to obtain the sanction of the Board of Trade to this practice the company had resort to a somewhat unusual device. Over the paper insulation of the concentric high-pressure cable a thin continuous strip of copper was wound prior to giving the cable its lead sheathing. Should a defect in the cable develop, this strip of copper would prevent the lead covering from being fused, since it would assist the latter as a conductor. This new feeder has practically duplicated the original system of feeders, since means of interconnecting it with the several transformer sub-stations have been amply provided for, and as the previously existing feeders can likewise be interconnected at the sub-stations a serious breakdown of the distributing system is practically impossible. The transformer sub-stations are 10 in number; their disposition over the area of supply may be seen on referring to Fig. 11. The most recent of them are of the double-deck type, the transformers being situated in the lower chamber. The transformers in use are almost exclusively of the Parsons enclosed type, and about 30 of the house transformers originally adopted in Cambridge are still left. Distribution to consumers is now on the three-wire system, partly with 420 volts between the outers and partly with 210 volts between the outers, the change from the old two-wire system having been recently made. All the outside work is done by the company's own workmen. An ingenious form of house box, patented by Mr. Barker and manufactured by the British Insulated Wire Company, is being employed in Cambridge. An illustration of the same reproduced from a photograph is shown in Fig. 12. The terminal screws are designed for use with a special screw-driver, also patented by Mr. Barker, but manufactured in this case by the Ediswan Company. This screw driver is provided with a bulged head, designed to slide into a corresponding enlargement at the base of the screw slot, so that when inserted from the side of the screw head the driver cannot be withdrawn from the slot by a direct vertical pull, and movement during the screwing operation is further prevented by a steel rod, which is pressed into a cavity provided in the screw head by means of a spring actuated from the driver handle. Hence, when the screw has been released, there is no possibility of its falling and short-circuiting the leads, since it is firmly held by the screw-driver. House connections may be, therefore, made or broken with impunity without cutting off the current, and to render this safe the screw-driver handles are well insulated with vulcanite. Fig. 13 shows the type of high-tension main junction-box employed at Cambridge, while Figs. 14, 15, and 16 shows how main-laying and the getting in of transformers are conducted in Cambridge. The last-mentioned figure reveals a length of Doulton conduit which was disturbed by the Corporation during the laying of sewers and broken as shown. It is only fair to mention, however, that compensation was obtained by the company.

A typical heavy-load curve obtained at the station is shown in Fig. 17. In conclusion, we have to thank Mr. Barker for his courtesy in showing us over the above-described works, and placing in our hands the information given concerning them.

NOTE ON THE ELECTRICAL RESISTIVITY OF ELECTROLYTIC NICKEL.*

BY J. A. FLEMING, M.A., D.SC., F.R.S.

The numerical values assigned by various experimentalists for the mass or volume electrical resistivity of certain metals differ very considerably. Some metals are without much difficulty prepared as often as required in a state of such chemical purity, and brought so easily into similar physical conditions as to annealing and density, that determinations made by different observers of their resistivity or specific electrical resistance are nearly identical. Matthiessen's long-accepted value for the mass resistivity of copper in the form of hard-drawn wire—viz., 0·14493 standard ohm per metre-gramme—was substantially confirmed by the more recent work of Mr. T. C. Fitzpatrick. Even the purest electrolytic copper now obtainable in an annealed condition does not show an electric conductivity more than 3 per cent. greater than that of a similar character prepared 35 years ago by Matthiessen.

In a research carried out in the years 1892 and 1893 by the author in conjunction with Prof. Dewar careful redeterminations were made of the volume resistivity at 0deg. C. of all ordinary metals, taken for the most part in an annealed condition and in a state of great chemical purity. The values so obtained for the electrical volume resistivity of silver, copper, gold, aluminium, zinc, platinum, tin, lead, magnesium, and iron agreed fairly well with the values given by Matthiessen, and quoted in most of the treatises on electricity. The resistivity of cadmium, as given by us, was, however, considerably larger than that usually stated, although our sample of cadmium was very carefully prepared. In the case of nickel, the purest nickel we were able to obtain was that prepared from nickel-carbonyl. Dr. Ludwig Mond, F.R.S., was so kind as to furnish us with two tubes of this nickel. It was found, however, to be too brittle to draw into wire, and the operation of melting it would have most certainly introduced impurities. Accordingly the nickel tube was cut up in the lathe into a spiral, and a resistance coil formed with it which could be used for taking the resistivity ratios at different temperatures, but which was not sufficiently uniform in dimensions to permit its volume resistivity to be calculated. Hence, in our published results we took the volume resistivity of this nickel at 0deg. C. to be 12,320 C.G.S. units, which is the value given by Everett, said to be derived from

* Paper read before the Royal Society, Dec. 14, 1899.

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Matthiessen's experiments, and simply calculated the resistivity at other temperatures from the experiments given by our own observations with the Mond nickel. About a year ago, however, Mr. J. W. Swan, F.R.S., sent me a sample of nickel wire which he had prepared electrolytically from a hot solution of very carefully purified nickelous chloride. The electrolytic metal was annealed by heating in an atmosphere of hydrogen, after having been drawn into wire through a die. The nickel wire so prepared and annealed is as soft as a silver wire. It had a fairly uniform diameter of about 0·01in., and a length of nearly 250cm. The mean diameter of this wire was taken with the micrometer microscope at regular intervals of centimetres with the following results:

DIAMETRAL MEASUREMENTS OF NICKEL WIRE AS READ BY MICROSCOPE AT REGULAR INTERVALS OF ABOUT 5CM.

Obs.	Diameter (inches).	Obs.	Diameter (inches).
1	0 0097	26	0 0100
2	0·0097	27	0·0096
3	0·00975	28	0 0098
4	0·0107	29	0 0093
5	0·0100	30	0 0099
6	0·0098	31	0·0102
7	0·0100	32	0·0098
8	0·01015	33	0·00975
9	0·01015	34	0·0095
10	0·0100	35	0 0098
11	0·0098	36	0 00985
12	0·0100	37	0·00965
13	0·01015	38	0·0098
14	0·0099	39	0·00985
15	0·0101	40	0 0101
16	0·0099	41	0·0096
17	0·0099	42	0 0094
18	0·01005	43	0·0098
19	0·0097	44	0 0098
20	0·0098	45	0·00995
21	0·0098	46	0·0098
22	0·00985	47	0·0098
23	0·0101	48	0·0096
24	0 0100	49	0·0099
25	0·01005	50	0·0101

The mean diameter of the wire, as obtained from the above 50 readings, was 0·00985in. This was checked by taking the density of the wire with all the usual precautions for obtaining a correct value. The length, weight in air, and weight in water were determined to be as follows:

Length of the wire	246·98cm.
Weight in air	1·1163 grm.
Weight in water at 18deg. C. + suspension	1·00175 ,,
Weight of suspension	0·1000 ,,
Weight of wire at 18deg. C. in water	0·99175 ,,

From the above observations the density was found to be 8·96 at 18deg. C. The mean diameter calculated from the length and density is then 0·00997in. Hence we have:

Mean diameter from micrometer measurement	0·00985in.
Mean diameter by specific gravity and length measurement	0·00997in.

The mean of both means is 0·00991in. = 0·02567cm. This last number was taken as the value of the mean diameter. The nickel wire was then soldered to thick copper leading-in wires, and wound on a frame of a kind suitable for immersion in liquid air. A description of this particular kind of resistance coil, which has proved itself to be exceedingly suitable for low-temperature work, was given in a paper describing the result of numerous observations on the resistivity of metals at low temperatures, published by Prof. Dewar and the present author in 1893. A coil having been thus constructed its resistance was taken at various temperatures in a bath of paraffin oil, and the results are as shown in the table below. The temperature of the bath was measured at the same time by means of a platinum thermometer (P_1) used in previous researches. The conversion of the platinum temperatures into centigrade temperatures was effected by means of a table drawn up by Mr. J. Hamilton Dickson for this thermometer. The measurements of the resistance at low temperatures (−78·2deg. and −182·5deg.) was obtained by measuring the coil in liquid air and melting CO_2 at the Royal Institution Laboratories, by kind permission of Prof. Dewar.

OBSERVATIONS ON THE RESISTANCE OF ELECTROLYTIC NICKEL WIRE.

Obs.	Total resistance of nickel wire.	Platinum temperature, *pt.*	Centigrade temperature, C.	Volume resistivity in C.G.S. units.
1	3 4284	1·057	1·232	6,974
2	3 7563	18·489	18 29	7,641
3	3·9470	28·676	28·32	8,029
4	4·1109	36 959	36·51	8,363
5	4·3506	48·740	48·21	8,850
6	4·5679	58·773	58 23	9.292
7	4·5778	59 315	58·78	9,312
8	4·7493	67 384	66·85	9,661
9	5 0403	80·550	80·11	10,253
10	5·2018	88·587	88·25	10,582
11	5·3000	93·544	93·29	10,782
12	5·3882	95 731	94·88	10,961
13	5 2379	89 289	88·97	10,655
14	5·0094	78·482	78·02	10,190
15	4·7273	66 700	66·17	9,616
16	4·5260	57·151	56·61	9,207
17	4 3586	48 704	48·18	8,865
18	4·1323	37·906	37·44	8,406
19	3 9620	31·226	30·83	8,060
20	3·8112	21·550	21·30	7,753
21	3 4318	2·205	2·35	6,981
22	2·090	−80·72	−78·2	4,251
23	0·710	−196·89	−182·5	1,444

The total resistance of the nickel calculated from the above observations is set out in the form of a curve (Fig. 1), having resistance as ordinates and temperature as abscissæ.

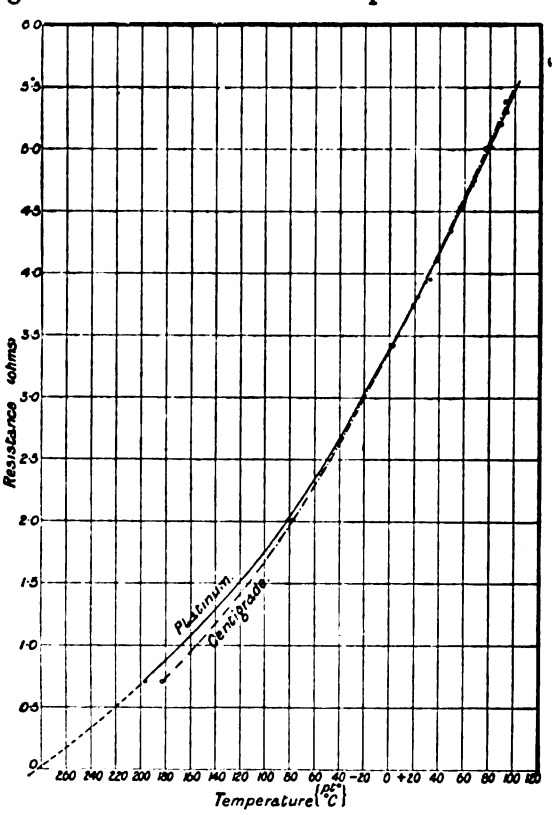

FIG. 1.—Temperature Resistance Curve for Electrolytic Nickel Wire.

The curves are given both for temperature in Centigrade degrees and temperature in platinum degrees. The curve shows that the resistance is falling steadily downwards to a zero value as the absolute zero of temperature is approached. In Fig. 2 the portion of the curve between 0deg. C. and 100deg. C is shown in an enlarged scale. In Fig. 3 the volume resistivity is set out in terms of temperature. The results show that the volume resistivity or resistance per centimetre cube of this electrolytic nickel at 0deg. C. is 6,935 C.G.S. units. The average temperature coefficient between 0deg. C. and 100deg. C. is 0·00618. The above observations indicate that this electrolytic nickel, as prepared by Mr. Swan, has an exceedingly different and much lower resistivity than that employed for test by Matthiessen 35 years ago.

The value of the mean temperature coefficient of the nickel used in the experiments of Fleming and Dewar in 1893, and prepared by Dr. Ludwig Mond, was 0·00622 between 0deg. C. and 100deg. C. It is clear, therefore,

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that some extraordinary electrical difference exists between nickel as it can now be produced electrolytically and nickel as it was produced by Matthiessen for his experiments. It would be interesting to ascertain if any specimen of nickel known to have been used by Matthiessen for his experiments still exists, and if so, to discover the nature of the impurity (if impurity was present), or at least the physical difference, which caused his nickel to have nearly double the electrical resistivity of that which can now be produced. I desire to record my thanks to Mr. J. E. Petavel and to Mr. A. Blok for assistance in these experiments.

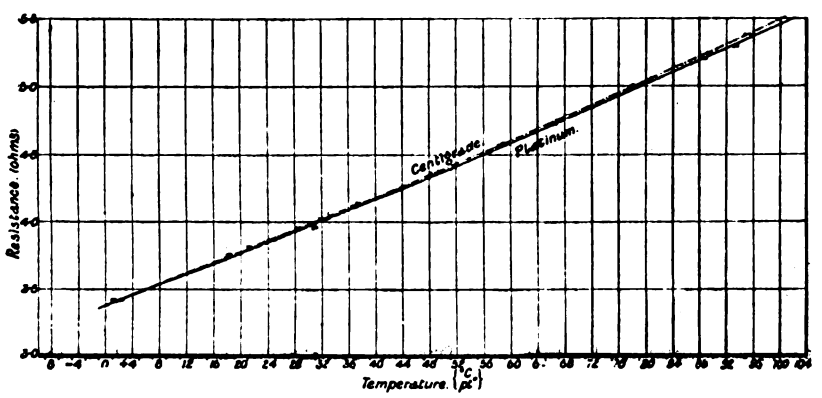

FIG. 2.—Temperature-Resistance Curve for Swan's Electrolytic Nickel Wire (Range, 0 - 100deg. C.).

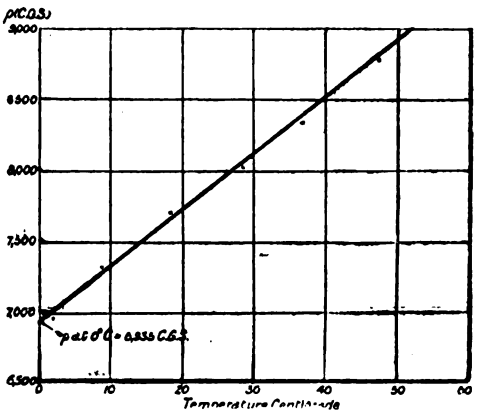

FIG. 3.—Electrolytic Nickel Wire (Curve to obtain ρ at 0deg. C.).

Note added Dec. 6, 1899.—Since writing the above short paper, I have discovered in a paper by Messrs. A. Matthiessen and C. Vogt a reference to the sample of nickel with which the present accepted figure for its resistivity was evidently obtained. This paper is entitled "On the Influence of Temperature on the Electric Conducting Power of Iron and Thallium," and its title would not lead a reader to look in it for a reference to the resistivity of nickel. Messrs. Matthiessen and Vogt therein state that samples of supposed chemically pure nickel and cobalt wires prepared by M. Deville were given to them by M. Wöhler. They measured the resistivity of these samples, but they state that their electrical behaviour gave them reason to believe that this nickel and cobalt were not pure. They give the electrical conductivity of the nickel as 13·11 at 0deg. C. taking hard-drawn silver at 0deg. C. as 100. Hence, if hard-drawn silver has a volume resistivity of 1,620 C.G.S. units at 0deg. C., it follows that Matthiessen and Vogt's value for the resistivity of their sample of nickel would be 12,357 C.G.S. units at 0deg. C., which is a number very close to that usually given in tables of electrical specific resistance.* Matthiessen and Vogt state in this paper that they hope to be able to prepare pure nickel electrolytically and obtain a value for its electrical resistivity. I have been unable to discover, however, that they ever carried out their intention. At any rate, the number which they give for the electrical volume resistivity of this nickel of the purity of which they evidently had suspicions has been accepted for the last 36 years as the true value.

THE ECONOMICAL GENERATION OF STEAM POWER.

BY BENJN. A. TAPP.

(Continued from page 23.)

As indicating in some measure the saving which may be effected by heating feed water in an apparatus similar to the above, we give the results of a test. The heater was constructed with 37 brass tubes, 4ft. long, 2in. external diameter, and No. 12 B.W.G. thick. The terminal steam pressure was 16lb. per square inch absolute, and with 7·45 gallons of water passing through the heater per minute the feed was raised from 56deg. F. to 205deg. F. A further test was made to ascertain the value of the feed-water heater used with a condensing engine. The gain in this case could not possibly be much, the whole question turning on the rate at which the exhaust steam would transmit its heat to the feed water. The engine in this case was a 6½in. by 10in. by 20in. compound condensing engine, with a terminal pressure of 8lb. per square inch and a vacuum of 12lb. The heater contained 19 brass tubes, 2in. diameter and No. 12 B.W.G. in thickness, also about 4ft. long.

Temperature of water to heater.	Temperature of water from heater.	Gallons per minute.
84° F.	134° F.	3·5
84° F.	130° F.	6·0
84° F.	126° F.	8·4

It was noted that the temperature of the hot-well was very low, and from this it would appear that no great

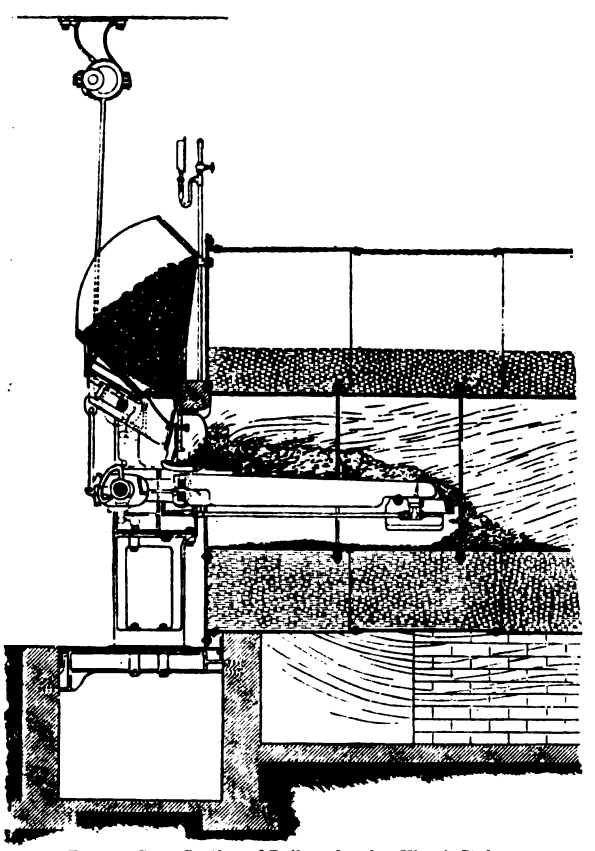

FIG. 2.—Cross-Section of Boiler, showing Vicar's Stoker.

econ my can be gained by adopting the heater with condensing engines. In fact, the writer considers that with modern facility for condensation, even with scarcity of water, and for considerable powers, the use of feed-heaters in such a way as to impair the vacuum cannot be recommended, except under peculiar circumstances.

We will now consider appliances for increasing the efficiency of the furnace. Under this heading we may

* The numerical value of the specific resistance of nickel given in various tables by different authors are not quite identical, and yet all so far found are stated to be derived from Matthiessen's experiments. Thus Everett ("C.G.S. System of Units," 1891 edition) gives 12,320 C.G.S. units at 0deg. C. as the value. Landolt and Börnstein give one value equivalent to 12 757 at 0deg. C. from the ratio of conductivity of nickel to that of mercury, and another equivalent to 12,014 at 0deg. C., derived from the ratio of the conductivities of hard-drawn silver to that of nickel.

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TABLE C.

—	Vicars.	Hand firing, forced draught.	Vicars.	Hand firing, ordinary draught.
Date of trial	23/6/90	24/6/90	21-27/7/86	13-19/4/86
Number of boilers	1	1	4	4
Description of boiler	Lancashire	Lancashire	Cornish	Cornish
Dimensions of boiler	30ft. × 7ft. 5in.	30ft. × 7ft. 5in.	28ft. × 6ft.	28ft. × 6ft.
Diameter of boiler flue	2ft. 9in.	2ft. 9in.	3ft. 6in.	3ft. 6in.
Area firegrate in square feet	22	33	45·6	84
Number of hours' trial	10	10	168	168
Description of coal	Bituminous (small)	Welsh (small)	Bituminous (slack)	Welsh
Total coal consumed	2 ton 13 cwt.	3 ton 4 cwt.	91 ton 16 cwt.	37 ton 10 cwt.
Coal burnt per square foot of grate, and per hour	27lb.	21·7lb.	26·9lb.	6lb.
Water evaporated per hour and per boiler	5,330lb.	5,020lb.	2,525lb.	1,083lb.
Water evaporated per pound of fuel	8·98lb.	7lb.	8·25lb.	8·65lb.
Price of fuel per ton	13s.	15s.	13s.	16s. 6d.
Cost of fuel per 10,000lb. water evaporated	6s. 5½d.	9s. 4⅔d.	7s. 4d.	8s. 6d.

TABLE D.

—	Davidson's Papermills, Aberdeen.	Hartlepool Paper Company.		Martin, Sons, and Co.'s Lindley.	Dorman, Long, and Co.	Stockton Malleable Iron Company's Works.	
Duration of trial	26½ hours	14½ hours	15 hours	10 hours.	16 hours	21½ hours	18¼ hours
Water evaporated per hour	1,139 gals.	1,207 gals.	1,128 gals.	1,249 gals.	1,080 gals.	993½ gals.	991 gals.
Water evaporated per pound fuel	8·34lb.	10lb.	8·48lb	9·14lb.	8·56lb.	11·05lb.	9·73lb.
Fuel per square foot grate	45lb.	—	—	45lb.	45·8lb.	—	—
Average temperature feed water	146deg. F.	180deg. F.	180deg. F.	320deg. F.	177deg. F.	168deg. F.	178deg. F.
Average steam pressure	83lb.	83lb.	83lb.	—	73lb.	—	—
Extra work by compressed-air furnace and stoker—							
1. Over hand firing	—	40 per cent.	31 per cent.	—	63¼ per cent.	31·9 %	31·6 per cent.
2. Over machine stoker and Camel furnace	50 per cent.	—	—	33 per cent.	—	—	—
Economy of C. A. machine	9 per cent.	8·5 per cent.	37·7 per cent.	9·6 per cent	42½ per cent.	25 per cent.	47 per cent.
Remarks	Water measured in tanks. Fuel weighed on machine.	Same fuel for hand firing and stoker tests.	3s. per ton cheaper fuel than before.	—	Same fuel for hand firing and stoker tests.	Ditto	3s. per ton cheaper fuel than before.

place the numerous mechanical sprinkling and coking stokers and automatic furnaces of English and American design, also forced and induced draught appliances, and water-tube grates, etc. Among the many mechanical stokers, we may note those of Messrs. Vicars, Bennis, Proctor, Hodgkinson, Meldrum and Clayton, Babcock and Wilcox, etc., all of which endeavour to attain a similar object—*i.e.*, to automatically feed into the furnace small coal and slack at a regular rate, and in the coking variety provision being made for coking the fuel before it reaches the actual fire; to gradually move onward the fire until in the form of ash, etc., it is discharged over the back end of grate into the flue, and becomes banked up and highly incandescent, which in its turn consumes any smoke passing over or impinging on it. Messrs. Vicars's stoker, one of the best known of the coking type, is provided with a divided hopper containing the fuel supply. Fuel is slowly pushed on to the firebars by means of reciprocating plungers, and by a slow reciprocating motion imparted to alternate sections of the grate is carried gently forward, allowing time for coking, etc., before it arrives at and is discharged over the back of the grate into the ashpit. The supply of fuel and motion of the firebars are all adjustable. The accompanying table (C) shows the performance of Messrs. Vicars's stoker against hand firing with and without forced draught, and Fig. 2 shows the details of this stoker.

Messrs. Bennis manufacture two kinds of stokers of the sprinkler type, described as their (1) "machine stoker" and "self-cleaning Camel furnace"; (2) "machine stoker" and "patent compressed-air furnace." The machine stoker works on lines similar to those previously described, the Camel furnace being a specially constructed arrangement of firebars; the compressed-air furnace (Fig. 3) being an arrangement whereby air is forced through the firebars to aid combustion, etc. Messrs. Bennis have guaranteed their stokers and furnaces in the following particulars:

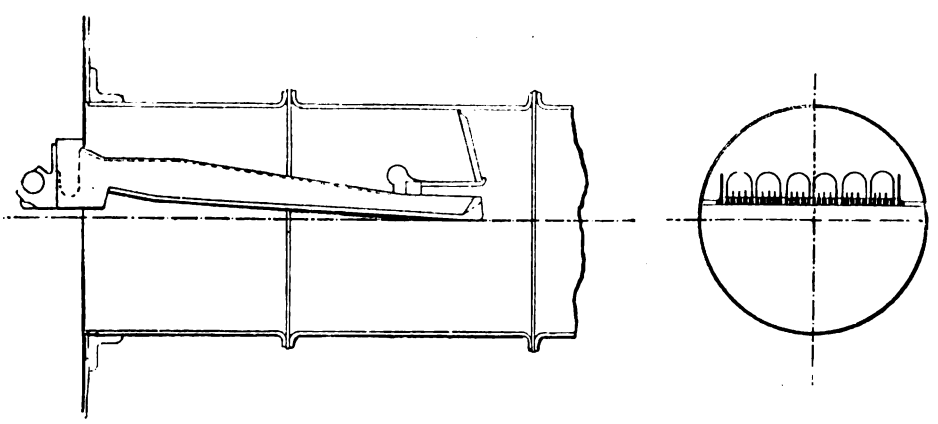

FIG. 3.—Details of the Bennis Compressed Air Furnace.

(1) machine stoker and self-cleaning Camel furnace—an evaporation from and at 212deg. F. of not less than 800 gallons per hour with good Yorks slack, also 7lb. of water per pound of coal; (2) compressed-air furnace and stoker—an evaporation minimum of 950 gallons per hour and 8lb. of water per pound of coal in the same manner; with the latter machine the steam production can be varied at will. Appended is a table (D) of results obtained from several trials of the stoker and compressed-air furnace, showing the extra work that was obtained from this furnace over the ordinary machine stoker and also over hand firing. Attention is also drawn to the large fuel consump-

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tion per square foot of grate and to the remarks as to class of fuel used.

A machine stoker of the coking type, possessing some novel features, is manufactured by the Babcock and Wilcox Company (Fig. 4). The grate is formed of practically an endless chain made up of short cast-iron grate bars, linked together and passing over drums at front and rear. The front drum is kept constantly rotating, motion being imparted through the eccentric rod and eccentric on a revolving shaft, over the front of boiler. The coal is fed over the whole width of grate from the hopper in front, and the rate of movement is such that the fuel is consumed during the period of its passage to the back of grate, and subsequently falls into the ashpit in an incandescent state. The brickwork construction at the front of this grate greatly facilitates the rapid coking of fresh fuel, and the arrangements generally are such as to ensure complete combustion. The whole of the grate can be run out to the front of the boiler on rails for repairs, etc.

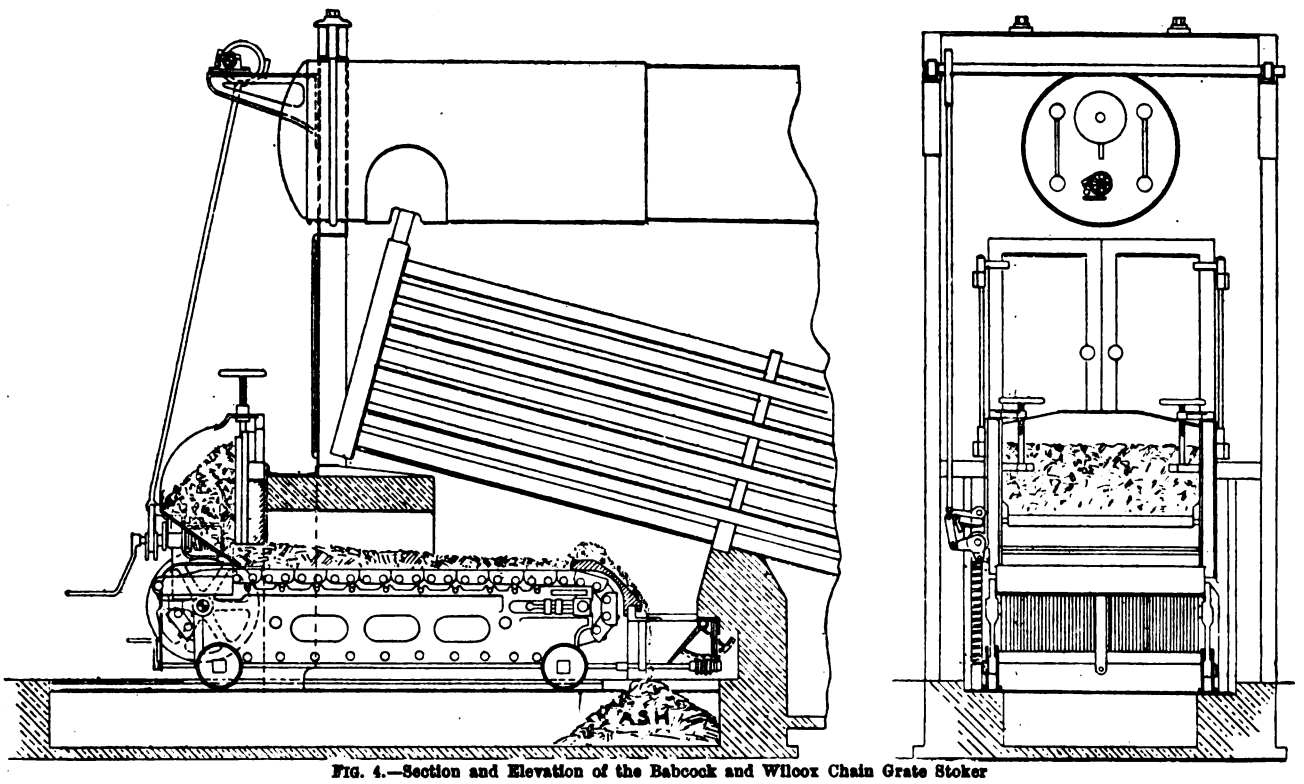

FIG. 4.—Section and Elevation of the Babcock and Wilcox Chain Grate Stoker

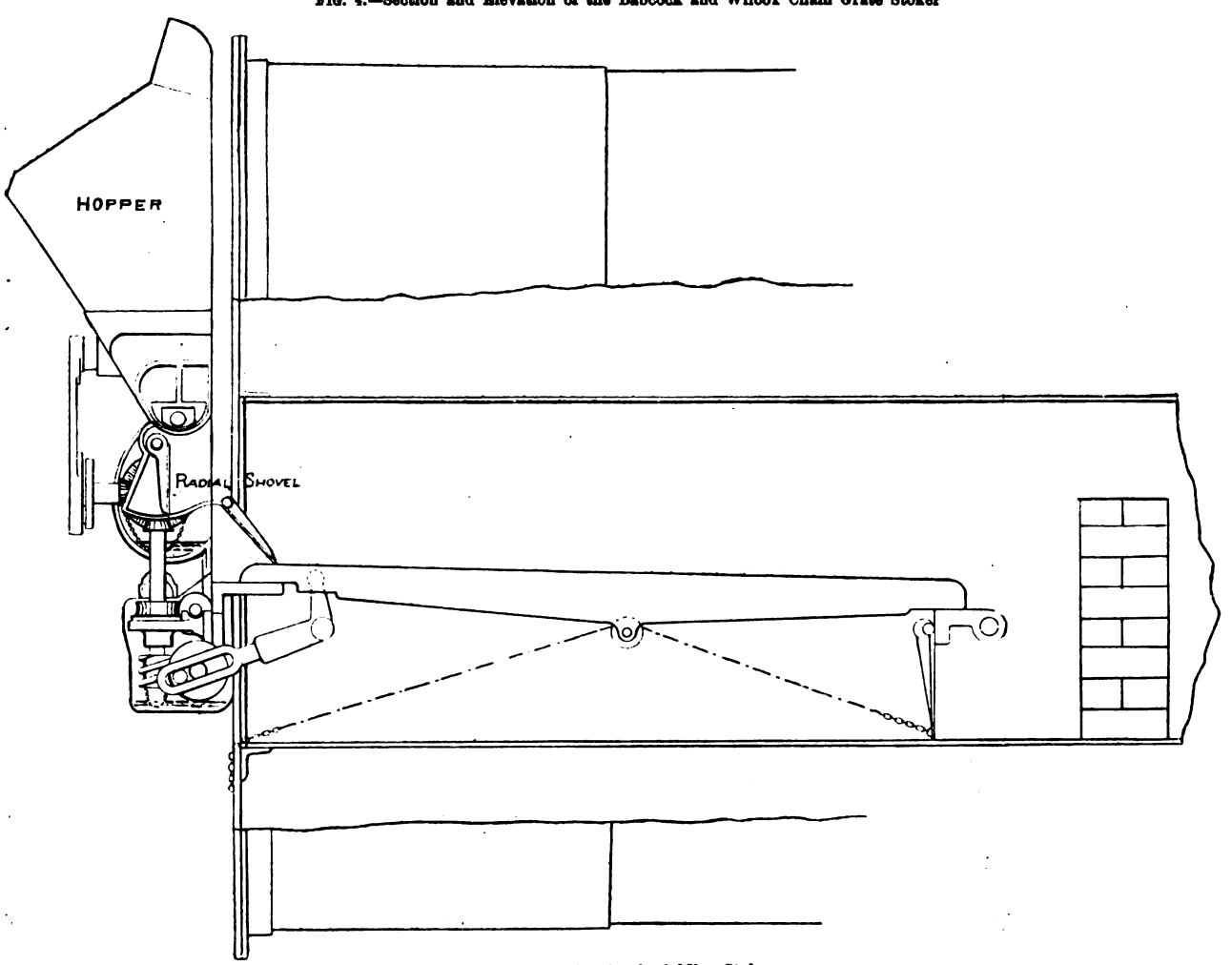

FIG. 5.—Proctor Sprinkling Stoker.

(To be continued.)

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street London, E C Anonymous communications will not be noticed.*

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FOLLOW OR START.

When the history of electrical engineering comes to be written, and its rise certainly falls between the beginning and end of the nineteenth century, it will probably be asked what part has England played in this great work. The reply will probably be far from satisfactory, and the credit of initiation will go to Italy, France, Germany, and America. As a matter of fact it seems almost impossible for this country to lay claim to any single piece of important apparatus in use in the industry. Certainly we cannot claim the practical dynamo, though we can claim the first indications of its possibility in the work of Faraday. From the time of his discovery to the time of Gramme the field lay fallow, and Gramme's work was the potential factor in creating electrical engineering. Similarly in every direction of progress the initiation has come from abroad. America has developed electric traction, and to its energetic exploitation of England is due the awakening here. If telephony be included within the realm of electrical engineering, then undoubtedly its rise is due to America, though had it not been for the labours of Prof. Hughes and his magnanimous giving to the world the results of his labours, we do not imagine that telephony would be what it is. But every electrical engineer can look round and decide the question for himself as to whom he is indebted for the tools he uses. Swan can claim the incandescent lamp by a narrow margin of time, but he was not the first by several to think of such a lamp, though, again, he was first as regards the attempt with a filament. Broadly, however, we think history will prove that in electrical things this country has followed, not started. If an examination be made, is the same to be found in other directions? Not, perhaps, to so great an extent, yet too much so to be pleasant. Are there any reasons for such a state of things, and, as Artemus Ward said, "if so, how many?" The number of reasons is large, quite too large to endeavour to enumerate in a short article. The first, and by far the most important, is a question of national temperament. We are conservative, we are secretive. We work, and work, and work, going over the ground that hundreds of others have trod because we know nothing of their doings, of their failures, or of their successes. We are not now trained to excel in work, we are trained to pass examinations. It may seem but a stupid joke to state and emphasise the statement that Englishmen are not readers, but it is true nevertheless. The American is a tenfold more methodic reader. It pays him to be so, and being paid he is satisfied. Of late years, thanks principally to the Japanese twins coming home, and by their energy getting the City Guilds to work, a great advance has been made in English methods of teaching technical subjects, though they are still far and away too old-fashioned. Technical colleges have been founded all over the land, but the result of their work has not had time to show itself, and we fear will be inoperative towards putting us to the front as starters, and not as we are now, mere followers. Will not someone in the closing

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year of the century organise a new start for the new century. British manufacturing works are large. They are organised to make things pay, but they are hardly organised to give a good chance to capable men. Many of them have one fixed idea, that "practice makes perfect." It is a good idea, but, like all other ideas, may be driven too far. We would suggest, as we have suggested before, that the large factories should educate theoretically as well as manually. The professor should be as much a necessity in a factory as the timekeeper. Brain and hand should be trained to work together, and we feel quite sure that in a short time an impetus would be given to improvement and invention.

THE DYNAMICABLES.

The next dinner of this association will be held, by permission of the committee, on Wednesday, Jan. 17, at the Whitehall Club, Parliament-street, S.W., at seven o'clock, when R. E. Crompton, Esq., will preside.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

SCHAFFHAUSEN CENTRAL STATION.

SIR,—We beg to acknowledge receipt of your journal, and are pleased to note the description it contains of the Schaffhausen central station. As to your remark about that puzzling loss of efficiency which by Mr. Kapp was brought home to the existence of coagulated oil in the bearings, we beg to complete your account by stating that the seat of this coagulated oil was by no means in the dynamo bearings, but that it was the spindles of the looms and self-actors of the mill which caused the extraordinary resistance, which circumstance lends to the case just its interesting feature.—Yours, etc.,

MASCHINENFABRIK OERLIKON.
(E. Huber.)

ELECTRIC LIFTS.

SIR,—I wish to correct a statement which appeared in the article on the Electric Construction Company's lifts in your issue of Jan. 5. The makers say the lifts "have given every satisfaction," but on enquiry you will find that the reverse is the case. In two cases which came under my notice, the liftman narrowly escaped what might have been a serious accident, the lift having got beyond control owing to some defect in the switch gear. At the present time the lift on Bunhill-row side is broken down, and the Electric Construction Company's man informs me it will not be in use for a month, owing to repairs which necessitate sending certain parts of the motor to their Wolverhampton works. I may say also that hardly a week has passed without one or other of the lifts being under repair. The company's managers may not know of the trouble the lifts are giving, but their fitters are constantly at the Bovril factory.—Yours, etc., WIREMAN.

REVIEWS.

Municipal Ownership v. Private Corporations, etc. By M. J. FRANCISCO, Rutland, Vt. Fifth edition, with Statistics to date. Published by M. J. Francisco and Son, Rutland, Vt., United States of America.

If you set out with the conviction that the dog is guilty and must be hung, there is no reason to worry about the verdict or the result. That is just what Mr. Francisco does. Corporate bodies are guilty: therefore they are corrupt—and hang them. This is clear from the title to his first division; thus: "Is it beneficial to the taxpayers? Is there any reason for adopting it except for political purposes? Is there a single plant that has saved money for the taxpayers when all the facts are shown? As a matter of fact, this pamphlet is not so much an argument for or against municipal ownership as a diatribe on the venality of American officialdom. The author assumes every public man to be a blackguard, simply working for self and party, with no real desire to use his mental or physical gifts for the benefit of his fellow-citizens. We absolutely refuse to accept that view of English public men, and while admitting there may be a fair sprinkling of black sheep, shall as yet contend that the action of municipal bodies is free from the taint of corruption. The majority of English public men are gentlemen, and have no private ends to serve. They often possess wealth, leisure, and ability, and place these at the service of their fellows without idea of reward. It is no detriment to a man's character to desire to stand well among his fellows, to want to lead rather than to follow, and to fight in the front rather than to be with the reserve in the rear. The black sheep are largely of recent importation, and so far as noise goes, undoubtedly they are pre-eminent in that direction. Then their ways are based upon American, and had they their way, politics would play as big a part here as over there. They angle for votes, tempt the thoughtless and ignorant, and generally play Old Harry in places where they gain the upper hand. Still, they are but a small minority, and we trust they will ever remain in that condition. It is not our intention to discuss seriatim the sentences in this pamphlet, the greater part of which are condemned by the last phrase in the first paragraph, to the effect that "assertions are not evidence." Just concrete comparisons are almost impossible, and more often than not woefully misleading. Again, our author makes much of when "all the facts are shown," but in his strident condemnation takes good care not to discuss factors that may tell against him. In fact, the whole pamphlet is a case of special pleading, and we only refer to it that no one may infer its conclusions are accepted on this side. Take only one simple case, which must be clear to everybody. The quantity of gas per ton of coal depends largely upon the quality of the coal, and to compare quantities without considering qualities is futile. Putting aside politics and honesty, we wonder why Americans can swallow five editions of this balderdash. Here, for example, is a clear statement: "Nearly all the arc lights furnished under municipal ownership [of course, referring to America.—ED. *E. E.*] are in *small villages that are not large enough to sustain a private company.*" Because these small village communities are enterprising enough to instal an arc lighting plant and to pay for the light, the cost of the arc from these small plants is, without a word of caution, compared, to its detriment, with that from larger plants. Surely, whatever one's convictions may be, there is no necessity to resort to methods of the kind put forward by this advocate of company work.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following are the first paragraphs of a report of the Swiss Visits Committee which was discussed at the meeting of the Institution last night: "The programme and itinerary of the visit were arranged by a committee (appointed by the Council of the Institution on March 9) consisting of Mr. J. W. Swan, F.R.S. (president), Prof. W. E. Ayrton, Mr. H. Edmunds, Dr. J. A. Fleming, Mr. W. M. Mordey, Mr. R. P. Sellon, Mr. A. Siemens, Mr. C. E. Spagnoletti, and Prof. Silvanus P. Thompson, F.R.S., acting in co-operation with Colonel P. E. Huber, of Oerlikon, Mr. C. E. L. Brown, of Baden, and Prof. W. Wyssling, of Zürich, who constituted a Swiss Reception Committee, and to whose genial hospitality and generous devotion of time, energy, and knowledge the success of the meeting was for the most part due.

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"A collection of technical notes descriptive of the works visited was drawn up by Prof. Wyssling for presentation to the members of the party, and was much appreciated by them. This collection, with a few slight alterations, and with additional notes (compiled on the same method) concerning works and installations not referred to in the original pamphlet, are here reprinted as affording a concise account of the various installations in a form eminently suitable for reference."

These notes are prefaced by a short *résumé* of the programme, with which our readers are now well acquainted. In the same way the notes of the various electrical works and central stations and electric railways visited consist, as a rule, of matter which has been more amply dealt with in our columns. These notes are most suitable for reference, but we regret to see that the committee have not seen fit to draw up a report in the usual acceptance of the word. As it is, the conclusions to be drawn from the visit as to the present standing of Swiss engineering practice, and as to the points in which we should follow the same in England, are left to individual members to point out. At the same time, a few leading points laid down by the committee would have improved the character of the discussion on the visit by offering definite statements to be confirmed or controverted.

With reference to the photographs taken by the members at the time of the visit to Switzerland and since exhibited in the library, we understand that the committee have selected 72 photographs from the large number exhibited, and by the kindness of Mr. W. C. Mountain have arranged for these to be enlarged and mounted in an album at cost price. The album will contain 12 enlarged prints 12in. by 10in., 24 photographs 6in. by 5in., and 36 photographs 4in. by 3in. Several of the subjects will be technical, but the greater part will be interesting views both of scenery and members. The price, bound in half basil, will be 27s. post free in England. Members who, though unable to take part in the visit, wish to obtain a copy are requested to apply to Mr. R. S. Erskine, 22, Stanford-road, Kensington, not later than Monday, Jan. 22.

FORTHCOMING EVENTS.

FRIDAY, JAN. 12.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Address on "The Theory of Structures and Strength of Materials," by Prof. T. Claxton Fidler, M.I.C.E.

SATURDAY, JAN. 13.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., paper on "Repairs to Hulls and Machinery in Modern Steamships," by Mr. J. White Boyd, M.I.M.E.

TUESDAY, JAN. 16.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Discussion on papers on "The Purification of Water after its Use in Manufactories," by Mr. Reginald A. Tatton, M.I.C.E.; and "Experiments on the Purification of Waste Water from Factories," by Mr. W. O. E. Meade-King, M.I.C.E.; and, time permitting, a paper on "Swingbridges over the River Weaver at Northwich," by J. A. Saner, M.I.C.E.

WEDNESDAY, JAN. 17.

Society of Arts.—At 8 p.m., ordinary meeting. Paper on "Ventilation without Draughts," by Mr. Arthur Rigg.

Royal Meteorological Society.—At 7.30 p.m., at Institution of Civil Engineers, annual general meeting. Presidential address on "A New Discussion of the Greenwich Meteorological Observations, 1848-1898," by Mr. F. Campbell Bayard, LL.M.

Institution of Mechanical Engineers.—Graduates' visit to the Royal Arsenal, Woolwich.

THURSDAY, JAN. 18.

Institution of Junior Engineers.—At 8 p.m., at the Technical College, Finsbury. Lecture on "The Balancing of Engines," by Prof. W. E. Dalby, M.A.

Chemical Society.—At 8 p.m., ordinary meeting.

FRIDAY, JAN. 19.

Royal Institution.—At 9 p.m., lecture on "Flight," by Lord Rayleigh, F.R.S.

Institution of Civil Engineers.—Students' visit to the hydraulic installations at Somers Town Goods Depôt and Kentish Town Locomotive Sheds of the Midland Railway. Assemble under clock at St. Pancras Passenger Station at 2 p.m.

FLUIDS IN MOTION AND AT REST.

Prof. C. V. Boys, F.R.S., delivered the last of his series of six lectures to juveniles on the above subject at the Royal Institution, Albemarle-street, on Tuesday, Jan. 9, the preceding lectures having been delivered on Dec. 28 and 30 and Jan. 2, 4, and 6. The course was well attended, not only by representatives of the rising generation, but by grown-up people also. As the audience assembled for the final lecture, each juvenile was presented with a copy of Prof. Boys's well-known book on soap bubbles, together with a simple toy illustrating a principle previously dealt with.

The title of Prof. Boys's lectures—"Fluids in Motion and at Rest"—perhaps hardly gave promise of the interest undoubtedly experienced by the audience. Many of us have been troubled in our youth with equations and mathematical expressions purporting to give a full and complete account of the properties of fluids. To see these properties illustrated and exhibited by experiments, many of them on a large scale, was a most delightful experience. It is, perhaps, too much to expect that each member of the juvenile audience went away well grounded in the principles of hydrostatics and hydrodynamics, but it may be confidently hoped that in after years an added interest will be felt by them when their attention is directed to the study of the principles of these sciences. Mathematical equations which might otherwise have seemed dry will be found to possess a new interest, as adumbrating principles previously seen in action.

A feature in Prof. Boys's treatment of the subject was the frequent references to applications of important principles to machines and contrivances used by engineers or in our daily life. The pressure of water was illustrated in the use of the Bramah press and Rigg's hydraulic engine. The inertia of water was illustrated by the water ram, an old friend which many people have, nevertheless, never seen in action, and a working model of the arrangement used for picking up water on the London and North-Western Railway. A centrifugal cream separator and a centrifugal filter were exhibited in action, and Mr. Killingworth Hedges's ingenious fluid speed indicator was explained and shown at work. The squirting of metals was led up to by the sodium press and the making of lead wire, and a most interesting exhibit of samples squirted by the Delta Metal Company was placed on the lecture table.

Prof. Hele Shaw kindly attended in person to assist in the demonstration of stream lines, using the apparatus which has brought him so much well-earned distinction. Froude's experiment, showing that in the constricted portions of a pipe through which a fluid is passing the pressure is less than in the wider parts of the pipe, was performed. A wonderfully simple and yet sufficient explanation of this seeming paradox was given. In the first place, it is obvious that the fluid must be moving at a greater velocity in the constricted portion than in the wide parts of the tube. In other words, when passing from a wide to a narrow part of a tube, the liquid is gaining in velocity. This can only be due to the pressure behind the liquid being greater than that in front of it. In connection with this principle, a small Venturi water-meter was exhibited in action, and it was explained that the Romans knew that the flow of water from an orifice could be increased by the attachment of an expanding nozzle. In certain cases, the pressure of water when passing round a sharp bend, or through a narrow constriction, may be diminished so far as to cause boiling to occur. This fact was illustrated by a simple experiment, and it was explained that the humming or rattling of water in the domestic water-pipes is due to this cause. It is well known that if air be blown through a small orifice in a piece of card-board, a piece of paper placed parallel to the latter will be attracted, and not blown away, as one might except. This experiment is in itself wonderful enough; but when a brass plate, to which a weight of 28lb. was attached, was seen to be pulled up in a similar manner, the delight of the audience was unbounded. The drift of round cannon shots and golf balls was explained, and illustrated by the aid of indiarubber balloons. The audience was also introduced to the indoor game of hall

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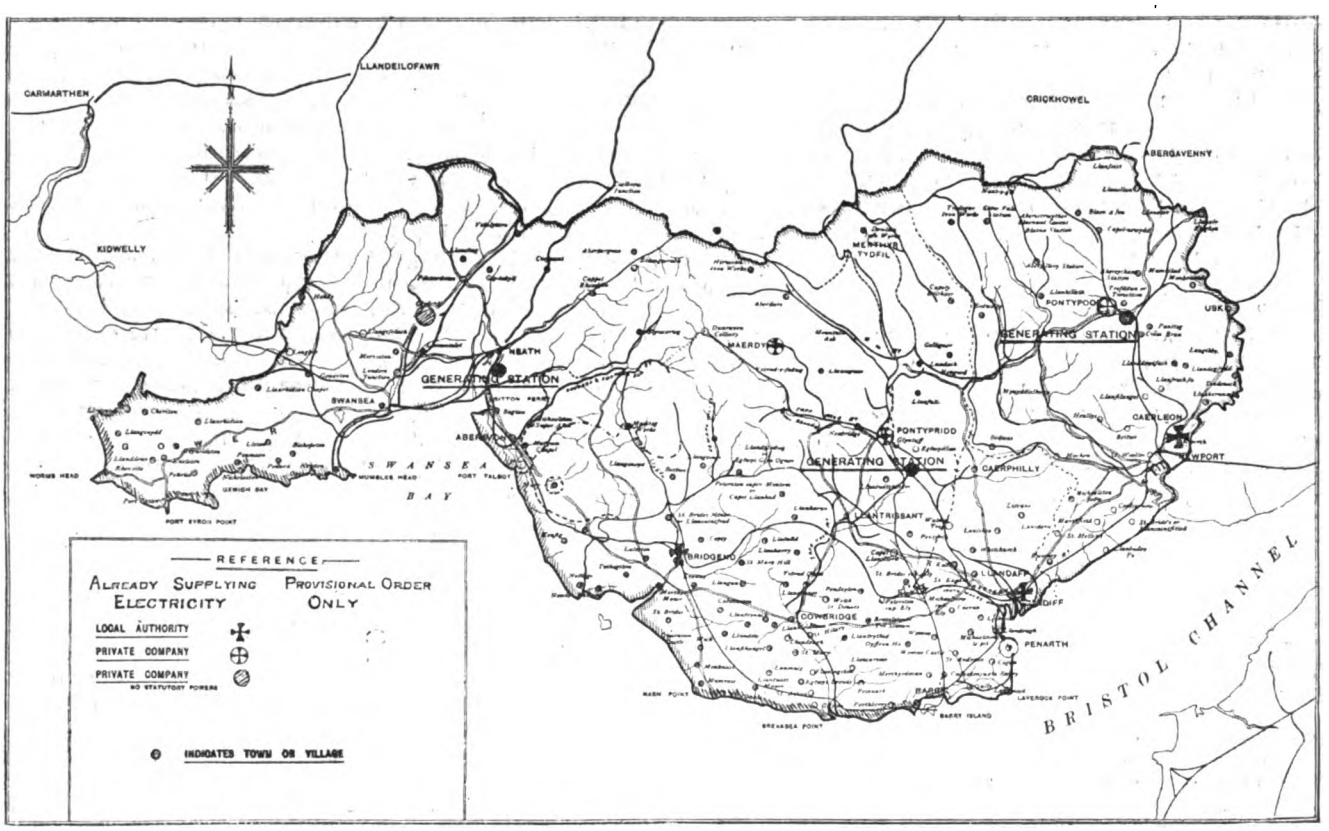
tennis—an invention of Prof. Oliver Lodge—which is played with inflated indiarubber balloons, a string tied across the room taking the place of the ordinary tennis net.

It was an excellent idea of Prof. Boys to illustrate the reaction of water in a pipe by means of an indiarubber hairdresser's band hung loosely over a wooden pulley revolving at a high velocity. The band was seen to elongate as the speed was increased; on the other hand, it showed no disinclination to assume any shape which might be imposed upon it. In connection with turbines, Parsons's steam-turbine was briefly described, and a model shown. It was stated by Prof. Boys that the "Viper," a torpedo-boat destroyer, just built by Mr. Parsons and provided with steam-turbines, had, at a trial trip on Monday, Jan. 8, attained a velocity of 41 miles per hour.

The space at our disposal will permit of only a few words further. Amongst other things, the action of a river when running round a bend was explained and exhibited experimentally, whilst an experimental waterspout about 5ft. long was shown. In the concluding lecture a number of experiments dealing with the surface tension of liquids were performed, and Prof. Boys's skill in the blowing of soap bubbles was once more made manifest. We learn with satisfaction that the lectures are shortly to be published in book form by Prof. Boys.



Map showing the Area of Electrical Power Distribution in South Wales.

ELECTRICAL POWER DISTRIBUTION IN SOUTH WALES.

In one of our notes last week we gave details of the area to be supplied by the South Wales Electrical Power Distribution Company if their Bill should receive the assent of Parliament. Through the courtesy of the engineers to the company, Messrs. Bramwell and Harris, we are now able to reproduce a map of the area, showing the positions of the generating station and also the numerous railways along which the mains are to be laid from these stations to the various towns. A statement giving in general terms the essential features of the scheme has also reached us, which clears up the point we raised as to what was a wholesale consumer. As defined in the Bill, anyone who undertakes to take 20,000 units per annum will be considered a wholesale consumer. These consumers may be supplied in areas already equipped with municipal supply of electricity only with the consent of the local authority. It is also provided in the Bill that any town not owning a provisional order can, after the Bill is passed, exclude the company from its area by agreeing to take all the current it requires from the company. The question of breaking up streets is not so clearly defined, as the statement says that "except where it is necessary to reach a manufactory no powers are sought to break up streets." This is tantamount to saying that any streets may be broken up, as, of course, mains must be laid to consumers. With regard to the financial problem of the supply over large areas, great stress is laid on the power factor of the load which the company will obtain by supplying consumers of widely varying needs. Thus it is pointed out that the electricity supplied from the Cardiff station for the year 1898-9 could have been provided by one engine of, say, 80 h.p. running continuously, whereas in order to meet the great pressure of the lighting demand which arises each day between, say, five and nine o'clock in the evening, the Cardiff Municipality have found it necessary to instal, not 80 h.p., but some 1,250 h.p. or more. In fact, for almost 20 hours out of the 24 the local station has to keep an immense reserve of machinery standing idle, while standing charges, interest on capital, rent, and wages, mount up hour by hour. The case of Cardiff is but one of many similar cases in this country. The new company believe that, owing to the varied demand that will have to be met by their linked-up system—demands from tramways and light railways working by day, pits and light users by night, towns that are busy one day a week because it is market day, and so on—that their machinery will be employed with fairly constant regularity, continuously bringing in its earnings, and so they will be able to supply the public with an efficient electrical service at a low price. The maximum prices are to vary from 4d. per unit for an intermittent supply to 2d. per unit for a regular load, and we think the company would do well to lay stress on the fact that consumers taking power for long periods will get their electricity much cheaper than the above maxima would lead one to expect. In fact, in a district where coal is so plentiful the company must make their profit out of large returns and low prices rather than from a restricted output paid for at higher rates.

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AN AMERICAN PACIFIC CABLE *

BY GEORGE OWEN SQUIER.

It is interesting to note that the idea of a trans-Pacific submarine cable was first discussed and considered by the late Cyrus W. Field nearly 30 years ago. The scheme of Mr. Field and his associates involved a route from California *vid* Alaska and the Aleutian Islands to Japan. Since that date, the subject in some form has been almost constantly before this country and Great Britain. This question has been discussed in the fifty-second, fifty-fourth, and fifty-fifth congresses, in each of which effort was made looking towards laying a cable at least as far as the Hawaiian Islands.

In a special message to Congress, dated Feb. 10, 1899, the President says: "As a consequence of the ratification of the treaty of peace between the United States and Spain, and its expected ratification by the Spanish Government, the United States will come into possession of the Philippine Islands, on the farther shore of the Pacific. The Hawaiian Islands and Guam becoming United States territory, and forming convenient stopping places on the way across the sea, the necessity for speedy cable communication between the United States and all these Pacific islands has become imperative. Such communication should be established in such a way as to be wholly under the control of the United States, whether in time of peace or of war. At present the Philippines can be reached only by cables which pass through many foreign countries, and the Hawaiian Islands and Guam can only be communicated with by steamers, involving delays in each instance of at least a week. The present condition should not be allowed to continue for a moment longer than is absolutely necessary."

The idea of a British Pacific cable, connecting the Dominion of Canada with the Australasian Colonies, almost from the first has been discussed from a national standpoint. Her Majesty's Government and the Colonial Governments most concerned, have been urged from time to time to consider the matter in its strategic and commercial aspects. Two Colonial conferences, in 1887 and 1894, were largely occupied with this subject, as evidenced by the exhaustive Blue-books which record their proceedings. The Dominion Government took the matter up in 1893 4, and invited the most reputable firms in the world to submit estimates for construction and laying.

In 1896, Mr. Chamberlain, Secretary of State for the Colonies, appointed a Pacific Cable Commission, which included among its members the Under Secretary of State for the Colonies, the High Commissioner of Canada, and the Agents-General for New South Wales and Victoria. This committee went into the whole subject of the practicability, cost, probable revenue, and management of the proposed enterprise, and elicited a fund of technical, commercial, and professional information upon cable manufacture and cable-laying in general, and upon this important project in particular, which is invaluable, and which probably could not have been obtained in any other manner. At this moment a Pacific cable touching only soil belonging to Great Britain is assured, both Canada and Australasia recently having been reported as joining with England in pledging themselves to the enterprise as a Government undertaking. The proposed route with surface distances involved is shown on the accompanying map, and is from Vancouver to Fanning Island, thence to the Fiji Islands, thence to Norfolk Island, and from there bifurcating to New Zealand and Queensland.

Since a Pacific cable will at last complete the telegraphic circuit of the globe, it will give the peculiar advantage of placing each point thereon in cable connection with every other point by two distinct routes either east or west. The cardinal idea in the British system has been that all State cables shall touch only British soil, and this principle has placed British cable traffic in the Pacific for ever at a disadvantage over the American cable for the reason that the only available route involves a single span of cable from Vancouver to Fanning Island, over 3,500 miles in length, whereas, by the annexation of the Hawaiian Islands, the United States, while following a similar principle, will have no span longer than the present Atlantic cables, or about 2,500 miles in length. Since the speed of cabling decreases in general with the square of the length of the cable, and the speed of the whole system is limited by the speed of the slowest span, that system requiring the longest single span is ultimately at a disadvantage, provided the systems are in direct competition. In the projected Pacific cable enterprises, however, although, as will be pointed out later, they will operate in close relations with each other, yet each has a sufficient prospective traffic to guarantee the enterprise as a sound financial success from the beginning.

* Paper read at the one hundred and thirty-eighth meeting of the American Institute of Electrical Engineers, New York and Chicago, Dec. 27, 1899.

American Cable Routes.

In the consideration which, from time to time, has been given the project of spanning the Pacific Ocean by a submarine cable, the northern route, *vid* Alaska, the Aleutian Islands, Siberia, and Japan, has been frequently proposed. In recent years the British Government, in its proposed line from Canada to Australasia, first projected this northern route owing to the absence, at that time, of information respecting the Southern Pacific Ocean, and the impression which prevailed that physical difficulties existed which offered insuperable obstacles to the laying of a cable on a direct route between Canada and Australasia. In consequence of this impression it was designed to lay the cable from Vancouver to Japan, touching at islands in the Aleutian and Kurile groups as mid-ocean stations. From Japan the connection with Australasia would have been obtained *vid* Singapore and the Eastern Extension Company's lines of telegraph. Through the intervention of the Government negotiations were opened with the view of securing one of the Kurile islands. Japan was asked to transfer to the British Crown one of these islands in order that the telegraph station should be under British protection, and an agent was sent to Washington who, after some difficulty, obtained conditional landing privileges on one of the Aleutian islands. Recently there has been a revival of interest in this route, especially now that the growing commercial interests of Alaska are becoming important. The plan proposes starting from Cape Flattery, thence to Sitka, distances (approximate) 803 miles, thence to Kadiak Island, 682 miles; thence to Dutch Harbour, 770 miles; thence to Attu, 810 miles; thence to the Japan-Russian border, 858 miles, thence to the Japanese land lines, 810 miles; from the Siberian border to the Siberian lines, 617 miles; and from Formosa to Luzon, 200 miles; in all 5,550 nautical miles, exclusive of the Japanese system. It will be noticed that this series of cables aggregating 5,550 miles makes no provision for American communication with the Philippines, except over the Japanese land lines from the north point of Japan to the south point of Formosa, a distance through a foreign territory of about 1,200 miles. Owing to the uncertainty of the Japanese land lines, which are frequently interrupted during the typhoon season, particularly in Formosa, it would be necessary, in order to ensure communication, to extend the Japanese cable system. Again, the Great Northern Telegraph Company, a Danish corporation, has exclusive rights, not only on the Siberian coast but also between Japan and the Asiatic coast.

Apart from establishing telegraphic communication free from foreign control between the United States, the Hawaii Islands, the Philippine Islands, and the island of Guam, the mission of an American Pacific cable should be to bring about a general reduction of cable rates. On the Alaskan route a large number of intermediate stations must be established and maintained, and there must be a division of receipts with Japan. A message *vid* Honolulu, an intermediate island station, and Guam would reach Luzon by four cable transmissions. The Alaskan route as proposed would necessitate about 15 separate stations, of which nearly one-half would be under Japanese control. Undoubtedly an Alaskan cable will soon be required, and apparently also the extension of such a cable system as a means of attaining a through line to the Philippine Islands is an attractive plan. This plan, however, leaves the United States in practically the same unsatisfactory

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position she is in at present in respect to communication with her Pacific possessions, and until definite and perpetual concessions are forthcoming can furnish even no guaranty of substantial reduction from the present high rates. It is believed that no one studying the true present and future interests of the United States can come to any other conclusion relative to an American Pacific cable than the one so admirably expressed by the President in his special message to Congress—viz., that this cable shall be "wholly under control of the United States." This cardinal idea—the principle also adopted by Great Britain after years of exhaustive consideration—at once excludes the northern route for the present, and limits the route to American territory.

Practicability.

There is no longer any doubt as to the practicability of the Pacific cable project from a technical and engineering point of view. A preliminary survey between the coast of California and the Hawaiian Islands was completed by the Navy Department in 1892, showing the entire practicability of this part of the route. Between California and the Hawaiian Islands several approximately parallel routes are practicable, but the one which seems to be favoured by the survey of 1892, as shown in the report of the hydrographic office of the Bureau of Navigation, is a rhumb-line between Monterey Bay and Honolulu on Oahu Island. The U.S.S. "Nero," under command of Commander Charles Belknap, U.S.N., has been engaged since April last in a survey of the bed of the Pacific along the proposed route of the cable from the Hawaiian Islands westward to the Philippine Islands and to Japan. A preliminary report of this survey recently received adds greatly to the knowledge of this part of the Pacific and to the data necessary before determining the exact route of the cable. This survey develops two unusual physical features along the route *vid* Midway Island. One of these is a submarine mountain, situated a short distance westward of the Midway Islands and rising from the floor of the ocean, having a depth of 2,200 fathoms, to within 82 fathoms of the surface. The second feature is one of the deepest submarine abysses yet found in the world, situated about 500 miles eastward of Guam and more than 4,900 fathoms in depth. These and other obstacles which may be found, however, can be avoided in laying the cable by making suitable detours around them as is ordinarily done.

A Mid-Ocean Island Cable Station.

The great decrease in speed and increase of cost consequent upon increase of length of a single span of the cable requires a landing station, if possible, between the Hawaiian Islands and Guam. The longest cable yet laid and in operation is the French cable from Brest, France, to Cape Cod, Mass., which is about 3,250 nautical miles in length, and there is no question that a cable directly connecting Honolulu and Guam could be successfully laid, if no practicable landing place between these points could be obtained. This single span, however (about 3,650 nautical miles, including "slack"), would for all time so reduce the through speed of the cable, and so increase the original cost, as to warrant unusual expense, if necessary, in preparing and maintaining an intermediate station. In this connection the large amount of technical evidence given before the British Pacific Cable Committee relative to the Vancouver-Fanning Island span, which is practically the same extreme length of 3,600 nautical miles, and of the utilisation of Fanning Island as a station, are valuable as showing entire practicability. Although both Wake and Midway Islands, which have been proposed as stations, are low atolls, rising but a few feet above high water and with little to sustain human life, yet either of these places is equal, if not superior, to Fanning Island. Further careful surveys will be necessary before the exact route west from the Hawaiian Islands to Guam can be finally determined. Fortunately for this enterprise the annexation of the Hawaiian group brought under the sovereignty of the United States 11 or 12 small rocky or sandy islands extending to the north-westward about 1,800 miles from Honolulu. These must be surveyed and considered from the cable standpoint before a final selection of route can be made. The distances in nautical miles along two provisional routes, including 10 per cent. for "slack" in laying, are as follows:

San Francisco to Honolulu	2,286
Honolulu to Midway Island	1,254
Midway Island to Guam	2,523
Guam to Dingala Bay, P.I.	1,496
Total *vid* Midway Island	7,559
San Francisco to Honolulu	2,286
Honolulu to Wake Island	2,205
Wake Island to Guam	1,435
Guam to Dingala Bay, P.I.	1,495
Total *vid* Wake Island	7,422

In Appendix I. are shown the great circle and rhumb-line distances involved and the geographical positions used.

Cost, Maintenance, and Operation.

The cost of laying cable depends mainly upon the materials used in its construction, and therefore fluctuates with prices current. The outer coverings are much the same in all specifications, according to the conditions of the case, but the copper conductor and the guttapercha insulation vary with the speed required over the cable. Since the length of the longest section of the proposed Pacific cable is approximately equal to each of several of the Atlantic cables, the type of the cable to be used for this section, and the speed obtainable, are subject to a close estimation. Of the 11 cables spanning the North Atlantic, the Anglo-American Company's cable laid in 1894, and the Commercial Cable Company's cable No. 3 laid also in 1894, have the greatest speeds. The former contains 650lb. of copper and 400lb. of guttapercha, and the latter 500lb. copper and 320lb. guttapercha per nautical mile. Either of these types of cable would give good results, and no cables of less equivalent speed should be considered. The following conservative estimate is made from the evidence obtainable relative to the establishment of this enterprise by the Government on a sound financial basis:

Maintenance and Repair per Annum.

Annual expenses of two cable repair ships	$200,000
Annual expense for new cable, assuming entire cable to be replaced in 40 years, or 200 miles per year	200,000
Working expenses	125 000
Reserve fund and interest on capital	400,000
Total net earnings of cable required	$925,000

This provision for laying 200 miles of new cable per year should perpetually maintain the value of the cable as an asset, and the reserve fund further provides that the entire capital shall be replaced at the end of 50 years, or what is equivalent, that a sinking fund shall be established, which, at the end of 50 years, will be sufficient to lay an entire new cable in addition to the permanent maintenance of the original one, so that at the end of 50 years two working cables will be provided for. Taking average conditions for long cables 10 years ago, the annual expenses for maintenance and repair—*e.g.*, for new cable required, etc., and not including the fixed expenses such as the repair ships—was about 30dol. per nautical mile. The great advancement in cable manufacture since has reduced the average repair rate materially, but assuming this rate as it then averaged, the total charge to this item is practically the same as that given by the independent supposition above. At present there is no first-class cable ship in the world flying the American flag, and which would therefore be under the control of the United States in time of war. It should be the policy of the United States, whether the Pacific cable is laid by the Government or by a subsidised company, to require that two complete cable repair ships, one, at least, also capable of laying long cables, equal to any yet constructed for these purposes, and flying the American flag, be stationed in the Pacific Ocean.

Speed.

The "speed" of a cable is a somewhat loose expression, and depends upon the voltage used, the particular apparatus employed in working the cable, as well as the design and construction of the cable itself, and the skill of the operators. Besides, there is a considerable margin between a speed which will do for press matter in ordinary plain language, and the speed permitted for code and cypher messages. "Speed" expressed in words per minute is misleading, since five-letter words are frequently taken as

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the basis, whereas in actual practice a telegraphic word averages about eight letters, the increase being due to code words and the omission of many conjunctions and prepositions when messages are sent in clear. A better method of expressing speed in cabling is in standard letters of a certain number of signals each, transmitted per minute, so that experienced operators can certainly and easily read them. The practical speed is the proportion of the maximum speed which remains after deductions are made for the words transmitted for which no revenue is received, on account of service prefixes, etc., repetitions, errors, corrections, necessary interval between messages, administrative messages connected with traffic, etc. In determining the deductions from the maximum speed to obtain the practical speed in paying words per minute there is little evidence at hand. In the perfected management of the Atlantic cables where keen competition exists this "dead" traffic has been reduced to 16 or 17 per cent. of the whole. For a Pacific cable an amount of "dead" traffic as great as 30 per cent. at first is estimated, and this could probably be reduced in successive years as it has been in the Atlantic traffic. Assuming 30 per cent. for "dead" traffic, and an increase of 90 per cent. of speed for duplex working, it is estimated that the maximum capacity of the cable in total paying code words, of eight letters each, would be about 11,800,000 per annum. The cost of maintenance and operation, etc., as above being 925,000dol. per annum, the average cost of transmission per telegraphic word is about ·08 cent. In connection with speed of cabling it may be said that the opinions of the best cable experts in the world as to the theoretical speed obtainable from a given cable over a given distance differs so widely as to inspire caution in making all estimates.

The present commercial rate from Washington to Manila is 2·38dol. per word, Government rate 2·255dol. per word, and the rate for "right-of-way" messages three times the normal rate. It is seen that at the present commercial rate to Manila, after allowing for present land rates to San Francisco, the proposed cable is required to operate less than 50 minutes per day in order to earn the income of 925,000dol. per year. Allowing the present rate to be reduced one-half, the cable would have to work less than two hours daily. If the rate per code word, of an average of eight letters, is placed at 50 cents from San Francisco to Manila, then, upon the above supposition, the cable need operate daily less than four hours to meet expenses. Assuming the cable to be interrupted as much as a quarter of the entire time, the figures above still appear striking.

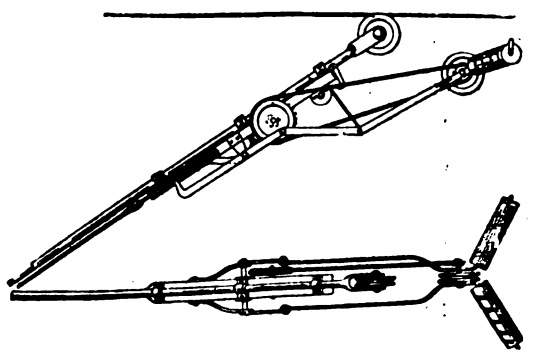
The desirability of the cable from an economic standpoint seems unquestioned. The Secretary of War says in his annual report: "The cable tolls of the War Department messages alone to and from the Philippines for the last five months have averaged monthly a rate of over 325,000dol. a year." This alone equals the interest at 3 per cent. on the sum of 10,845,000dol. It is reasonable to assume that the dispatches of the other departments of the Government would at least increase this amount by one-quarter, which would make the present Government cable tolls to and from the Philippines equal to the interest at 3 per cent. on approximately 13,500,000dol. Fully 90 per cent. of this sum goes to foreign corporations, while all Pacific cable expenditures would remain in the United States. In an ocean cable enterprise the largest item of annual expense is invariably the interest on the capital invested. No one can borrow money at a less rate than the United States Government, and, furthermore, as a Government enterprise, the cable is at once relieved from earning any sums for dividends, and is only required to maintain itself in a prudent and sound financial condition.

PROPOSED MANAGEMENT OF THE CABLE AS A GOVERNMENT ENTERPRISE.

Assuming that the proposed Pacific cable will be established by the Government, opportunity will be presented in this new and unoccupied field of the Pacific, unfettered by precedent and obligations, to introduce such radical changes in the policy and business management of the enterprise as will operate advantageously to the whole people who are directly concerned, and for whom the cable is primarily built. Private corporate management naturally aims at large dividends for its stockholders. It is a matter of statistics that in cabling throughout the long distances involved in the East, out of every 100 messages sent, 99 are purely commercial in character and one of private nature. Cabling throughout the world is so expensive that it is only resorted to for urgent commercial purposes. The present tariff rates strictly limit the kind of traffic offered, and prohibit all other than that of the most urgent nature, and are sufficiently high to keep the long cables actually idle for a considerable portion of each 24 hours. The enormous volume of the present mails indicate that the world's cable plant could be duplicated many times, and all kept full to overflowing if the cable rates were sufficiently reduced. *(To be continued.)*

A NEW TROLLEY REPLACER.

Mr. P. Kaufmann, of Lockport, N.Y., has recently patented a new trolley wire finder. The device consists of a frame of tubing about 14in. long. It is worked by means of a spring at the foot of the pole, which spring is connected by means of a wire to the replacer frame. The connection in this case is not made directly, but, as will be seen in the illustration, through a rack bar. The method of operation with this device, we gather from the *Street Railway Journal*, is that when the ordinary trolley wheel leaves the wire, it carries the replacer wheel up with it until it reaches the wire. This puts into action a double lever in the frame of the device, which disengages the rack bar attached to the spring. This spring then draws up the replacer, and in so doing pulls down the trolley. The grooved deflecting rollers on the auxiliary trolley wheel then carry the wire to it.



This wheel is connected by a sprocket chain on the pole to a gear wheel, and its revolution turns the latter. This gear wheel engages the rack bar and retains the spring until the rack bar touches a hasp, which holds the frame in the replacing position. As this hasp is released, the frame drops down, and the ordinary trolley wheel is guided to the wire. At the same time the bar at the end of the frame engages the rack bar, and the device assumes its original position. From the illustration which we give the details will be found to be clearly given, the auxiliary apparatus being larger in proportion to the trolley pole than is really the case.

THE HEAT OF FORMATION OF IONS.*

BY A. HOLLARD.

The author refers to a previous article in the same journal treating of the method of the formation of ions after Arrhénius's theory, but the variation of energy which accompanies this formation has not been fully gone into. When a salt enters into solution in water one part is dissolved without dissociation, while the other part in dissolving dissociates into ions. The quantity of heat set free or absorbed in consequence of the solution of the salt ought then to be the sum of two quantities of heat—the one proportional to the dissolving of the salt which is not dissociated, and the other proportional to the dissociation of the salt into its ions. These quantities of heat have been calculated from the thermo-dynamical principles as a function of the molecular conductivity and of the

* Translated from the *Revue générale des Sciences*.

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temperature by several scientists, and particularly by Messrs. Van t'Hoff and Rudolphi. The author does not discuss these calculations, which are a little complicated, but confines himself to the statement that these formulæ have been verified by experience and by exact determinations. What is, however, most important to know is the quantity of heat absorbed or set free by the passage of an element, either a metal or a metalloid, to the ionic state when it is dissolved in water. It is the measurement of this quantity of heat which is the object of the following article. If one knows the heat of ionisation of all the known elements it will be easy to find the heat of ionisation of any salt whatever, as the heat of ionisation of this dissociated salt will be equal to the sum of the heat of ionisation of its ions.

The elements, either metals or metalloids, in order to pass into a state of ions in solution, absorb a certain quantity of heat. This quantity of heat has been calculated for a great number of metals and metalloids by Ostwald. His method is exceedingly simple, and is based on the following considerations. The elements in entering into solution are only able, according to the theory of Arrhénius, to pass into the state of ions if they have the opportunity of receiving an electric charge. In particular, the metals amongst which hydrogen is included always pass, when being dissolved, to the ionic state, and ought in consequence to receive a certain electric charge as cations. This charge should be positive. Plunged into electrolytes they release this charge from the metal ions which they find in solution. If these metal ions thus lose their charge they pass into a state of molecular metal and are precipitated, at least those are which are not multivalent, in which case they are only able to yield a part of the charge—that is to say, they lose one of their valences. Thus iron in dissolving in a solution of copper sulphate forms ions at the expense of copper ions, which are precipitated in the metallic state. In the same way copper is dissolved in ferric chloride at the expense of the ferric ions (Fe^{+++}), which pass into the state of ferrous ions (Fe^{++}). Leaving on one side secondary reactions which may happen, one then observes, when metals are dissolved, either a precipitation of metal (or a setting free of hydrogen) or a diminution in the valency in one of the metals present in solution. The solution of the elements being thus interpreted in the light of the theory of ions, let us see how Ostwald calculates the heat of ionisation of these elements. He considers a molecule of zinc which is dissolved in a solution of copper sulphate which is completely dissociated. The reaction can then be expressed by the following scheme, where the symbols represent molecules in grammes,

$$Zn^{++} + Cu^{++}SO^{4} = Zn^{++} + SO^{4} + Cu + 50{,}100 \text{ calorie-gramme-degrees.}$$

Sulphate of copper. Sulphate of zinc.

The ions Cu, SO^4, and Zn are represented with double charges. They are, in fact, bivalent, and possess consequently, from the theory of Arrhénius, $2 \times 96{,}537$ coulombs per molecular gramme. The positive sign preceding the heat of reaction (50,100 calories) indicates that in these reactions heat is set free. The negative sign, on the other hand, will indicate an absorption of heat. The above equation indicates that the heat of ionisation of the molecular gramme of zinc, less the heat set free by the passage of a molecular gramme of copper ion into metallic copper, is 50,100 calorie-gramme-degrees. If j (zinc) and j (copper) represent these heats we get

$$j \text{ (zinc)} - j \text{ (copper)} = 50{,}100 \text{ calorie-gramme-degrees.}$$

As the heat of ionisation of copper, which serves as the basis for all Ostwald's determinations, is $-17{,}500$ calorie-gramme-degrees at 17deg. Centigrade, we have then j (zinc) $= 50{,}100 - 17{,}500 = +32{,}600$ calorie-gramme-degrees. The method in which the heat of ionisation of copper has been determined will be described presently. It will be seen from the above that the heat of ionisation of zinc is the opposite sign to that of copper. In other words, while copper absorbs heat in passing into the ionic state, zinc, on the other hand, sets heat free. This difference corresponds to other properties of these metals. For instance, zinc is easily dissolved in acids—that is to say, it easily forms ions. Copper, on the other hand, is easily reduced, and can only be dissolved in those acids which are the best oxidisers. From the heat of ionisation of zinc Ostwald deduced that all other metals with the same routine, of which the general principle may be stated in the following terms. When a metal dissolves in the solution of another metal and precipitates the latter, the heat of ionisation of the first metal is equal to the resultant heat of this reaction + the heat of ionisation of the second metal. This theory presupposes that the first salt and the salt formed in the reaction are both completely dissociated. From the heat of the ionisation of zinc Ostwald deduced that of hydrogen. Thus zinc dissolves in hydrochloric acid, and, according to Thomson, gives off 34,200 calorie-gramme-degrees. At the same time it sets free two atoms of hydrogen for every atom of zinc dissolved. We then have:

$$j \text{ (zinc)} = 34{,}200 \text{ calories} + 2\,j \text{ (hydrogen)};$$

but $$j \text{ (zinc)} = 32{,}600 \text{ calories};$$

then $2\,j \text{ (hydrogen)} = 32{,}600 - 34{,}200 = -1{,}600$ calories,

and $j \text{ (hydrogen)} = -800$ calorie-gramme-degrees.

The heat of ionisation of hydrogen is, as may be seen, very small. It follows that the heat of ionisation of metals is very nearly equal to the heat which accompanies the dissolving of these metals in acids when only hydrogen is set free. It only differs from this for each atom set free by 800 calorie-gramme-degrees. Each are set free by the conversion of the hydrogen ions into hydrogen gas. The heat of ionisation of the other metals is obtained in the same way, and are given in Table I. This method supposes, as we have already said, that the solutions are completely dissociated.

TABLE I.

	For a gramme-atom.	For a valency.
Li	+ 62,000	+62,000
K	+ 61,000	+61,000
Sr	+115,500	+57,750
Na	+ 56,300	+56 300
Ca	+107,000	+53,500
Mg	+106,700	+53,350
Al	+117,500	+39,166
Mn	+ 48,100	+24,050
Zn	+ 32,600	+16,300
Fe (ferrous)	+ 20,000	+10,600
Cd	+ 16 200	+ 8,100
Co	+ 14,600	+ 7,300
Ni	+ 13,500	+ 6 750
Fe (ferric)	+ 7,900	+ 2,633
Sn (stannous)	+ 2,000	+ 1,000
Tl	+ 1 000	+ 1,000
Pb	- 1,000	- 500
H	- 800	- 800
Cu (cuptic)	- 17,500	- 8,750
Hg (mercureus)	- 20,500	-20,500
Ag	- 26,200	-26,200

The heat of ionisation of metalloids is also determined very simply. Take, for instance, the case of chlorine. The heat of formation of the aqueous solution of hydrochloric acid in parting with chlorine and hydrogen gas is 39,300 calorie-gramme-degrees. This heat of formation, according to the ionic theory, only represents the heat resulting from the passage of hydrogen and chlorine gas into the ionic state. Thus, $39{,}300 = j$ (H) and j (Cl); or j (Cl) $= 39{,}300 - j$ (H) $= 39{,}300 + 800 = 40{,}100$ calorie-gramme-degrees.

Ostwald has found in this way the results which we give in Table II.

TABLE II.

	For one gramme atom.	For one valency.
Fl	+49,800	+49,800
Cl	+40,100	+40,100
Br (liquid)	+29,100	+29,100
I	+13,900	+13,900

In the preceding tables the heats of ionisation of metals and metalloids relative to one valency have been arranged in a decreasing order. From the considerations which are given above, in either table each element in the columns relating to one valency is able to precipitate all the

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elements which follow it, and to be precipitated by all the elements which precede it. It is seen that the heat of ionisation of the metals—that is to say, the heats corresponding to their passage into the ionic state—in solutions completely dissociated, are independent of the nature of the anions of these solutions. We thus see, again, the law stated by Tommasi, which is much older than the theory of ions. This law could be stated as follows: "When one metal is substituted for another in a salt solution, the number of calories set free is for that metal always the same, whatever may be the nature of the acid radical which forms part of the salt." However, this law of Tommasi's is only true for solutions which are completely dissociated.

(To be continued.)

SHEFFIELD TRAMWAYS.

A Board of Trade inspection of the new Intake route of the Sheffield Corporation electric tramways was held on Monday afternoon last. The service was originally intended to have been started on New Year's Day, but owing to difficulties in the way the official inspection had to be postponed. The inspectors were Sir Francis Marindin, who inspected the track, and Mr. A. P. Trotter, who investigated the electrical equipment. The line as inspected on Monday consists of a section of nearly 1½ miles, but it is intended to further extend it for about another mile, into Intake village. The route is a rather difficult one, steep gradients and sharp turns being met with. The gradients in Duke-street are 1 in 11 and 1 in 12, and the average gradient for the whole track is 1 in 17 and 1 in 18. For this reason it is only proposed to use single-decked cars on the route. On the trial run, pauses being made occasionally to test the brakes, the whole journey there and back occupied about three-quarters of an hour.

The first car contained, in addition to the two inspectors, Alderman Clegg; Mr. C. F. Wike, the city surveyor; Mr. A. L. C. Fell, electrical engineer; Mr. J. Orme, superintendent of tramways construction, and others. On the completion of the trip the inspectors expressed themselves quite satisfied with the arrangements, and in consequence of this favourable opinion the cars started running on Wednesday. We gather that there are only two cars working the route at present, these cars being run on a 20 minutes' service. There are, however, other cars waiting to be used—12 having been delivered at Tinsley during the past month and more being expected shortly—but until more progress has been made with the extension of the power-house there is not sufficient power available to drive them. Though a good speed is allowed up hill, the steepness of the down gradient is such that three miles per hour must not be exceeded at the steepest places. Practically the whole of the downward journey can be accomplished without the use of current.

THE MANCHESTER TELEPHONE QUESTION.

The telephone situation at Manchester is now complicated by the fact that a license has been granted to the Mutual Telephone Company, Limited, by the Postmaster-General. This license does not give the company powers in Manchester itself, but by it Salford and other districts near can be supplied. The license was dated Dec. 30, and at the meeting of the Manchester Town Council last week the following letters on the subject were read from the Postmaster-General:

General Post Office, London, Jan. 2, 1900.

Sir,—With reference to your letter of Nov. 2 last, enclosing a copy of a resolution of the City Council of Manchester respecting the application of the Mutual Telephone Company, Limited, for a license to transact telegraph exchange business in the Manchester telephone area, I am directed by the Postmaster-General to state that he would be glad to learn as soon as possible whether the City Council have arrived at a final decision with regard to the establishment of telephonic communication in Manchester. A license terminating in 1911 was granted to the company on the 30th ult. authorising them to transact telephone business in the borough of Salford and in the urban districts of Moss Side, Wilmslow, Stretford, Audenshaw, Gorton, Altrincham, Sale, and Swinton and Pendlebury, but not in any other parts of the Manchester area.

The Postmaster-General decided to grant this license only on receipt of urgent representations that it was necessary for the continuance of the operations of the company that a license should be obtained or or before the 31st ultimo, and also on receipt of resolutions of the authorities of the various localities included in the license in favour of the company's application.

In view, however, of the present general uncertainty as to the best mode of providing a new telephone exchange system in the Manchester area, the Postmaster-General has thought it right to insert a special condition reserving to himself the right of revoking the license wholly or in part at any time before 1911, and I am to enclose for the information of the City Council a copy of a letter to the Mutual Telephone Company, Limited, in which the reasons for this special condition are fully set forth.—I am, sir, your obedient servant,

The Town Clerk, Manchester. G. H. MURRAY.

This second letter reads as follows:

General Post Office, London, Dec. 30, 1899.

Sir,—The Postmaster-General has had under consideration your letters dated the 8th, 16th, and 23rd ultimo applying for a license for Salford and other parts of the telephone exchange area of Manchester, and the representations made by you and Mr. Thomson at our recent interview.

The Mutual Telephone Company, Limited, of which you are the secretary, was incorporated primarily to establish a telephone system in Manchester and the surrounding district, and up to a recent date it received the approval and support of the Corporation of Manchester.

Under the Telegraph Act, 1899, the Postmaster-General is prohibited from granting a license to transact telephone business to a company save with the consent of the local authority for each part of the area in which it proposes to carry on business.

When, therefore, the company recently applied for a license for the Manchester exchange area, the Postmaster-General required the production of satisfactory evidence that the Corporation of Manchester and the other local authorities consented to the grant of such a license. The result was to show that while the important county borough of Salford and the authorities of many of the districts round Manchester were favourable to the application, the City Council of Manchester rejected a resolution of consent in favour of one for enquiry into the question of telephonic supply to the city, and instructed a committee to report on the subject.

Under these circumstances the Postmaster-General would naturally have waited a reasonable time before granting any license to the company within the exchange area of Manchester, in order to allow the Corporation of Manchester to come to a definite decision one way or the other. For it is obvious that, as Manchester is the centre of the exchange area and the point on which communications converge, the wishes of the municipality of the city as to the most effective form of telephonic competition within the area cannot be ignored.

The company, however, have pressed the Postmaster-General to grant them a license for Salford and the other districts which have consented to the company's application before the end of the year, on the ground that the subscription for shares in the company was conditional on the obtaining of a license on or before Dec. 31, 1899.

It appears to the Postmaster-General that the position of the Mutual Telephone Company is radically changed when it ceases to enjoy the definite support of the Corporation of Manchester. At the same time the Postmaster-General recognises the exertions of the founders of the company to improve telephonic communication in Manchester, and he would gladly facilitate the operations of the company, so far as he can do so consistently with the promotion of a really effective competition throughout the Manchester area.

The Postmaster-General is of opinion that were he at this moment, while the course to be adopted by the city of Manchester is under the consideration of its Council, to grant an irrevocable license to the company for an important portion of the Manchester exchange area, he would be prejudicing the full consideration of the question how effective competition can best be established in the area. He is anxious that when the Corporation of Manchester, the central authority, shall have come to a decision the other local authorities should be able to consider the whole circumstances under conditions which would preserve their freedom to take such action as they might deem best; and in this view he thinks it necessary to reserve to himself the right of revoking, as to any district within the licensed area, any license he may now grant, in order that the consideration hereafter of the most expedient course may not be prejudiced by any step which he may have now taken in consequence of the peculiar position of the company. His desire is

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to keep the question open, in order that it may be decided when all the elements for a decision are supplied.

The Postmaster-General has been informed by Mr. Thomson, the chairman, and by yourself, the secretary of the company, that the company is prepared to accept a license on these terms, and I am therefore directed to inform you that such a license has now been executed by the Postmaster-General. At the same time I enclose a duplicate of the license for execution by the Company, and I am to inform you that on receipt of such duplicate duly executed, the part executed by the Postmaster-General will be handed to the company.—I am, sir, your obedient servant, (Signed) G. H. MURRAY.

Frederick Scott, Esq., Secretary, the Mutual Telephone Company, Limited, 33, Brazennose-street, Manchester.

At the meeting in question a motion was on the agenda to the effect that a previous resolution submitting the telephone question to a special committee be rescinded, and in that event the following motion would be brought forward: "That the application of the Mutual Telephone Company, Limited, to the Postmaster-General for a license to provide a system of public telephonic communication in the Manchester exchange area for a term which shall not extend beyond that of the existing license of the National Telephone Company be, and the same is hereby, approved by this Council (under and for the purposes of Section 3 (2) of the Telegraph Act, 1899), subject to the terms and conditions on which the Mutual Telephone Company shall hold and exercise such license being hereafter arranged to the satisfaction of the Corporation, and reserving to the Corporation a status to communicate with and be heard before the Postmaster-General or other Government authority in reference to the subject and as to the conditions of any license affecting the city of Manchester." In view, however, of the steps taken by the Postmaster-General, the motion was withdrawn and the whole matter referred to the special committee *re* telephones. The committee was also instructed to consider the memorial from the Mutual Telephone Company, Limited.

The granting of the above-mentioned license is a compliment to the Mutual Telephone Company, but it seems to us extremely improbable that it will do much to further telephone competition in the districts for which it is granted. It is obviously absurd to expect a company to lay down an extensive system of mains and to erect large exchanges when the utmost limit of their powers is about 11 years and the possible limit a few months. The terms of the license now held by the company are practically those of the model form for telephone licenses to be granted to companies, as the only variation of moment is the introduction of the clause under which the license can be withdrawn at any time. There are no special provisions to compensate the company should such a step be taken by the Postmaster-General, and the terms to be granted in that case to the company for its plant and mains should either the municipality or the Post Office decide to purchase are not definitely set down. Under these conditions it will be a bold step if the board of directors decide to at once incur liabilities for the establishment of exchanges on extensive lines. We fully appreciate the good work which has been done by the Mutual Telephone Company, Limited, in pushing forward telephone competition, and trust that the special committee of the Manchester Town Council on telephones will speedily make up its mind to some definite course of action.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

235. I have a bar drum armature which gives off 400 amperes 110 volts. After a 12 hours' run the temperature rise was 50deg. F. The other night the load was 300 amperes for only six hours; upon stopping, the temperature rise was found to be 155deg. F. There had been no sparking during the run. The electrician found, upon testing, nothing wrong, except that one or two connections were discoloured; he remade these joints, and since then the machine has run as well as ever. Account for this phenomenon.—F. J. A. M.

236. In a smooth-core two-pole drum armature what advantage is gained from the lamination of the copper conductors? Give figures, and state if the same apply to the conductor in slot-wound armatures.—T. G. J.

ANSWERS.

Question No. 229.—In the specification for a compound-wound traction generator the insulation is to be able to withstand an alternating current of 3,500 volts applied between the windings and frame; what would be the best way to obtain the current and apply it? It is also specified that after 24 hours' run at full load the surface temperature in no part of the armature or field windings shall exceed 45deg. F.; what is the best way of obtaining surface temperature, and can you suggest any other desirable tests to put such a generator to before accepting same from contractors?

Best Answer to No. 229 (*awarded* 10*s.*).—If the contractors have arranged to supply a machine whose insulation will stand the test of 3,500 volts alternating E.M.F., then it is, naturally, their business to see that this test is carried out to the satisfaction of the receiver, and they must provide the means of making the test. As to how it is to be done, that, too, is a matter for the makers. But a very satisfactory method of obtaining a high voltage for such testing purposes as this is to employ a small alternator, running at, say, 200 to 300 volts, and then transform up to the required voltage by means of a small transformer. In a factory which is in the habit of making tests of insulation, this forms part of the works' testing set, and is fitted with all necessary appliances, such as terminals, etc., for bringing the current to the machine to be tested. The test is one which should be carried out only under careful supervision by a competent test-room official, owing to the danger of the high voltage. The insulation of all the parts of the testing set must naturally be good, and the leads from transformer terminals to dynamo windings and frame must be fixed to the dynamo by clamps or some other suitable means, and by no means held on by hand, else serious accidents may occur. These precautions being attended to the switch may then be closed, and the voltage allowed to act over the insulation resistance of the machine for as long as is thought desirable.

The next question is a very difficult one to answer, as are indeed almost all questions connected with temperature measurements. But a satisfactory method of obtaining field-magnet temperatures is to employ a very fine bore sensitive thermometer, with as small an amount of mercury bulb as possible. This should be applied to the magnet surface some time before the machine ceases to run, and held there by a piece of cotton waste over the bulb, which is itself held in place by a piece of string tied round the magnet bobbin, or by some other suitable means, which will be readily suggested by the shape of the magnets or their mode of construction. This method allows the thermometer plenty of time to rise to its maximum, and the temperature can be observed at intervals, and an idea thus obtained as to whether it is already stationary at the end of the run or not. As to armature temperature, this must of course be taken when the machine has ceased running, and in this case a sensitive thermometer must also be applied at once, so that the actual temperature may be got as quickly as possible. It is to be noted that in a drum armature, or a deep ring, the surface temperature will continue to rise for several minutes after rotation is stopped. This is because the fanning action has ceased, and therefore heat is not conducted away by the air so quickly, and the external temperature rises. Temperature tests are, as a rule, very unsatisfactory, because the temperature

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rises quite differently under different circumstances. The test may take place near an open door, and this will actually make a difference of many degrees in the rise. If the generator is direct coupled, it is quite possible that the magnet limbs nearest the steam-pipes—should the generator be placed so that some are nearer than others—will be much hotter than the rest. And, finally, the surface temperature gives actually no information as to the internal temperature of coils or armature. If the magnets, for instance, are wound fairly deep, the internal layers may be actually much too hot for a quite moderate rise in surface temperature. A much better method of specifying for temperature rises would be to stipulate that the difference between the resistance of the windings cold and hot should not be more than such and such an amount, this amount corresponding to the mean allowable maximum rise, which, of course, would be greater than the permissible surface rise, and might in average cases be, say, 90deg. to 100deg. F. This would give a resistance increase of about 20 to 25 per cent. considered over the whole winding. This is not so important for armatures, because there the surface temperature is more nearly equal to the mean, the winding not being so deep as in magnets as a rule. But for magnets the specification ought certainly to demand the test to be made by means of resistance alteration, not as being a perfect means, but as being certainly better than the usual method of cotton waste and thermometer. Particulars as to connection between temperature and resistance, and other data concerning copper, are to be found in your issue of Dec. 22, pp. 785 and 786, and should be carefully read in this connection.

Most assuredly, the machine should not be accepted from the contractors on the strength simply of temperature and insulation tests. It ought to be thoroughly tested in addition as to whether it will do the work which it has been specified to do. The compounding should be tested, and if it is not right it must be altered. The test is made, of course, by observing voltages at different loads, from full load to no load. These should be all of the same value. Another very important point is to observe if the machine sparks when the load is suddenly altered. This is a very important matter in a traction generator, because it is just in such a case that load does alter very rapidly, and by very large amounts, and as it is impossible to stand by the brushes and constantly alter their lead, the machine must be built so as to run sparklessly.

In fact, just such tests should be applied as will be equivalent to the working circumstances of the machine, and if the machine is not considered satisfactory under these tests, then it should not be accepted until it is altered so as to be satisfactory, because only when a satisfactory test is obtained is it possible to expect that the machine will also run well under its normal working conditions.—T. C.

Answer to No. 229 (*awarded* 5*s.*).—It is usual to obtain the high voltages required for insulation tests by means of an alternate-current static transformer, of which the primary is fed direct from the mains, if an alternate-current supply is available, or from the mains through a rotary converter, if only a continuous-current supply can be obtained. If there is no electric supply to hand, a substitute can be made by fixing two slip rings on to an ordinary continuous-current dynamo, and using it as an alternate-current generator. The transformer used must not be a toy one of very small capacity (such as an induction coil), but should be one capable of giving 5 kw. to 10 kw. at the full voltage (3,500) required. For, however well the generator under test may be insulated, a small amount of current is sure to pass from the winding to the frame, and in a very small transformer even this small current will seriously lower the terminal volts; so that though the transformer may give the full 3,500 volts on open circuit, they will drop off considerably as soon as the secondary is connected to the generator. The steady application of 3,500 volts for half an hour or so is required for the proper carrying out of the test. The safest way to apply the voltage is to connect one end of the transformer secondary direct to the windings and the other end to the framework of the machine through a thin piece of fuse wire. Then switch the current partly on and gradually increase the voltage, either by cutting out resistance from the primary or by having the secondary arranged in a number of separate sections which can be switched in one at a time, thus avoiding the inductive rise of voltage which sometimes occurs if the transformer is suddenly switched on or off. In this way, if there is a serious fault in the insulation, the fuse will melt as soon as a certain low voltage is exceeded, and before any additional damage is done by the high-tension current passing through the fault.

The temperature mentioned in the question (46deg. F.) is presumably the allowable *rise* above the atmosphere after 24 hours. Forty-five degrees Fahrenheit is a very moderate increase, but is probably justified on the ground that the machine will constantly have to stand large overloads. The surface temperature is almost invariably obtained by means of a thermometer with the bulb pressed tightly on to the winding or core by a pad of dry cotton wool or waste. In the case of the field winding a position on one of the coils where it is faced by a neighbouring coil should be chosen as being the hottest. In the case of the armature the temperature should be taken at at least two points—one on the centre of the core on the surface, and the other on the end connectors. The thermometers should be put on immediately that the machine stops, and should be left on until the temperature recorded reaches a maximum and just commences to fall again. In a large armature heat may continue to soak out and the surface temperature to rise for a quarter of an hour or more after stopping. The temperature of the surrounding atmosphere should be taken at a point at least a yard off the dynamo and engine, and shielded from draughts.

Referring to the last part of the question, other desirable tests for a traction generator are: (1) the machine should be run for one or two hours at 50 per cent. overload without damage or overheating; (2) the full load should be suddenly switched on or off without producing any great speed change or damaging the armature conductors; (3) it should be possible to so set the brushes that they do not require any shifting, and do not spark when the load is varied from nothing to full load or over; (4) the machine should compound up about 10 per cent. from no load to full load, and this rise in voltage should occur more or less regularly as the load increases, and not all at once between no load and, say, quarter load, as is sometimes the case.—Q.

Answer to No. 229 (*awarded* 5*s.*).—The best method of obtaining an alternating current of 3,500 for the purpose of testing the insulation resistance of a dynamo, would be by the employment of a magneto-generator. In the first place, these can be procured to give any required voltage; and secondly, they are reliable, and, being of small size, are handy for use. As the specification states that the whole machine must stand the application of this voltage, the best method of applying it would be to take off any leads for the external circuit, and couple all the electrical portions together—that is, let the brushes rest on the commutator, the brush leads, series and shunt connections, all be duly connected to their respective terminals; if, then, one lead from the magneto be securely and cleanly fixed to one brush-holder, or other exposed current-conveying part, and the other lead be secured to any convenient part of the frame, say under the nut of a pedestal bolt, the test can be made. With this generator may be conveniently associated an ohmmeter, and if the insulation resistance is found low or defective, the various parts can be disconnected, and each tested separately, until the faulty place or places are discovered.

With reference to the temperature tests, the best method is that of using several thermometers, one of the ordinary class hanging in the testing-room, and the others of the large flat-bulb type. One of these should be secured to the surface of one of the field coils before the test commences, so that periodical readings may be taken of this, and also the room temperature during the run. As it is impossible to take the temperature of any moving part when running, these must be left until the conclusion of the test. While the armature is rotating a good deal of the surface heat is thrown off, so that the surface is considerably cooler than the core; after stopping, this interior heat gradually oozes out, hence no test should be made until this temperature attains its maximum, about 15

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minutes after stopping. The flat-bulb thermometers should then be held for a couple of minutes, one close to the armature and the other to the commutator, the bulbs being pressed close by means of a piece of waste to prevent the escape of heat.

A further condition often specified is that when the machine is running at full voltage no spark shall be obtainable upon making intermittent contact with a wire between any pole and the frame. As a traction set is liable to sudden variations in load, the angular difference in lead should be noted between full load and no load, and also the difference in amperes the armature will give, without sparking, at any intermediate points. The efficiency of the machine is another most important point, and this may be taken if there is more than one machine by Hopkinson's method; if only one machine, the best method will be by the use of a transmission dynamometer. Another test should be made to see if the machine compounds properly; this can be done by knocking off the load preparatory to stopping, and noting if the volts remain steady. Also, owing to the rise in temperature of the shunt, its resistance will increase and the field flux fall. This will be remedied by inserting a shunt resistance, and gradually cutting this out during the run in order to maintain the voltage. The amount of external resistance required to be added in the first instance for the purpose of cutting out should be noted, and should not be permitted to be excessive.

Tabulating these tests we find them as under: insulation test with generator; insulation test with intermittent contact; temperature test; fixity of lead with varying loads; efficiency test; compounding test; test for external shunt resistance.—F. J. A. M.

COMPANIES' MEETINGS AND REPORTS.

FLEETWOOD AND DISTRICT ELECTRIC LIGHT AND POWER SYNDICATE.

The first annual meeting of the Fleetwood and District Electric Light and Power Syndicate, Limited, was held at the North Euston Hotel, Fleetwood, on Friday last, Mr. J. G. Seed presiding.

The directors reported that the installation was almost completed, and it was hoped that a supply of electrical energy would be available for lighting and motive power before the end of March. Owing to the very great activity in the building and engineering trades, there had been some unavoidable delay in the completion of the various contracts.

The report was adopted, and Mr. J. T. Herbert Baily re-elected director, a vote of thanks to the chairman closing the meeting.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Tynemouth.—The Corporation invite tenders for free wiring. Particulars may be obtained from the Borough Engineer.

Berga (Province Barcelona, Spain).—The Municipality will on Jan. 18 receive tenders for the electric lighting of the town and suburbs for 20 years.

Tunbridge Wells.—The Corporation invite tenders for a 400-kw. steam alternator. Tenders by Jan. 25. Full particulars in our advertisement columns.

Belfast.—The Electric Committee invite tenders for the supply and erection of 400-kw. steam dynamos. Tenders by Feb. 8. Particulars in our advertising columns.

Newcastle-upon-Tyne.—The New Tramways Committee of the Corporation invite tenders for one 2,000-h.p. generator required early in 1901. Tenders by Jan. 16. Particulars in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for the supply of one 420-kw. direct-coupled continuous-current dynamo. Tenders by 22nd inst. Particulars in our advertisement columns.

Ferrol (Province Coruna, Spain).—The Municipality will on Jan. 16 receive tenders for the electric lighting of the town for 15 years. Specifications may be inspected at the office of the Electrical Engineer.

Utrera (Province Seville, Spain).—The Municipality will on Jan. 16 receive tenders for the electric lighting of the town and suburbs. Specifications may be inspected at the office of the Electrical Engineer.

Hull.—The Electric Lighting Committee invite tenders for the supply and erection of 30 cast-iron street section pillars, each containing eight switch fuses, etc. Tenders by Jan. 24. Particulars in our advertising columns.

Basking Town.—The Urban District Council invite tenders for the supply and erection of two continuous-current transformers and switch gear and underground cables and roadwork. Tenders by Jan. 23. Full particulars appear in our advertising columns.

Yarmouth.—The Town Council invite tenders for the supply of about 800 tons, or thereabouts, of steel girder tramway rails, of from 80lb. to 90lb. per yard, deliveries to commence not later than June 1, and the whole to be delivered on or before Sept. 1, 1900. Tenders by Jan. 30.

Newcastle-upon-Tyne.—The Corporation invite tenders for the laying down in Newcastle of about 11 miles of double-line tramway, the rails and fastenings and the poles being supplied by the Corporation. Specifications, etc., may be obtained from the City Engineer, Town Hall, Newcastle. Tenders by Jan. 24.

Sunderland.—The Corporation invite tenders for the supply of tramways switchboard. Specifications and forms of tender can be obtained of Mr. J. F. C. Snell, borough electrical engineer, at his office, Dunning-street, Sunderland, on payment of two guineas. Tenders to Mr. Fras. M. Bowey, town clerk, by 12 noon on 26th inst. Details in advertisement columns.

Tunbridge Wells.—The Corporation invite tenders for the enlargement of their central electric lighting station, adjoining the South-Eastern Railway Goods Station, at Tunbridge Wells, to be carried out under the superintendence of and in accordance with drawings prepared by Mr. C. H. Strange, A.R.I.B.A., of Tunbridge Wells. Tenders by Jan. 15. Specification, etc., may be inspected at the Town Clerk's Office at the Town Hall.

Birkenhead.—The Corporation invite tenders for constructing and erecting a new electricity generating station in connection with the electric tramways in Craven-street, Birkenhead. Plans, etc., may be obtained from Mr. C. Brownridge, A.M.I.C.E., borough engineer and surveyor, Town Hall, Birkenhead, upon deposit of a sum of £3. 3s., which will be returned upon receipt by the Corporation of a bona fide tender. Tenders by Jan. 16.

Plymouth.—The Plymouth Corporation is prepared to receive tenders for 500-kw. high-speed steam dynamo and motor-generator; 500-kw. high-speed steam alternator (disc armature); 200 accumulator cells for 1,680 ampere-hours capacity; four Lancashire boilers, with mechanical stokers, piping, ejector condensers, valves, economiser; high and low pressure paper-insulated and lead-covered mains, etc. Tenders by Jan. 31. Full particulars in our advertisement columns.

Beira (Portuguese East Africa).—The Companhia de Mocambique invite tenders for laying down the necessary plant for lighting and supplying with electricity the town of Beira (Portuguese East Africa), including the monopoly for the working of same for a period of 25 years from the date of the signing of the contract. Full particulars with regard to terms, etc., may be obtained at the offices of the Company, 12, Austinfriars, London, 45, Rua do Alecrim, Lisbon, and 7, Rue Lafayette, Paris.

Ilford.—The Urban District Council invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, etc.; pipework, etc., in engine and boiler house; two 200-kw. and one 100-kw. steam dynamos and motor boosters (vertical enclosed high-speed engines); storage batteries; main switchboard and connections; overhead 15-ton engine-room travelling crane; underground mains, conduits, and roadwork for private and public lighting; arc lamps and posts; and station lighting. Tenders by Jan. 20. Full particulars in our advertisement columns.

Melbourne (Victoria).—The Corporation invite tenders for the supply and delivery of the necessary plant, and the superintendence of its erection, and of the carrying out of the work in connection with the electric lighting of the city, to specifications as follows: (1) boilers (dry-back or water-tube type, with superheaters) and economiser; (2) steam-engines, dynamos, equaliser, booster, and switchboard; (3) feeders, mains, and arc light leads, with all bitumen or insulating material; (4) accumulators. Specifications, etc., can be obtained from the Agent-General for Victoria, 15, Victoria-street, Westminster, London, S.W., on and after the 28th instant, on payment of £1. 1s. for each specification, to be returned on receipt by the Corporation of a bona fide tender. The specifications and drawings may be seen at (but not obtained from) the office of Dr. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders by March 1. Full particulars appear in our advertising columns.

RESULTS OF TENDERS.

Battersea.—The Vestry have accepted the following tenders: Messrs. J. and A. Law, lamp-posts, £3,126; Callender's Cable and Construction Company, Limited, laying stoneware casings, £1,500.

Hastings.—The Town Council have accepted the tender of Messrs. Bellis and Morcom for another engine at £1,385, and of the Brush Electrical Engineering Company for a 200-kw. alternator at £1,455.

Bradford.—The City Council have accepted the offer of the Electricité et Hydraulique (Société Anonyme), of Charleroi, Belgium, to supply electrical equipment for 100 electric cars, at £217 per car, less 10 per cent.

Glasgow.—The Corporation have accepted the tender of the National Conduit and Cable Company, Limited, New York, at £150,617. 1s. 11d., for supply of electric feeders on the city tramways, upon receipt of a guarantee for 10 years.

East London (Cape).—The tender of the Brush Electric Engineering Company for the supply of three additional cars for

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the electric tramway service of the East London Town Council has been accepted, delivery to be made within two months of receipt of order.

Sheffield.—The Tramways Committee have given power to their General Sub-Committee to order from the Brush Electrical Engineering Works 20 double-decked and 15 single-decked cars on Brill trucks for the sum of £11,863. 2s. 6d.; and from the British Thomson-Houston Company, Limited, 20 G.E. 52 and 15 G.E. 58 standard electric brake equipments for the above cars for the sum of £10,814. 16s. 6d.

Wrexham.—The tenders noted by us on Dec. 15 as recommended for acceptance have now been accepted with the following alterations: (Section A) the amounts for economiser, brickwork setting, and dust destructor have been struck out, and fresh tenders are to be invited for dust destructor. Messrs. Babcock and Wilcox's tender is therefore reduced by £2.127 to £2,173; and in Section C, Messrs. Brook, Hirst, and Co.'s tender for switchboard is £589 instead of £539.

Birkenhead.—The Corporation have accepted the following tenders: Mr. Alfred Wenner, 32, Oxford-street, Manchester, condensing plant; Messrs. Carrick and Ritchie, Waverley Engineering Works, Edinburgh, overhead travelling crane; British Insulated Wire Company, Prescot, feeder mains; British Thomson-Houston Company, Limited, 83, Cannon-street, London, E.C., construction, supply, and delivery of 13 single-decked and 31 double-decked electric motorcars for tramways, £28,866.

Blackpool.—The Corporation have accepted the following tenders, amounting to about £30,000: Babcock and Wilcox, London (Section A—boilers); Parsons and Co., Newcastle (B—steam alternators); Cowans, Limited, Manchester (C—switchboard); British Insulated Wire Company, Prescot (D—mains); British Electric Transformer Manufacturing Company, London (E—transformers); Hart Accumulator Company, London (F—storage battery). The tender of Mr. Edmund Taylor, for the construction and laying of a tramway extension in the carriage-drive from Church-street to Springfield-road, has also been accepted.

Glasgow.—Section A (boiler-house plant)—one Lancashire boiler, with mechanical stokers and other fittings, etc.: Eight tenders were received, ranging from £940 to £1 256, and that of Messrs. Tinkers, Limited, amounting to £955, was accepted. Section B (engine-house plant)—one 300-kw. steam dynamo and pipework: 15 tenders were received, ranging from £3,140 to £5,002, and that of Messrs. Mather and Platt, Limited, amounting to £3,988, was accepted. Section C (extension of switchboard): Four tenders were received, ranging from £210 to £280, and that of Messrs. Crompton and Co., Limited (the makers of the main switchboard), amounting to £251, was accepted. Section D (condensing plant): Eight tenders were received, ranging from £493 to £759, and that of Messrs. E. Chester and Co., Limited, amounting to £493, was accepted.

Rathmines.—The Rathmines and Rathgar Urban District Council have received the following tenders for the extension of the electricity supply mains:

W. F. Dennis and Co., London	£4,125
British Insulated Wire Company, Limited, Prescot (accepted)	4,130
St. Helens Cable Company, Limited, Warrington	4,311
Callender's Cable and Construction Company, Limited, London	4,374
W. T. Henley's Telegraph Works Company, Limited, London	4,523
W. T. Glover and Co., Limited, Salford	4,701
Western Electric Company	4,724

BUSINESS NOTES.

TRACTION.

Blackpool.—An additional £6,000 is to be borrowed for new tramcars.

Lowestoft.—The Town Council intend to oppose the proposed East Anglian light railway.

St. Helens.—An enquiry is announced into the Town Council's application for an additional tramway loan of £25,000.

Leigh. (Lancs.)—A committee of the Town Council is considering the introduction of electric traction into the town.

Stockton Heath.—A parish meeting was held last night to consider the proposed Warrington and Northwich light railway.

Farnworth.—The proposed combined traction and lighting scheme is estimated at £22,000. A loan will be applied for.

Folkestone.—The Town Council have declined to consent to the application of the Sandgate and Hythe Electric Company, Limited, re the company's Bill for a tramway.

Mansfield Woodhouse.—The Council are conferring with Messrs. Webb and Co., London, solicitors to the syndicate which seeks power to make a light railway in the district.

Brighton.—The Town Council have formally confirmed their resolution to promote a Bill empowering the Corporation to construct and work tramways, to erect electric generating stations, etc.

Airdrie.—The Town Council are asking the Coatbridge Town Council to co-operate with Airdrie in supporting the New General Traction Company, Limited, in order that the wants of the public might be supplied.

Dover.—The traffic returns for the week ended Jan. 6. were £158. 19s. 1d. as compared with £155. 0s. 7d. for the corresponding period in 1899, being an increase of £3. 18s. 6d.

Carlisle.—The General Purposes Committee have agreed to request the tramway company to make a single line of tramway on Warwick-road with passing places instead of the double line as originally contemplated.

Brownhills.—A committee has been appointed to consider the various details not provided for in the Walsall Corporation Tramways Bill, and also in the proposed Wolverhampton, Essington, and Cannock Chase Junction Railway Bill.

Coventry.—The Board of Trade will certify the tramways of the Coventry and District Tramways Company as extended for public use on the company undertaking to carry out certain requirements, including the relaying of the line on Priestley's Bridge.

Dundee.—At a meeting of the Dundee Town Council on the 5th inst., it was stated that all the electrical power plant would soon be on the site, and it was desirable that it should be fully utilised as soon as it arrived. It was eventually agreed by 20 votes to 4 to proceed with the preparations for the Maryfield extensions.

Plymouth.—With regard to the immediate extension of the tramways to Laira, it is thought that if a line could be made to pay it ought to be constructed at the earliest possible moment. The total tramway receipts for the quarter ending Dec. 30 amounted to £3,960, while the expenditure, estimated at £300 a week, came to £3,900.

Light Railway Orders.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation orders for the construction of a light railway from Ryhl to Prestatyn, from Haughley to Laleworth, with a branch to Debenham and Westerfield, from Aldershot to Farnborough, and from Lowestoft to Kessingland.

Queensbury.—The District Council are in negotiation with the Halifax and Bradford Councils for the terminus of their tramway systems which are to be extended to Queensbury. Each of the two towns desire to take their trams as far as possible into the village. If allowed to do so, they would overlap. Halifax appears to be the favourite.

Beckenham.—An enquiry by the South-Eastern Metropolitan Tramways Company whether the Council will be prepared to supply them with current for traction purposes in relation to the proposed tramway through the tongue of land has been referred to the Council's advisers.

Darlington.—A special meeting of the sub-committee for trams of the Corporation was held recently with the object of considering the whole position. No information was given to the Press, but it is understood that the Imperial Tramway Company are to be asked to formulate new proposals, so as to approach closer to the plans of the Corporation.

Wimbledon.—The Urban District Council are asking the Croydon Rural District Council to share the cost of securing an expert report furnishing plans and estimates for the line from Tooting to Wimbledon Station, with a view to a joint application for a provisional order. They have also decided to inform the Surrey County Council of this proposal.

Walton-le-Dale.—At the next meeting of the Council a motion is to be discussed to the effect that the resolution recently passed with reference to the Preston Corporation tramway scheme be rescinded. The clerk has been authorised to take any steps necessary to protect the Council when the Preston Corporation applied for powers to run electric tramways.

Echt Light Railway.—The Echt light railway order made by the Light Railway Commissioners having been withdrawn by the promoters (the Great North of Scotland Railway Company), the Aberdeen District Committee of the County Council have appointed a special committee to consider the advisability of promoting a scheme themselves or of combining with any other body.

Skirbeck.—At the last quarterly meeting of the Parish Council the Chairman said that with reference to the scheme for electric tramways he had seen the manager of the company who proposed to carry out the work, and he had told him that the application of the Boston Corporation for a provisional order for electric lighting put them out of court altogether. There was, therefore, an end to the scheme.

Driffield.—At the meeting of the Urban Council on Monday, a letter was read from Messrs. Ward, Thomas, and Co., Manchester, who have the Beeford-to-Driffield light electric railway in hand on behalf of private capitalists, asking for an appointment with the clerk preparatory to the completion of the plans for presentation to the various local bodies concerned, and also for deposit with the Light Railway Commissioners.

Rhyl.—The Light Railway Commissioners have now finally decided to sanction the construction of the proposed light railway along the coast from Rhyl to Prestatyn. The motive power will be electricity, and it is anticipated that the line will present few engineering difficulties, as the ground over which it will be taken is almost level. The line will start from the entrance to the pier at Rhyl, and terminate in the High-street, Prestatyn.

Whitehaven.—At the last meeting of the Town Council on Wednesday it was decided to sanction the proposal of the English Industrials Company, Market-street, Manchester, to lay an electric tramway in Whitehaven and neighbourhood, the route being from Cleator Moor, the centre of the iron ore industry, through the village of Hensingham, continuing along the principal streets of Whitehaven and on to the Workington boundary.

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Whitnash.—The Parish Council have decided not to oppose the proposal of the Leamington and Warwick Tramways Company to extend their line in the direction of Whitnash by the overhead electric system. The Warwick Rural District Council are considering the matter on account of the alleged danger likely to be occasioned by the turn-out at Whitnash. The promoters will probably be asked to place the same opposite the village green.

Bolton.—The electric tramway system at Bolton, which was inaugurated last week, is said to work satisfactorily. Seven of the 10 routes constituting the system are now being worked. There are about 31 miles of track, covering 28 miles of street. Fifty thousand passengers travelled the first day, 45,840 of whom paid their fare. Owing to the difficulty of collecting tickets, and of the nuisance arising from the waste tickets finding their ways into the sewers, the introduction of the box system is to be reconsidered.

Foleshill.—At the last meeting of the Guardians and Rural District Council the clerk reported the receipt of a letter from the Board of Trade, enclosing reports by Mr. W. C. North and Mr. Trotter upon their inspection of further portions of the Coventry electric tramways, in which they stated that the company had been informed that on receipt of an undertaking that they would comply with the recommendations contained therein, the Board would issue a certificate approving of the extension of the tramway to Bell Green.

Leith.—The Town Council on Wednesday remitted to the special committee on tramways the appointment of a sub-committee to ascertain and report whether, in the event of the Corporation purchasing the tramways, the Edinburgh and District Tramways Company, as lessees of the Edinburgh tramways, would enter into an arrangement with the Corporation by which the tramways from Pilrig to the foot of the Walk would be worked by cable power and the remaining tramways in the burgh by electricity to be obtained from the Corporation.

Nelson.—The Town Council have carried the following resolution: "That in pursuance of the enabling provisions of the Light Railways Act, 1896, the Light Railway Commissioners be requested to confer upon the Council of this borough, by means of the Nelson light railways order, the Colne and Trawden light railways order, and the Barrowford light railway order respectively, authority to enter into an agreement with the promoters of the two latter orders to work or to contract for the working of the light railways proposed to be authorised by those orders."

Wandsworth.—At the last meeting of the District Board, the General Purposes Committee reported that they had considered the London County Council's light railway scheme for a railway from Clapham to Wandsworth and Putney, and recommended that the scheme be opposed, and that they be authorised to take the necessary steps therefor. It was decided after some discussion to adopt the recommendation of the committee, and in the meantime to approach the Council to ascertain if they would agree to insert in their order such provisions as the Board desired.

Mid-Cheshire.—The scheme to provide a light railway from Warrington to Northwich has created much interest throughout Mid-Cheshire, and considerable support is being accorded to it. According to the *Financial Times*, members of the parish councils of Little Leigh, Barnton, Anderton, and Winnington have had a conference with Mr. Scotter, civil engineer, to see if arrangements could not be made for the scheme to include the villages named. If plans could be prepared for a westerly branch to provide for the districts in question, it was unanimously decided to support the project before the Commissioners.

Bath.—The Light Railway Commissioners on Tuesday concluded the enquiry with regard to applications to establish light railways in Bath. In May last a London firm made application, and they were followed six months later by the Urban Sanitary Authority. The Commissioners refused both applications, stating that that of the promoters could not succeed in view of the opposition of the two road authorities—the County Council and the Corporation. With regard to the Corporation's application, it had not been proved that there was any widespread desire, either in the city or outside, for tram extensions, and so that must also fail.

Scarborough.—The Town Council on the 4th inst. decided to omit the tramway clauses and the proposal to widen the Valley Bridge from the parliamentary Bill which they are promoting next session The Council's Bill provided for various important schemes, including the laying down of a tramway on the Foreshore-road, new Marine-drive, and Royal Albert-drive, and at a recent public meeting the cab drivers and cab proprietors opposed the Bill, and defeated it on the tramway clauses. A poll of the town was demanded, and has been fixed for the present month. The Council have thus given way to the cabmen's opposition.

Ashton-under-Lyne.—The Town Council have adopted the Highways and Tramways Committee's report on a conference with the Oldham, Ashton, and Hyde Electric Tramway Company, Limited, on the subject of tramway extension through the borough to Hyde, *vid* Dukinfield, Newton Moor, and Godley. The company are making an application to the Board of Trade to construct an extension of the company's lines by way of Cavendish street, Ashton, over Alma Bridge, at the boundary between Ashton and Dukinfield. The committee, after considerable discussion with the deputation from the tramway company, reserved its decision.

Wigan.—The Highways, Streets, and Sanitary Committee in their report on the plans deposited by the South Lancashire Tramways Company, made several suggestions. Mr. Chambers and Mr. Grindrod attended at a recent meeting on behalf of the South Lancashire Tramways Company, and were informed that the Council strongly objected to two lines of tramways in the narrow carriageway through the principal streets, and required the carriageway to be made at least 27ft. wide throughout the Council's district. A representative of the company has since met the Council, and the latter still have the matter under consideration.

Middlesbrough.—At Tuesday's Council meeting it was proposed to refer back a recommendation that the necessary steps be taken for obtaining an injunction restraining the tramway company from watering the lines because when the roadway was in such a condition that mud, etc., caked on the lines, the cars skidded, and consequently over-run the stopping-point, while the mud became a non-conducting material to the current. It is said that should the Corporation obtain an injunction and exercise it, and accidents arise in consequence, they may find themselves in a difficult position. The amendment was discussed, but was finally negatived.

Rawmarsh.—At a meeting of owners and ratepayers of the district of Rawmarsh on Thursday in last week a resolution was passed to oppose the Rotherham Corporation Bill whereby power is sought to extend the boundaries of the borough of Rotherham, and to confer powers on the Corporation in respect of tramways, street improvements, water and gas supply, and for other purposes, and to incur such costs as may be necessary in such opposition. At a subsequent special meeting of the Urban District Council this resolution was confirmed, in addition to the following: "That the Council do hereby authorise and direct their clerk to take such steps as may be necessary to promote a Bill in Parliament to authorise the construction of tramways in the parishes of Rawmarsh and Greasborough and in the borough of Rotherham, and to authorise the widening of bridges over which the tramways may pass, and for other purposes to incur such costs, etc."

Aberdeen.—The electric tramways on the Woodside route had a highly successful run last week, the receipts being no less than £110. The amount collected on the route on the corresponding date last year was £49. On Saturday a total of £68 was received, as against £36 last year. The receipts for the whole tramway system on New Year's Day was £222, compared with £145 on Jan. 1, 1899. At the last meeting of the Council the town clerk read a letter from the Board of Trade referring to the inspection of the electrical equipment of Woodside tramways by Mr. Trotter, and stating that, while it was not in the power of the Board to grant provisional sanction for the opening of the line pending the inspection of the track, they would raise no objection to the lines being worked on the responsibility of the Corporation. The track had since been inspected, Mr. Gordon said, by Major Marindin, but no formal certificate regarding the opening of the tramways had been received.

Portsmouth.—At the meeting of the Tramways Committee on the 7th inst. it was reported that the tramways company had offered to work the undertaking for another year, and to waive the claim that the Corporation must take over the omnibuses, hearses, wedding coaches, etc., in addition to the tramways, subject to the Town Council agreeing to allow the company to retain the lines from North-end (one of the suburbs) to Cosham, which is outside the borough boundary. The company, it is understood, is desirous of working this section of the line in connection with the proposed Waterloo and Cosham light railway, the terminus of which would be at North-end instead of Cosham, as originally intended. The company's proposal was not accepted, although the committee appeared willing that the company should retain the lines for another year if the present deadlock could be settled in this way. The directors of the Provincial Tramways Company met subsequently in London. They had before them a proposition from the town clerk of Portsmouth with reference to the Portsmouth tramways, but refused to entertain it.

Sheffield.—Mr. Fell, the electrical engineer to the Sheffield tramways, has made the following report to the Tramways Committee, for which we are indebted to the *Sheffield Daily Telegraph*: "The work on the Intake route is now very nearly completed. A serious delay has been caused by the non-delivery of some feeder pillars, which have been on the railway for several weeks; these have only just come to hand. A trial trip was made over the line on Saturday last, and proved satisfactory. The line is now ready for the Board of Trade to inspect same, and can be opened for traffic immediately it is passed. The work on the Hunter's Bar route is proceeding satisfactorily. If the weather is fine it will be ready for opening by the middle of February, but as there will not be sufficient power at the power-house before the beginning of March, it cannot be opened for traffic before that time. Messrs. John Brown and Co., Limited, have nearly completed the four extra boilers at the power-house, but there is no floor round the new boilers, and the roof over same has not yet been started. The steam-pipes for the extensions are now being delivered. Some of these left Wednesbury on Nov. 25, and have only just come to hand. The boilers mentioned above cannot be put under steam until the steam-pipes are fixed. My own staff are now doing this work. Serious delay has been experienced in the erection of the first large engine and dynamo, owing to the engine builders' difficulty in obtaining satisfactory materials. A large number of their castings, which were made in Sheffield, proved defective, and had to be rejected. Mr. Morley, of Messrs. Cole, Marchent, and Morley, Limited, was here yesterday, and had an interview with Mr. Moller, representing the British Thomson-Houston Company, Limited, and myself. I informed these gentlemen that it was absolutely necessary for them to state a definite date on which the engines would be complete and ready for work. Mr. Moller stated that it would take about a week before he would have his work sufficiently far advanced to allow the engine builders to proceed with the erection of the engine. Mr. Morley stated that it would take them six weeks to complete the engine

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after the British Thomson-Houston Company had completed the work. From this it appears that the engines will not be ready for work before March 1, 1900. In accordance with the terms of the contract, the first engine should have been completed by Sept. 8, 1899; but as the foundation for the first engine was not ready for the engine builders until Oct. 23, 1899, the engine should have been completed in six weeks from that date, or by Dec 4 1899. The British Thomson Houston Company could not erect any part of their dynamo until Messrs. Cole, Marchent, and Morley had fixed their bed-plate; consequently their work has been much delayed, and, in addition to this, some of their materials have only just been delivered. The Electric Railway and Tramway Carriage Works, Limited, of Preston, have delivered the six special single-decked cars for the Intake route, but the Brill trucks for these cars have not yet been delivered. They are expected this week. Messrs. Milnes, of Birkenhead, have delivered six out of the thirteen double-decked cars which they have to supply. The remaining seven are expected very shortly. The British Thomson-Houston Company are now erecting these on the Peckham trucks which they have supplied. The Preston company will most probably deliver 10 double-decked cars this month, 10 double-decked cars in February, and 10 double-decked cars in March. The 35 cars on order from the Brush Company will be delivered between June 8 and Aug. 7. I find that a large number of our motormen are leaving Sheffield owing to the fact that on some of the routes the cars only run for a comparatively short time, and the men only work on an average eight hours per day. This means that they only receive 28s per week. I think it will be advisable to give the men on the ordinary routes a fixed wage of not less than 30s. per week, and on the Walkley route not less than 32s. per week, and recommend that this be done. If the cars do not run a sufficient number of hours to allow the men to work the full time at the rate of 6d. per hour, to make up the above amount they can be given work in the sheds." The Tramways Committee have adopted the recommendations of the electrical engineer, including the one in regard to the wages of motormen. The traffic superintendent reports that the gangways for passengers have put an end to the crushing which was formerly the cause of so much complaint. The Watch Committee have passed a resolution protesting against the gangways being placed on the footpaths without their consent first being asked. The city surveyor has been authorised to prepare plans and estimates of the cost for laying-out the land agreed to be purchased at Machon Bank-road so as to give accommodation for 80 cars, making provision for future extensions. The following members of the Tramways Committee have been requested to give special attention to the sections named: Brightside, Attercliffe, and Pitsmoor sections, Councillors Carr and Knowles; Heeley and Nether Edge sections, Alderman Styring, Councillors J. R. Wheatley and Wing; Walkley and Hillsborough sections, Councillors Hobson and A Muir Wilson; Ecclesall-road section, Councillor A. Muir Wilson; Intake section, Councillor John Smith. Passes are to be issued to these gentlemen for use while acting on behalf of the Tramways Committee.

LIGHTING AND GENERAL.

Dewsbury.—A loan of £9,920 has been sanctioned for lighting, etc.

Belfast.—The quantity of current sold in 1899 shows an increase of 54 per cent. over 1898.

Bradford.—Twenty-nine applications have been received for the post of electrical engineer.

Newport.—Mr. Ellis, the office manager of the electricity department, has been granted an increase of £50 per annum.

Coventry.—The Electric Light Commitee have adjourned for six months the question of extending their mains to Foleshill.

Newcastle.—The contract with Messrs. Middlemiss Bros. for excavation of the foundation of the electric power station at the Manors, has been sealed.

Removal.—Messrs J. C. Lyell and Co.'s offices have now been removed to 59, Victoria-street (first floor). The stores will remain as before at 55, Victoria-street.

Saltburn.—The Assets Company are asking for additional wayleaves for their cables. It is proposed that no further wayleaves be granted except at a charge of 2d. per yard per annum.

Eastbourne.—An electric organ has been installed in the Presbyterian church. Application is to be made to the Postmaster-General to make the post office in Grove-road a telegraph office.

Edinburgh.—At a meeting of the Electric Lighting Committee on Wednesday it was reported that from Dec. 8 last to the 4th inst. there had been applied for the equivalent of 5,294 8-c.p. lamps.

Ecclesfield.—The Public Lighting and Electrical Supply Committee have considered the 32 applications received for the appointment of electrical engineer, and have appointed Mr. James Moss, of Derby.

Lancashire.—A conference of municipal corporations will be held on the 23rd inst. at Manchester for the purpose of considering and, if thought desirable, opposing the Lancashire Electric Powers Bill.

Wrexham.—The Town Council have decided to advertise afresh for tenders for a destructor. The engineers estimate the total cost of the combined lighting and destructor undertaking at £21,722. 9s. 7d.

Melton Mowbray.—Messrs. C. A. Parsons and Co. have received from Edmundsons' Electricity Corporation, Limited, the order for two 75 kw. condensing type turbo dynamos for the electric lighting of the above town.

Carlisle.—The Electric Lighting Committee have decided to abolish meter rents. They have also agreed to erect five more arc lamps in the streets of the city, bringing the number up to 30, as originally proposed.

Battersea.—At Wednesday's meeting of the Vestry a report was received from the Lighting Committee stating that Mr. W. Willis has been appointed chairman of the committee for the ensuing three months.

Lowestoft.—The draft agreement with the National Telephone Company with respect to the laying of underground wires, etc., are to be further considered when Mr. Bennett and Mr. Hawtayne have been consulted on the matter.

Limerick.—Mr. J. G. Enright's lighting scheme is before a committee of the whole Council. The cost of the electric lighting scheme is estimated at £19,000, and with current at 5d. per unit a profit of £400 per annum is anticipated.

The Charge of Stealing Electricity.—At the London County Sessions (Clerkenwell sittings) on the 10th inst., before Mr. W. R. McConnell, Q.C., "no bill" was returned on the charge of fraudulently abstracting electricity by diverting the current by means of an alleged improper contrivance, preferred by the Hammersmith Vestry against one Alfred John Harrison.

Deeside.—The Town Council on Wednesday rejected the recommendation of a special committee that the site at the foot of the quarry behind the gasworks be acquired for electric lighting works. The committee were appointed to carry out the electric installation on the lines laid down by Prof. Fleming, and they contended that their duties were ended by the negativing of their recommendation.

Thornton-Scarth Lighting Syndicate.—Messrs. Lockerbie and Wilkinson, Limited, Birmingham, have acquired the whole of the patents, stock, plant, and goodwill of the Thornton-Scarth Automatic Lighting Syndicate, Limited. The sales management of this department will be, as formerly, in the hands of Mr. E. L. Lovetus, and the firm will continue the "Thorscar" trade mark for their productions in this line.

Birstall.—At a meeting of the Birstall Chamber of Commerce on Wednesday a letter was read from the clerk to the District Council with reference to the question of supplying electric light in the town, stating that it was not the intention of the Council to undertake a scheme of electric lighting at present, and their position with regard to any private undertaking depended so much upon circumstances that it was not possible to give a definite answer applying to all cases.

Northallerton.—The public lighting was inaugurated on Monday night. Arc lamps of the Solar long-hour type are used for brilliantly lighting the main thoroughfares, and a considerable number of incandescent lamps for lighting the side streets and lanes. One of the novel features is the adoption of aluminium conductors for the overhead mains. The works have been designed and carried out to the specification of Mr. J. Ernest Hutton, A.I.E.E., to whom is due the formation of the company, which promises well.

Newcastle.—A report from the Town Improvement Committee and the New Tramways Committee relative to the proposed Gosforth electric lighting provisional order, was adopted by the City Council on Wednesday. The Newcastle-on-Tyne Electric Supply Company, it was reported, were about to instal electricity at Gosforth, and proposed to interfere with the tramways and streets without the permission of the Corporation. The committee recommended that a letter be sent to the Board of Trade objecting to the granting of such powers.

Sheffield.—At Wednesday's meeting of the City Council it was announced that in consequence of an application to borrow £100,000 for the purposes of the electric light undertaking, a reply had been received giving leave to borrow £71,120. The letter added that the sums which the Board had excluded from the loan were as follows: proposed expenditure on machinery, £12,280; steam boilers, pipes, condensers, etc., £9,000; machinery connected with the proposed public lighting, £7,600. The Board would defer giving a decision as regarded those sums until the Council were in a position to furnish more precise information as to them. The City Hospitals Committee's recommendation of an expenditure of £25 per annum on a new direct telephone line from the Lodge Moor Hospital to the Sheffield exchange, and on extension instruments to the doctors' rooms at Winter-street and Lodge Moor, was not confirmed.

Appointments Vacant.—The Tramways Committee of the Manchester Corporation require the services of a competent electrical engineer to act as the chief assistant of the city electrical engineer.—The authorities of the Hertfordshire County Lunatic Asylum are prepared to appoint an electrical engineer.—The Edinburgh Corporation require two switchboard attendants.—A shift engineer is required at Leith.—Ashton, Frost, and Co., Limited, Blackburn, require the services of a thoroughly competent electrician to take charge of department.—The Brush Electrical Engineering Company require the services of a superintending engineer to superintend, from their London head office, the execution of the company's lighting, power, and traction contracts.—A meter inspector is required at Halifax.—There are also vacancies for improvers, trimmers, and for a stall attendant for the Paris Exhibition. Full particulars of above vacancies will be found in our advertisement columns.

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Londonderry.—Various letters in reference to the lighting of Artizan-street, Rosemount, Clarence-avenue, etc., have been referred to the Inspection Committee.

Walmer.—A conference between the committees of the Walmer and Deal Town Councils is to be held on the matter of electric lighting as well as the proposed railways.

Bury.—Mr. A. H. Roe, of Bradford, has been appointed resident electrical engineer of the borough, out of 72 applicants. The extensions of the electric lighting works will probably be in full running order by the middle of March.

Sandwich.—The English Industrials, Limited, have reduced their offers for telephones to £2. 10*s.* per instrument, plus ½d. per call, or a maximum of £6. 5*s.* The Council have decided to defer action until receipt of more definite information.

Batley.—The National Telephone Company are seeking to make an agreement with the Corporation for the laying of the company's telephone lines underground instead of overhead, and the matter is now being dealt with by a small sub-committee.

Chesterfield.—The Town Council have adopted a resolution recommending the Electrical Energy Committee to consider and report upon the desirability of using gas-engines for the purposes of the generating station to be provided for the borough.

London Gazette.—The last day for receiving proofs in the estate of A. Blackburn and J. Walter at Upper-lane Mills, Cleckheaton, Yorks, is Jan. 24. J. A. Binns, official receiver, 31, Manor-row, Bradford. A dividend of 1*s.* 1d. has been declared.

Margate.—The Isle of Thanet Electric Light Company's system of electric tramways, now being constructed, will be opened in August next. The lines will connect Westgate, Margate, Broadstairs, and Ramsgate. The electric lighting concession for the district is held by the same company.

Warrington.—Mr. W. H. Grimsdale, of Hammersmith, has been appointed temporary electrical engineer and clerk of works. The following scale of charges for electric lighting is to be adopted: 6d. per unit for the first 1½ hours per day per quarter, 3d. per unit after the first 1½ hours per day per quarter.

Broughton.—The Parish Council will again petition the postal authorities to extend the telegraph to the post office at Great Broughton. A small committee has been appointed to wait upon the most influential people in the district, and ask them to be guarantors in the event of the petition being granted.

Monmouth.—At the last meeting of the Town Council it was decided that another turbine and another engine of 100 h.p. would be required, in addition to the extra turbine now on order, to supply the increased demand for private consumption of electric light. A committee was authorised to prepare the estimate of the cost.

Camberwell.—Statutory notice has been received from the County of London and Brush Provincial Electric Lighting Company of intention to lay electrical conduits on both sides of Whateley-road from Barry-road, crossing Lordship lane, in Melbourne-grove, both sides as far as Lytcott-grove, and on both sides of Lytcott-grove.

Kendal.—The Town Council, having decided to have an installation of the electric light, have engaged the services of Messrs. Handcock and Dykes, and have made special arrangements with them in consequence of their having Mr. Ritson on the spot, who will take the position of resident engineer while the works are in course of construction.

South Africa.—We learn from the *British and South African Export Gazette* that the South African Mutual Life Assurance Company, Capetown, are negotiating with the United Electric Company, Toronto, for the supply of two direct-connected units and systems of accumulators for power and light for their new offices in Port Elizabeth.

Leigh (Lancs.).—The electric lighting supply was switched on for the first time last week. The installation has cost over £10,000, and is on the three-wire system, at a pressure of 440 volts. At present only the compulsory area is lighted, but extensions are already projected. The charges are 7d. per unit for the first hour, and 2½d. per unit afterwards.

New Company.—The Keynsham Electric Light and Power Company, Limited, has been registered with a capital of £5,000 in £1 shares, the object being to adopt an agreement with the Western Counties Electric Light and Power Syndicate, Limited, and its liquidator, and to carry on the business of an electric light and power company in all its branches.

Whitehaven.—With regard to the electric lighting, it is stated that the quantity of current consumed by the public lamps continues to increase. In 1896 it was 79,689 units, at the rate of 171 units per lamp per annum. Last year it was 86,508 units, or at the rate of 189 units per lamp. In the former year the town had to pay £1,328. 2*s.* 11d., and in the latter £1,441.

Dudley.—At the last meeting of the Town Council it was proposed to associate with the electric generating station a refuse destructor. It was estimated that nine cells would be required, representing a cost of £7,000, and that the annual expenditure would be £1,050, exclusive of the interest and repayment of loan. After a lengthy discussion, the resolution was lost.

Cardiff.—At a meeting of the Electrical and Lighting Committee on Thursday last week the insufficient lighting of Penhill was complained of, and the committee promised improvement. Designs were submitted of lamps for the electric lighting of Canton Bridge, and the designs were submitted for consideration to Mr. Appelbee (electrical engineer) and Mr. Harpur (borough engineer).

Accident.—In the official report of the electric car collision in Glasgow on New Year's Day, referred to in our last issue, it is stated that after the accident the brakes were found to be in perfect order, and that the accident was the result of the driver of the colliding car being in a state of intoxication. The latter and the conductor of the other car are still in hospital in a critical condition.

Sudbury.—The Town Council on Tuesday approved of Mr. Hawtayne's report on the electric lighting of the town, also to a report as to the lighting on the Wents Estate recommending the adoption of a scheme at a cost of £580, the power to be obtained from a dynamo run at the waterworks pumping station. Private consumers to the extent of 1,000 lights have already notified their intentions of taking current.

Wrexham.—Details of the accepted tenders will be found in another column. The total amount to be expended will be as follows: boilers, £2,932; steam dynamos, say £7,286. 10*s.*; switchboard, £589; mains, £4 499 11*s.* 7d.; accumulators, £991; crane, £140; consumers' connections at estimated amount, £1,500; buildings ditto, £750; destructor, about £2,000; 5 per cent. fees, £1,034. 8*s.*; making a total of £21,722. 9*s.* 7d.

Accident.—Five workmen were admitted to the Seamen's Hospital, Greenwich, on Friday last, suffering from scalds sustained through the bursting of a pipe in connection with a boiler on which they were engaged at the Deptford electric lighting works. The wounds, which were chiefly on the upper part of their bodies, were not serious, and the men are progressing favourably.

Presentation.—On Thursday, Jan. 4, the officials and staff of the Derby electricity works presented Mr. James Moss, who has recently been appointed borough electrical engineer at Eccles, with a handsome set of carvers in suitable case, and also a solid silver toast-rack, as a mark of their appreciation and good wishes in his new appointment. Mr. Wilmshurst made the presentation in a very felicitous speech, to which Mr. Moss replied in suitable terms.

Alfreton.—Mr. J. S. Barnes has prepared a report on the electric lighting of the town. He estimates the capital outlay at £11,500, and the annual expenses at £590 The ratepayers have had the following questions submitted to them: (1) Are you in favour of the town adopting the electric light? (2) Assuming that the cost of the electric light will not exceed that of gas, are you prepared to take the light in your house or business premises? Any remarks on the subject?

Aberdeen.—With the view of meeting next winter's load, an additional 700 h.p. engine and dynamo is to be installed in the existing engine-room, the estimated cost being £6,325. The price of electric current for the six months from Jan. 1, 1900, has been fixed as follows: (1) for lighting—for the first hour daily of the maximum demand 6d., thereafter 3d., per Board of Trade unit; (2) for motive power—for the first hour daily of the maximum demand 3d., thereafter 1d., per Board of Trade unit.

British Westinghouse Co.—This Company has forwarded to us their circulars numbered from 1,005 to 1,009 respectively. These deal with the following subjects: direct-current multipolar generators and motors; lightning arresters for both alternating and direct current circuits; series arc lighting generators; belt-driven single-phase alternators from 1,100 to 2,200 volts and 133 frequency; and belt-driven polyphase alternators designed for a standard frequency of 60 and voltages of 220, 440, 1,100, and 2,200 respectively. We hope to refer to these circulars more in detail in a future issue.

General Electric Co.—This Company has sent us some more additional sheets to their catalogue, which deal with new electric apparatus introduced since the 1899 edition was published. As is natural, the subject matter on these additional sheets varies widely. Thus we notice a new type of electric radiator, a dynamo field rheostat made with resistance wire covered with enamel, a triplex power pump electrically driven, and several accessories for electric lighting work. The last sheet is devoted to electrolytic interruptors for X-ray and wireless telegraphy work, and to sending and receiving apparatus for the signalling by the waves so produced. The triplex pumps are being stocked in sizes capable of dealing with from 85 to 2,240 gallons per hour under a 300ft. head of water.

British Thomson-Houston Co.—This Company has just issued a new pamphlet (No. 52) dealing with the direct-current enclosed arc lamps of the carbon-feed type they have standardised. These lamps have been carefully designed, and can be equipped with a great variety of globes and reflectors to enable them to give light most economically in any situation. The combinations thus possible are five in number, and range from two globes with reflector above to a single small globe with reflectors both below and above it. By this latter combination a widely-diffused light is obtained, and strong shadows are eliminated. The lamps are designed, as a rule, to burn on circuits from 100 to 125 volts, but we notice that single lamps to take 2½ amperes from a 220-volt circuit are listed. Even with this it appears that all the necessary resistance is contained in the case at the top of the lamps. Special short lamps for use on board ship or in other places where there is little headroom are listed. At the end of the pamphlet curves of the distribution of light round the lamps with double globes and with the single globe and reflector are given, which show how important it is to choose the accessories to the lamps with special reference to the area to be lighted.

Stock Exchange Settlements.—The Stock Exchange Committee have appointed Jan. 17 as a special settling day for the British Westinghouse Electric and Manufacturing Company's 100,000

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5 per cent. preference shares of £5 each, £3 paid, Nos. 1 to 100 000; and the 25th inst. for Crompton and Co.'s further issue of 14 320 shares of £3 each, £2 paid, Nos. 32,099 to 46,418; and have ordered to be quoted in the official list the British Westinghouse Electric and Manufacturing Company's 100,000 6 per cent. preference shares of £5 each, £1 paid, Nos. 1 to 100,000.

Telegraph Reservists.—The remaining members of the 24th Middlesex (Post Office) Rifle Volunteers, being also first-class army reservists of the Telegraph Battalion, Royal Engineers, received telegraphic instructions on the 9th inst. to join at Aldershot forthwith. The men at the time were engaged in their ordinary pursuits at the Central Telegraph Office, but they were immediately released from duty by the authorities. Messrs. Forth and Haydon, of the Leeds postal and telegraph staff, have also rejoined the Telegraph Battalion Royal Engineers.

Colne.—The estimate for the proposed technical institute includes an item of £1,433 for ventilation, heating, and lighting by electricity. Mr. Cooper, the electrical engineer, has entered upon his duties. The sub-committee along with the engineer, are inspecting suitable sites in the borough on which to erect the generating station. A circular is being issued with a view to ascertaining the names of persons who propose to take a supply of electricity when the committee are in a position to supply the same. Provisional office accommodation is being found in the town hall for the electrical engineer.

Shannon Water and Electric Power Co.—At a meeting held on Saturday a resolution was passed stating that the principal fishery owners in the Limerick fishery district, mill and factory owners using the waters of the Shannon below Lough Derg, riparian proprietors, and users of the water for navigation purposes, view with grave apprehension the works intended to be carried out by the proposed Shannon Water and Electric Power Company, and for which parliamentary powers are sought, and calling upon the Chief Secretary for Ireland and the Commissioners of Public Works in Ireland to refuse their sanction to such a scheme.

Beckenham.—The Urban District Council have received the following report of the Electric Lighting Committee: "A letter from the British Insulated Wire Company, Limited, with reference to prospective arrangements for free wiring was read, and the subject was ordered to be brought up again when the contractors are in a position to make a definite proposal. Subject to satisfactory arrangements with the British Insulated Wire Company as to the sinking fund, the Council is recommended to give a general authority for the extension of mains where the contractors and the officers of the Council agree that there is a reasonable prospect of adequate custom."

Pembroke.—Renewed application of the National Telephone Company for leave to lay underground wires in the Pembroke district has been referred to the Roads Committee of the Urban District Council. The letter referred to a notice which had been given by the Council to determine on Dec. 31 an existing agreement with reference to the telephone service, and said the company desired to place the telephone system in Dublin and the surrounding districts on the best possible footing. They were prepared, if the required facilities were granted, to reduce the rate of charge to subscribers to £3. 10s. per annum with 1d. call, and to close the Ballsbridge exchange and connect the township with the central exchange in Dublin. A reduction of the charge for laying down the wires was also asked.

Personal.—We are informed that Mr. J. A. Matthews, having been offered the post of electrical engineer to the Vulcan Boiler and General Insurance Company, Limited, 67, King-street, Manchester, has resigned the position of designer and head of the dynamo department of Messrs. Ashton, Frost, and Co., Blackburn, a position he has held for the past 4½ years.—We understand that Mr. Frederick Grover, M.I.M.E., has resigned his position at the Yorkshire College, Leeds.—We learn that Mr. W. A. Fraser, electrical engineer of the Lancaster Corporation, as a member of the Middlesex Yeomanry, has volunteered for service in South Africa, and having satisfied medical and other requirements, will leave for the front during the present week.—Mr. Appelbee, the electrical engineer at Cardiff, has recently been married.

Wimbledon.—A letter from the Kingston Town Council offering easier terms for the lighting of the workhouse is now being considered by the Building Committee of the Guardians. At the last meeting of the Urban District Council, Mr. Caswell said that during the first week that the electricity works were in progress the coal cost 1s. 1½d. per unit. For the week ending Dec. 7 it was reduced to 2·32d. per unit, and this had been further reduced until it was only 1·3d. per unit, and the engineer had said that he hoped to get it down to 1d. The estimated revenue for the current quarter was £1,060, while the expenditure was estimated at £650. During one week the cost of current to the consumer was £121, and the cost at the works £46. It is being urged that the work of roofing over the tipping platform should be commenced without delay.

Wigan.—On Thursday afternoon last week, the Mayor of Wigan (Mr. J. T. Gee) laid the foundation stone of the new power station in connection with the electrical undertaking of the Wigan Corporation. The Corporation's scheme involves the expenditure of £85,000 for electric lighting, and £40,000 on two lines of tramways. The probable expenditure in the future, which will include the working by traction of the whole of the Wigan and district tramways, is estimated at between £300,000 and £400,000. Mr. Worthington, the chairman of the Electric Light and Tramways Committee, shortly described the undertaking. The Electric Light and Tramways Committee report that since the supply has been started they have had no mishaps, and everything has run in exceedingly smooth order. By the aid of a temporary storage battery they expect to be able, within a week's time, to supply a larger number of customers than they have on their books at the present time.

Bacup.—The minutes of the Electricity Committee, which were confirmed at the last meeting of the Town Council, contained the following: "The report prepared by Mr. Charles D. Taite, A.I.E.E., electrical engineer to the Corporation of Southport, was considered. The borough surveyor submitted plans for the proposed electric light station, and an estimate of the cost of the buildings and chimney, amounting to £5,400. It was resolved that the necessary applications be made to the Local Government Board for their sanction to a loan of £22,400, and for their approval of the use of the proposed site for the generating station, and to the Board of Trade for their sanction under the Bacup Electric Lighting Order, 1890, of the system proposed to be adopted for the supply of electric energy, and that the Electricity Committee be empowered to take such other steps as may be necessary to carry into effect the foregoing resolution, subject to their reporting from time to time to the Council."

St. George-the-Martyr.—At last week's meeting of the Vestry the General Purposes Committee reported that they had had under their consideration the character of the electric energy supplied by the London Electric Supply Corporation, Limited. Letters had been received from the Board of Trade and the London County Council enclosing copies of communications from the company explaining the reasons for the irregular nature of the supply, and stating that steps were being taken to prevent any further cause for complaint. The committee found that, notwithstanding these repeated assurances, the character of the electric energy had not improved, and the supply continued to be totally insufficient for illuminating purposes. The committee had instructed the vestry clerk to again write the Board of Trade urging upon them the importance of steps being taken to compel the company to fulfil the terms of their obligations as laid down in the London Electric Lighting Order, 1899. It was agreed that the London County Council should be asked to take action against the company.

Gloucester.—At a special meeting of the City Council on Tuesday the following minutes of the Electricity Supply Committee were considered and confirmed: "Proposed further loan—Mr. Hammond submitted a statement showing the amount of loan sanctioned by the Local Government Board for the electricity works, and the expenditure and commitments in respect thereof, from which it appeared that the works included in the estimate would be carried out at about the estimated cost. The statement also gave particulars of the estimated cost of the proposed additional plant required for the electricity works, including additional mains, arc lamps, meters, demand indicators, and incidentals; and also an estimate of the expenditure in respect of the refuse destructor, including the incidental buildings, high-level road, steam-boiler and pipe work, mortar mill, etc., showing that the further amount required would be as follows: electricity works, £9,425; refuse destructor, £8,575—total, £18,000. It was resolved that the Council be recommended to apply to the Local Government Board for sanction to borrow the further sum of £9,425 for the electricity works and £8,575 for the refuse destructor." In presenting the minutes for confirmation, Mr. C. H. Clutterbuck, chairman of the Electricity Committee, said that at present the applications for the light had been so numerous that the committee felt justified in asking for this additional loan. If they delayed to do so, they would only inconvenience those who were anxious to have the light. No town, he believed, had ever started a scheme with so many customers, excepting Plymouth. This showed how heartily the citizens of Gloucester were taking up the light. The applications to date were as follows: available for private lighting, 12,000 8-c.p. lamps; less total of present applications, 9,771; required for municipal buildings, say 2,000, equals 11,771, leaving a balance available for private lighting, 229.

Grantham.—Adverting to the resolution passed by the Council at their previous meeting consenting to the application of the Urban Electric Supply Company, Limited, to the Board of Trade for a provisional order, subject to purchase and other terms being arranged, the Electric Lighting Committee presented to the Council last week a print of the proposed order as deposited by the company with the Board of Trade. Particular attention is called to Clause 8, which gives the Council option, at 12 months' notice, to purchase the undertaking at the expiration of seven years from the commencement of the order or at the end of any subsequent period of seven years. The maximum prices set forth in the schedule are: for any quantity exceeding the equivalent of 91 hours of supply at the maximum power which has been demanded by the consumer, at the rate of 7d. per unit; for any further quantity not exceeding the equivalent of 91 hours of supply at such maximum power, at the rate of 4d. per unit; and 2d. for any further quantity. The provisional order does not contain clauses relating to street-lighting or charges for motive power, these being outside the order. The committee therefore proposed that the Council should make an agreement under which the company would not be allowed to make a charge (upon the maximum demand system) exceeding for street-lighting or other public purposes 7d. per unit for the first hour, and 2d. per unit after the first hour; for motive power 4d. per unit for the first hour and 1d. per unit afterwards. Further, the company would have to adopt a system of free wiring to be approved by the Council, and the site of the installation station would also have to be approved by the Council. The committee recommended the Council to consent to the provisional order as submitted, provided

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that the company entered into an agreement substantially in the form presented.

Hereford.—At the last meeting of the City Council an honorarium of 100 guineas was granted to Mr. John Parker, A.M.I.C.E., the city surveyor, in recognition of the services rendered by him in connection with the electric light undertaking. At the same time Mr. F. G. Poulton was appointed resident electrical engineer, at a salary of £150 per annum, his duties as clerk of works having expired. In moving the adoption of the committee's report to the above effect, the Mayor explained how Mr. Parker had, at the request of the committee, designed and carried out the works, which by the terms of his appointment he was not bound to do. The outcome was that they had erected these works, which, he (the Mayor) ventured to say, would do credit to any electrical engineer. Mr. Parker had never suggested to anybody that he ought to be remunerated for what he had done, and although the amount of the honorarium was considerably less than the value of the work, Mr. Parker's reward would be not so much the pecuniary one, as he would feel that he had left behind him a monument that would hand his name down to future generations. Other members of the Council spoke highly in favour of the resolution, and Mr. Parker briefly thanked the Council for the substantial manner in which they had been pleased to recognise his services in connection with the electric light installation. We quote from the last report of the Electric Lighting Committee as follows: "There are now actually connected and taking the current the equivalent of 1,654 8-c.p. lamps, and agreements have been signed for a supply equivalent to an estimated additional 2,500 8-c.p. lamps. The committee have also received intimation that there will be further numerous applications for the light shortly. The machinery is working very well, and the committee believe that the Council have every reason to be satisfied with the manner in which the contract was carried out. The various tests have shown excellent result, and the committee are glad to state that the condenser is now being used, and consequently the vibration which caused some annoyance to residents in the neighbourhood during the trial runs prior to the opening of the works will not be experienced again. It was due merely to vibration through the atmosphere from the main atmospheric exhaust pipe, and not to the machinery, which is running perfectly smoothly, and there is an entire absence of vibration." This report was adopted at the last meeting of the Council.

Plymouth.—A report was presented to the Electricity Committee of the Corporation at their last meeting by Mr. J. H. Rider, the borough electrical engineer, upon the extension of plant and mains required to meet the public demand for the electric light. The report, according to the *Western Morning News*, says: "Besides the arc lighting and the tramways, our present machinery can supply 7,500 lamps of 8 c.p. at one time, and we have already a demand for over 12,200 lamps of 8 c.p. It is not usual to find that more than about 60 per cent. of the lamps connected are burning at one time, and on this basis we can supply our present connection, but no more. To provide for the demand still existing, and for the ordinary growth of the undertaking, it is absolutely necessary to put down additional lighting machinery before next winter. The difficulties in the way of quick delivery from manufacturers at the present time are so great that orders must be placed at once if we are to have the plant in time. I recommend that a 700-h.p. steam generator for 500 kw. output, with two additional boilers, steam-piping, economiser, and connections, be provided. This will raise our plant capacity to a total of 1,100 kw., and allowing the necessary spare plant will permit of the connection of about 25,000 8-c.p. lamps, in addition to the arc lighting and the tramways. The present spare space at the works will be occupied by the tramway plant already authorised, and to make room for this addition the buildings must be enlarged. As still further extensions of plant will certainly be required in 1901 to provide for the new tramways and private lighting, I strongly recommend that the buildings be lengthened at once by about 90ft., thus giving us engine and boiler rooms of 190ft long each. This will allow four additional 700-h.p. sets to be erected, over and above those already proposed. Applications for supply have been received from many parts of the town where at present there are no mains laid, and as we are bound under the provisional order to give such supply, I recommend that low-pressure cables be procured for Mutley Plain, Tavistock-road, Old Town-street, King-street, Russell-street, Frankfort-street, Treville-street, Whimple-street South, Princess-square South and West, Market-avenue, Drake-street, Courtenay-street, and Embankment-road. Cables for the Compton trams will be laid in Mutley Plain and Tavistock-road, and the lighting cables could be laid all at the same time. These extensions of mains will necessitate two additional high-pressure feeder cables and two more transforming sub-stations, one by Sherwell Chapel and the other on Mutley Plain. I estimate the cost to be: steam generator, £6,250; boilers, piping, economisers, etc., £2,800; mains, £7,890; service cables, meters, etc., £1,570; sub-stations and transformers, £1,910; switchboards and connections, £250; extensions to buildings, £12,500; additional work already authorised by Council—viz.: raising the wharf wall, coal conveyors, negative booster, laying pipes in Cattewater, mains in Tothill-road, Greenbank, and Elliot-street, motor for stoker gear, office furniture, £2,710; estimated amount overspent on original sanction, as already reported, £10,720; contingencies, £1,400—making a total new loan of £48.000. This additional loan would not only enable us to add some 12,500 lamps to our load, but would also provide buildings for considerable extensions of plant. The extra lamps should bring in a revenue of about £5,000 per annum, while the enlarged buildings will allow future extensions to be carried out at a greatly reduced proportionate outlay. The interest and sinking fund charges on the additional capital, reckoned at 2¾ per cent., and 25 years repayment, come to £2,760 per annum, while the additional works charges for coal, water, wages, etc., would come to about £1,500 per annum, or a total expenditure of some £4,260." The committee recommend that tenders be forthwith invited for the requisite machinery, cables, etc., and that the borough surveyor prepare plans at the earliest possible moment in order that tenders may be invited for the extension of the building. A report by the borough surveyor shows that the sum paid to Pethick Bros. for the erection of the electricity station was £12,344. The contractors claim £936 more for the extra facing to the external walls of the building, but this the borough surveyor declined to allow, as there was no order or instruction for such an extra. Mr. Paton also disallowed the claim of the firm to be paid on the terms set out in their tender for the completion of the works within nine months on the ground that the delay was not their fault. The tender for completion of the works in nine months was about £400 in excess of that for carrying them out in 12 months.

PROVISIONAL PATENTS, 1900.

JAN. 1.

27. **Improvements in electric arc lamps.** Henry Lyon and John Burrell Talbot-Crosbie, 121, West George-street, Glasgow. (Complete specification.)
35. **A method of and apparatus for drying insulated wires for electrical purposes in the process of winding.** Hugo Hirst and Thomas Hawkins, 73, St. Stephen's road, Upton Park, London.
45. **Improvements relating to electrical incandescence lamps of the newest type.** Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts Gesellschaft, Germany. (Complete specification.)
63. **Improvements connected with ceiling roses of incandescent electric lights.** John Doust, 166, Fleet-street, London. (Messrs. Schmahl and Schulz, Germany.)
65. **Improvements in the manufacture of electric conductors or cables.** Gerald Carlyle Allingham and William Fennell, 46, Lincoln's-inn-fields, London.

JAN. 2.

87. **Improvements in single-phase induction motors.** William Gould Rhodes, Royal Technical Institute, Peel Park, Salford.
92. **Improvements in or connected with the manufacture and production of pipes or conduits for electrical conductors, or for conveying liquid gases or for analogous purposes.** Albert Harris Howard, 47, Lincoln's-inn-fields, London.
100. **Improvement in regulating the supply of gas, electricity, or any other matter for illuminating and heating purposes.** Bernhard Wilmshurst Hounsell, 228, Underhill-road, East Dulwich.
105 **Improvements in electric lamps applicable for advertising purposes.** Thomas Mason, 165, Queen Victoria-street, London.
115 **Improvements in advertising by means of electric lamps and apparatus therefor.** Joseph Richard, 55, Chancery lane, London.
138. **Improved method of telegraphing, indicating time, or actuating mechanism electrically.** César René Loubery, 111, Hatton-garden, London.
146. **Speed governor attachment for electrical apparatus.** James Henry McGurty and Thomas McEwan, jun., Norfolk House, Norfolk-street, Strand, London.
147. **Improvements in electric water filters.** William Luther Teter and John Allen Heany, Norfolk House, Victoria Embankment, London. (Complete specification.)

JAN. 3.

159. **Improved means of taking up the slack of flexible wire cord or other material used in electric or other fittings.** Arthur Hugo Cecil Gibson and Ernest George Miles, 16, Bankes-road, Small Heath, Birmingham.
163. **Improved automatic make and break for electric circuits.** Peter Cochran McFarlane and David Reid, 154, St. Vincent-street, Glasgow.
164. **Improvements in or in connection with electric incandescent lamps.** Clarence Metcalfe Stead and George Frederick Carr, 30, Park-row, Leeds.
174. **Improvements in electrically-driven cranes and similar machines.** Frederick Henry Royce, Cooke-street, Hulme, Manchester.
176. **A current receiver for electric railways.** Hermann Lachenmeyer, 77, Colmore-row, Birmingham. (Complete specification.)
178. **Improved means of making the electrical connections with carbon electrodes.** Harry Baker, 55, Chancery-lane, London.
182. **Improvements in electric ignition devices for internal-combustion engines.** Percy Wilbraham Northey and the Electric Motive Power Company, Limited, 74, Caistor-road, Balham, London.

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194. A new or improved method of determining the voltage obtaining at a near or distant part of an electric circuit or the average voltage obtaining at several parts thereof and apparatus therefor. Michael Birt Field, 1, Handen-road, Lee.

201. Improvements relating to conduits for electric railways. Reginald Belfield, 322, High Holborn, London.

216. Improved manufacture of active mass for accumulator batteries. Richard Rodrian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

JAN. 4.

240. Improvements in or relating to magnetic brakes and magnets suitable therefor and for other purposes. Thorsten von Zweigbergk, 111, Hatton-garden, London. (Complete specification.)

246. Improvements in automatic electric switches. Frederick Haggar Headley, 322, High Holborn, London.

247. Improvements in electromagnetic mechanism suitable for use in indicators, relays, bells, and the like. Frederick Haggar Headley, 322, High Holborn, London.

246. Improved electric switch mechanism. Edward Bennett Viles, 322, High Holborn, London.

254. Improvements in subterranean conductors for electric railways. James Leverson, 17, Marloes-road, Kensington, London. (Karl Zebisch and Joseph Steinbach, Austria.)

260. Improvements in apparatus for the generation and electrolytic application of electric currents. Francis Edward Elmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Partly communicated by John Oliver Surtee Elmore, India.)

261. An improvement in safety electric fuses. Henry Charles Gover and John Miles Moffat, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

264. Improvements in apparatus for wireless telegraphy. Guglielmo Marconi, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

JAN. 5.

293. Electricians' pocket companion. William Duthie, Temora, West Cults, Aberdeenshire.

JAN. 6.

361. Double-link detachable chain for electric light purposes. Andrew Hamilton McNaught, 24, New Bridge-street, Ayr.

396. Improvements in electricity meters. Martin Behrendt, 46, Lincoln's-inn-fields, London.

399. Improvements in telephone call stations, to be rendered operative by the insertion of a coin. Auguste Chabaud and Emile Chabaud, 45, Southampton-buildings, Chancery-lane, London.

400. Improvements in electric arc lights or lamps. Charles Andrew Lee, 56, Paulton's-square, Chelsea, London.

SPECIFICATIONS PUBLISHED.

1898.

26315. Means for supporting electric meters for tramway cars. Murphy.

26610. Electric arc lamps. Crompton and Pochin.

27053. Overhead electrical wire holder. Foy.

27556. Incandescent electric lamps. Bottelli.

1899.

825. Electrical measuring instruments. Harris.

1869. Electrical condenser and apparatus for producing powerful electric waves. (Date applied for under International Convention, Nov. 25, 1898.) Orling and Braunerhjelm.

3100. Electromagnetic cut-outs and other like apparatus specially applicable to electric arc lamps. Smithson and Sharpe.

3778. Dynamometer for use in laying submarine cables. Murphy.

4327. Electro-pneumatic controlling system. (Date applied for under International Convention, Aug. 20, 1898.) Westinghouse.

19031. Driving and steering gear for electrically-propelled motor road vehicles. Kühlstein and Vollmer.

20471. Electric batteries. Boult. (Delafon.)

20507. Electric igniter for gas. von Arnswaldt.

20743. Electricity meters. Tourtel. (Rissler and Bauer.)

20767. Phonographs. Mills. (Edison.)

20882. Sliding contact for telescopic or similar adjustable electroliers. Weidlich and Neis.

22533. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Steinmetz.)

22536. Electric circuit changers. British Thomson-Houston Company, Limited. (Oxley.)

22666. Chemical generator of electricity. Anderson.

22857. Medicinal light-curative apparatus for the production of complete or partial baths of chemical and electrical rays of light. Cunow.

TRAFFIC RETURNS.

Line.	Returns for week Ending		1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
			£	£	£	£	£
Birmingham Tramways Co.	Jan.	6	3,927	3,855	+ 72	—	—
Blackpool-Fleetwood	,,	6	140	166	- 26	—	—
Bradford City Trams	,,	7	335	—	—	—	—
Bristol Tramways Co.	,,	5	2,766	2,506	+ 260	—	—
City & South London	,,	7	1,144	1,143	+ 1	—	—
Dover Tramways	—		—	—	—	—	—
Dublin U.T., elec. cars	,,	5	2,059	390	+1,669	—	—
Dublin S.D. Electric	,,	5	415	438	- 23	—	—
Halifax Corporation	—		—	—	—	—	—
Hull Corporat'n E.S.	,,	6	682	—	—	—	*e* 17,711
Liverpool Corporat'n	Dec.	30*d*	6,820	6,885	- 65	—	—
Liverpool Overhead	Jan.	7	1,455	1,339	+ 116	—	—
Sheffield Corporation	,,	7	1,818	—	—	—	—
South Staffordshire	,,	7	405	457	—	—	—

d Partly electrical. *e* Since July 5.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Tuesday.
Aron Electricity Meter, Ld., 6 p.c. Cum. Pref. Shs., 1-125,000	1	2-2
Blackheath & Greenwich. District Elec. Lt., Ord. 1,201-101,200	1	1-1
Blackpool and Fleetwood Tramroad	10	17-19
Bournemouth and Poole Electric Supply, Limited, Ord.	10	12-13
—— 4½ per cent. Cum. Pref.	10	10-11
British Electric Traction, Limited, Ordinary, Nos. 1-80,000	10	15-16
—— 6 per cent. Cm. Pf., 30,001-60,000	10	12½-13½
—— 5 per cent. Perpetual Debenture Stock	100	125-128
British Insulated Wire, Ord., No. 1 to 40,000	5	11½-12½
—— 6 per cent. Cum. Pref., No. 1 to 27,500	5	6½-6¾
Brompton and Kensington Electric Supply Co., Ordinary	5	7-8
—— 7 per cent. Preference	5	9-10
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	110-115
—— 4½ per cent. 2nd Debenture Stock	100	102-105 xd
Callender's Cable Company, Debentures	100	110-115 xd
—— Ordinary	5	12½-13½
—— 5 per cent. Pref.	5	5½-5¾ xd
Central London Railway, Ordinary	10	9½-10 xd
—— Pref. Half-Shares	5	4½-5 xd
—— ,, ,, deferred	5	4½-5 xd
Charing Cross and Strand	5	9½-10½
—— 4½ per cent. Cum. Pref.	5	5½-6
Chelsea Electricity Company	5	7½-8½
—— 4½ per cent. Debentures	100	109-111
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	12½-13½
—— 5 per cent. Debenture Stock	100	122-127 xd
City and South London Railway, Consolidated Ordinary	100	59-62
—— ,,	5½	4½-5½
—— 4 per cent. Debenture Stock	100	125-130
—— 5 per cent. Pref. Stock '91	100	143-148
—— ,, ,, '96	100	135-140
County of London and Brush Prov. Elec. Light Co., Ord.	10	10-11
—— 6 per cent. Cum. Pref.	10	13-14
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	107-110 xd
Crompton and Co.	3	3½ 4
—— 5 per cent. Debentures	—	96-101 xd
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	93-96 xd
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	4½-5½
Electric Construction, Limited	2	1¾-2¼
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	104-107
W. T. Henley's Telegraph Works, Ordinary	5	12-13
—— 4½ per cent. Preference	5	5-5½
—— 4½ per cent. Debentures	100	111-114
India Rubber, Gutta Percha, and Telegraph Works	10	20-21 xd
—— 4 per cent. Debentures	100	100-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	8	8-8½
London Electric Supply, Ordinary	3	2½-2¾
—— 6 per cent. Pref.	5	5½-6
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	102-104
Metropolitan Electric Supply, Limited, Ord.	10	13½-14½
—— 62,501-85,000	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	116-118 xd
—— 3½ per cent. Mortgage Debenture, Red.	100	96-97 xd
National Telephone, Ordinary	5	4½-5½
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	98-100 xd
New General Traction, Limited, Ordinary	5	3¾-4
—— 6 per cent. Cum. Pref.	5	5-5½
Notting Hill Electric Lighting Company, Limited	10	15½-16½
Oldham, Aston, and Hyde Electric Tramway, Ordinary	10	18-19
—— Preference	10	10⅜-10⅝
Oriental, Limited, 1879	1	1⅜-1⅝
—— £5 Shares	5	7-7½
—— £4½ Shares, New	4½	6¼-6½
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,310	5	6¾-7½
Potteries Electric Traction, Ld., Ord., Nos. 26,667-40,000	10	11-12½
—— 5 per cent. Cum. Pref., Nos. 1-20,000	10	10-11
Royal Electrical Company of Montreal	1½	150-170 xd
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	4-4½
St. James's and Pall Mall, Limited, Ordinary	5	14-15
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	34-38
—— 5 per cent. Bonds	100	102-105 xd
Telegraph Manufacturing, Ordinary	5	9-10
—— 5 per cent. Cum. Pref.	5	5¼-5⅝
Waterloo and City Railway, Ordinary	100	101-104
Westminster Electric Supply, Ordinary	5	13½-14½

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NOTES.

Indiarubber.—The first public sale of indiarubber held at Antwerp last week yielded good results, insomuch as a a slight rise in price took place generally. This rise can only be due to the demand, as the present war does not affect the supply of rubber from Africa.

Sydney Exhibition.—It is reported that the New South Wales Parliament has negatived a proposal to hold an international exhibition in Sydney in 1901. Mr. Lyne, the premier, however, has announced that he will probably bring forward a scheme, if it can be carried out without any expense to the Colony.

The Scottish Automobile Club.—We are pleased to note that the Edinburgh Town Council have decided to grant the use of the Waverley Market on May 3 next for an exhibition of motorcars on the occasion of the run from London to Edinburgh and back, organised by the Automobile Club. The proceeds of this show, after the expenses are covered, are to be devoted to the war relief funds.

Cantor Lectures.—We regret to note that the series of Cantor lectures which was to have been delivered by Major P. Cardew on "The Supply of Electrical Energy" before the Society of Arts will not be delivered, owing to the absence of Major Cardew from England. The society announce that, in consequence of this, Prof. J. A. Fleming, D.Sc., F.R.S., has undertaken to deliver a course of lectures on "Electric Oscillations and Electric Waves," to be given on May 7, 14, and 21 respectively.

Lighting Railway Carriages.—From a report recently made by Messrs. Preece and Cardew on the cost of lighting railway carriages by electricity, it appears that the total annual cost per coach would be £13. 16s. 6d., based on the cost of fitting and running 400 coaches with an average of 12 lamps of 8 c.p. per coach. The total capital outlay for lighting this number of coaches is estimated at £32,000. These figures somewhat exceed those contained in a report on the same subject by Mr. Worby Beaumont some months ago.

Explosion at Dover.—An explosion, resulting in considerable damage to the workmen, occurred on the East Cliff section of the National Harbour works at Dover last week, due to the premature explosion of a charge of dynamite. It is believed that a defective fuse caused the accident, as it is said that time-fuses have recently been substituted for electricity. While we believe that electric ignition is the best and safest means of exploding charges in such work, it will be remembered that the last accident at Dover was said to be due to its use.

Henry Commemoration.—We are glad to note that in Albany the one hundred and second birthday anniversary of Joseph Henry is to be celebrated. Up to the present we have not heard exactly the form this commemoration will take, but it is hoped that some prominent memorial of this eminent electrician will be set up. The discoveries in electricity and physics made by this scientist are in a small measure commemorated by the fact that the unit of self-induction is named after him, but it is only right that in Albany there should be a more tangible memorial of his name.

Steam-Turbines.—We learn from the presidential address given by Rear-Admiral G. A. Melville to the Mechanical Society of American Engineers that Mr. G. Westinghouse is working on the interesting subject of steam-turbines. It was stated in this address that Mr. Westinghouse had already attained success in connection with the design of steam-turbines for driving electrical generators, and that he is now working on a steam-turbine which is to develop some 2,000 h.p. We are not informed, however, on what principle these turbines are working, but everyone must admire the pluck of Mr. Westinghouse in experimenting on such a large scale.

Telephone Progress.—We learn that the Erie Telephone System made a net gain of 3,972 subscribers in December, making the total number connected on Dec. 31 106,564. Thus the net increase for the year has been 43,714, or nearly 70 per cent. of the total number of subscribers connected on Jan. 1, 1899. The management predict that the growth for the year 1900 will increase the grand total number connected at the close of the century to 150,000. The increase during the present year shows what can be effected under energetic management. It is rather too much to hope that the Post Office exchanges in London will go ahead as quickly as the above.

Science Teaching.—A conference of science teachers was held last week in London, being convened by the Technical Education Board of the London County Council. A wide range of subjects was dealt with at the conference, but throughout special stress was laid on the need of practical instruction. Almost all of the speakers emphasised the advantage of teaching students science rather by personal experience than by lectures only. In this way object lessons with the liberal use of experiments were advocated. At the same time certain speakers condemned the elementary text-books in science now used by the London School Board, which, as we have often said, are more historical than practical.

Fused-in Platinum Wire Protection.—We notice that a very simple and effective device has been invented by Mr. W. Palmaer, of Berlin, for protecting a platinum wire which has to be fused into the wall of a glass vessel. This has often to be done in electro-chemical apparatus, and it is of the utmost importance that a good contact should be secured without injuring the platinum wire. In order to obtain this result, Mr. Palmaer recommends that only a very short piece of wire should project outside the glass vessel. Around this short projecting wire is placed a small piece of narrow glass tubing, which is fused on to the glass vessel. A good contact can then be obtained, without in the least injuring the platinum wire, by filling this small tube with mercury.

An Improved Tramcar.—We are informed that the Dublin United Tramways Company have just made a novel addition to their rolling-stock in the shape of a vestibule electric motorcar of an improved type. The staircases on this car are enclosed within the vestibules, which will prevent passengers falling off on to the roadways. Access to the roof is made through a "hatchway" above the vestibules, and on top the passengers are quite railed in, the rails of the roof completely encircling the car. Complete protection is afforded to both motorman and conductor from bad weather, and the platform area is increased so that it has accommodation for parcels, etc. The seats on top are provided with a cover. The seating capacity of this car is for 25 inside and 37 outside.

A Record Station.—We are pleased to note that the electric lighting works of Plymouth have already been found inadequate to meet the demand of the town for light and power, and that the Plymouth committee responsible for the same have agreed to extend the works at once. The most noticeable feature in the report of that body is the statement that the income from the first six months' working is sufficient to enable the committee to pay all their expenses, together with the interest and sinking fund due for that period. These first six months include an equal proportion of summer and winter,

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so that Plymouth may justly be said to have established a record. Congratulations are due to Mr. J. H. Rider for the success of the station, which he has designed and engineered from the very commencement.

Sectional Switches.—The advantage of dividing a trolley wire up into distinct sections fed from switch pillars was exemplified on Monday last at Sheffield. In the afternoon one of the switch pillars at the bottom of West-street was to all appearances on fire, due to some defect in one of the cables leading into the pillar. It appears from the account before us that the arc between the conductors continued until the current was cut off from the station. The damage done was not very great, but the traffic was interfered with for a short time. The defect was then got over by cutting out the defective switch pillar and short-circuiting the sectional insulators in the trolley wire. In Sheffield these switch pillars are placed at one-quarter mile intervals, so that the trolley wire had sufficient capacity to carry the current required for such a small section.

Electroid Gas.—We chronicled the introduction of electroid gas in the earlier days, and were unable then to ascertain the difference between it and acetylene. From a communication from the department of her Majesty's Chief Inspector of Explosives to the clerk of the Bridlington Rural District Council we now learn that this gas is air admixed with acetylene. The letter states that the installation at Hunmanby, near Filey, has been recently carefully examined by the department. The result of this expert examination is that the system is described as exceedingly dangerous to the public, and the letter suggests "that a warning should be issued to the licensees to the effect that the license will be revoked or will not be renewed (according to the terms in which the license was granted)." The Inspector of Explosives, it is stated, is to advise the Secretary of State to take steps for the issuing of an Order in Council prohibiting the mixing of acetylene with air or oxygen in the same way as the compressing of acetylene has been prohibited.

Import Duty on Electricity.—The *Electrical World* has collected some interesting historical facts as to the previous decisions of the U.S.A. Treasury with respect to imposing a duty on electricity generated in Canada and transmitted across the border into the States. Several years ago the question was raised with respect to a power scheme for the Canadian side of Niagara, and the promoters were informed by an assistant secretary of the Treasury that no tariff duties would be assessed. The present officials of the department seem, however, to be inclined to rule otherwise. In that case electricity would be classed under the "drag-net clause," which imposes a duty of 20 per cent. *ad valorem* on all unenumerated manufactured articles. The Ontario Power Company naturally protest that the electric current cannot be regarded as an article within the meaning of the Act. Five or six years ago it was proposed to levy tariff duties on natural gas conveyed in pipes across the Niagara River, but after legal opinion had been obtained it was held that natural gas was not a manufactured article. It has therefore been admitted free, and we trust that electricity will also escape.

Submarine Cables.—The latest proposal from France with respect to the management of submarine cables comes from the Colonial Committee of the Council of Foreign Trade, which is said to include all the prominent members of the French Colonial party. This committee has passed a resolution asking the Government to call a conference in Paris during the present year to consider the revision of the 1884 Paris Convention. The committee considers that this convention is practically a dead letter, as it makes no provision for protecting the cables owned by neutral Powers in time of war. The French committee expresses its willingness to co-operate with the United States, but it does not desire to co-operate with England. It is not easy to understand how an international conference in connection with submarine cables without a representative from England would be able to do more than pass recommendations. In view of the fact that England owns three-quarters of all the submarine cables, it is not to be expected that we should accept resolutions which are passed by the representatives of countries only owning the remaining quarter.

Two-Party Line.—The New York Telephone Company, in extending its telephone service in Manhattan, has introduced a system by which expense is saved by connecting two subscribers on to the one line. The novel feature of the system is that a selective signalling device on the relay switchboard enables either of the subscribers on the two-party line to be rung up without disturbing the other. Of course, when the subscribers are calling, only one can use the line at a time. The rates which are to be introduced this year for the subscribers on such lines range from £12 per year for 600 messages up to £27 per year, when 1,800 messages are likely to be sent. If in the first case the 600 messages are exceeded, 4d. extra per call is made for the excess. This excess per call decreases in the case of more frequent users of the telephone, being reduced to 3d. per call with a subscriber who undertakes to make 1,800 calls per annum. It does not seem to us that these rates are exceptionally low, but our contemporary quotes them as an example of the policy of the company in reducing rates. From this we are led to presume that the charges for telephone connections in Manhattan must have been very excessive in the past. The above company has during 1899 increased the number of its subscribers by no less than 10,500. We are also informed that the company are making provision well ahead for a still further increase in their business.

Fighting by Electricity.—The following interesting note from the *Pictorial Magazine* shows the education in science which the rising generation is receiving from our powerful contemporary: "Signor Marconi, the brilliant Anglo-Italian, whose wireless telegraphy set the whole world agog not long since, bids fair to surpass himself. He claims to have discovered the means of blowing up the most powerful ironclad or torpedo at a distance of some 20 miles without the help of explosives of any description, his only stipulation being that the object of attack has a powder magazine, and is heavily coated with metal—the thicker the better. His plan is this: He sets two spear-shaped wires on some high elevation, such as a turret or mast-head. These are connected with a powerful dynamo fixed on the ground. So soon as the ironclad is sighted the points of the wire are focussed towards it, and the dynamo is set in motion. The electric waves discharged from the wires sweep through the air until attracted by the ironclad, which acts as an electric accumulator. After a few minutes, varying in length with the strength of the dynamo, the charge on the ship is so great that sparks begin to fly from all quarters, and particularly inside the powder magazine, with its iron walls. The result need not be told." Our opinion of the matter is that the writer of the note should be made to disclose the result with full explanations, under a penalty of five years' penal servitude.

A High-Tension Switch Gear.—The large switch gear for working at 12,000 volts now in use on the Chambley transmission plant, referred to in another note, is of special interest. All that appears on the face of the

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board is a small iron frame through which a long wooden lever can be moved, through about 120deg. A small iron cylinder is placed over this and unlocked with it. This latter is connected by means of a lever on the back of the switchboard to two valves, each placed in an air duct, into which air is pumped from a fan blower. These air ducts are two wooden boxes running the entire length of the switchboard, and are situated so that when the valve is open a jet of air impinges on the contacts of the high-tension switch, thus destroying the arc. The iron handle directly above the high-tension switch cannot be opened until the valve in the air duct is also opened, thus always ensuring an air blast on the breaking contacts. For the switch itself, the moving lever on the face of the board is directly connected to a rocking lever which moves to and fro a trolley containing the dead side of the switch. This trolley moves forward and engages with one set of contacts connected to the upper 'bus bars, or backwards to the lower 'bus bars, according as the lever is moved to the right or left of the centre. The contacts of the two sets of 'bus bars are 9ft. apart, and though the "off" position of the trolley is midway between the two, a break of 6ft. may be produced by moving the lever slightly past the centre. There are two of these switches for each generator and line panel. To prevent arcs from jumping from one switch to another, they are separated by marble barriers 2ft. high.

Manufacturing Systems.—The presidential address of Mr. Henry Hodgson to the Manchester Association of Engineers is given in abstract elsewhere in this issue. In this the vexed question of the relations between capital and labour is again taken up, and the review of the situation may be of some service. The president's statements with respect to the working on piece prices scarcely represent, we believe, the view held of these by the various trade unions. He did not, however, point out one side of the question, which is, that having a given piece price, the workmen so adjust their rate of production that the money earned should not induce a reduction in the price for a given quantity of work. In this way the men receive no encouragement to increase the earning capacity of a given quantity of plant. A more equitable system of working piece prices is that of fixing the price slightly higher, and then dividing the excess earned by the workman over his time wage into two parts, half going to the employé and half to the firm. In this way, while the workman by individual effort can increase his own earning capacity, he yet at the same time decreases the cost of the work to the firm, and also the indirect cost due to the capital charges on the machinery employed. The system often employed in the United States carries this principle still further, in that the price per piece is increased with the increased production. In this case the man receives every encouragement to work as many machine tools as he can, with the result that for simple repetition work the United States are able to easily outbid any of our English manufacturers. While we agree in part with the president's conclusion, no solution which avoids the giving of a differential wage in proportion to a man's capabilities can again give England the lead in certain work.

Electrolytic Gases.—The following is an abstract of a paper by Mr. W. Kösters which appeared in the *Ann. Phys. Chem.* The abstract appears in the January number of the *Journal* of the Chemical Society, and reads as follows: The author confirms Townsend's results, who showed that gases obtained by electrolysis have a positive or negative charge according to the nature of the gas and the electrolyte employed, but rejects the theory that the phenomenon is to be explained by the escape of undischarged ions from the electrolyte. A connection is rather suggested with the observation of Lenard, that air is negatively electrified when falling drops of water encounter an obstacle, and with the closely allied phenomenon of a gas being electrified by its passage through water. Gases rendered non-electric and freed from dust particles by filtration through a tube connected to earth and filled with moist cotton-wool, were bubbled through various electrolytes. A comparison of the electrification produced with that obtained in electrolytic gases showed that the charges in the two cases generally agreed in sign, but were not at all proportional in quantity. Further, the ratio of the charge to the volume of gas was much greater in the case of the electrolytic gases, but experiment showed that this might be due to the presence of fine particles of the electrolyte. When hydrogen is bubbled through pure water, the former acquires a considerable negative charge; this action, however, is prevented by very small quantities of any dissolved substance. For a number of inorganic acids and salts the electrifying action is found to vary with the concentration in a similar manner. In concentrated solutions the action either is nil or approaches that value. The electrification of hydrogen bubbled through sulphuric acid of specific gravity 1·3 is independent of the temperature. Absorption of the gas by the liquid slightly diminishes the electrification produced.

Rotary Converters. — The first number of the *Electrical World* for the New Year contains an article on the rotary-phase converter by the late Prof. R. W. Quick. We regret the decease of such an eminent writer on this subject. In the article in question the heating of the armature when used to convert from one number of phases to another is most carefully gone into mathematically. From the first investigation Prof. Quick found that, in order to get the average rate of heat produced in the whole armature, it was necessary to get expressions for that rate in each portion of the armature between successive leads to collecting rings. The heat for the whole armature is then obtained by taking the average of these rates. On further investigation he found that the heating was also affected by the position of these leads. For instance, when converting in whatever way, from one-phase to three-phase or from two-phase to three-phase, etc., it is always more economical to have one lead of one phase coincident with one lead of the other phase, not only because the average rate of heat production is less, but because the maximum heat loss in any conductor is less. From a table showing the maximum, minimum, and average heat losses when a certain rotary converter was used to convert from single-phase to three-phase, from single-phase to two-phase, and from three-phase to two-phase, this point is clearly shown, as is also the fact that in the last transformation the heat loss is less than when the machine is used as a continuous-current generator. Prof. Quick proceeds to deal with the effect of a lag in current on the heat loss, and to extend his calculations to the conversion from M phase to N phase. The armature reactions are also dealt with. With respect to the lag in the current the author found that with a given lag of, say, 30deg. in the output current, the heat loss was greater when converting from a greater number of phases to a less number than when converting in the reverse way.

Patent Royalties.—A new Bill has recently been introduced into the United States Congress by Mr. R. W. Reeves, the chairman of the House Committee on patents, which is intended to enable the Patent Office to intervene between inventors and manufacturers. The Bill provides that royalties on patented articles, which should be at least equivalent to 1 per cent., but not more than 10 per cent. on the assumed cost of manufacture, shall be paid to the

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Commissioner of Patents on behalf of the owner of the said patents. When these royalties have been received the articles in question will be stamped, and until this has been done they will not be allowed to leave the hands of the manufacturer. In order to facilitate the system of royalties, the owner of the patent will have to file a sworn statement of his estimate of the cost of manufacturing the article, and on this estimate the royalty will be based. The estimate can, however, be revised on behalf of the manufacturer every two years. The idea of the Bill seems to us to contemplate undue interference between private persons by the Government office, and we are sure that it would be exceedingly difficult to work the system should the Bill pass. Also, it would not interfere with the unfair practice by which a manufacturer having obtained the sole right for supplying patented articles under royalty, prefers to keep the same off the market, and in this way prevents the owner of the patent receiving the advantage due to him for his invention. Another change, which is much more likely to do good, which is contemplated during the present session of Congress, is the establishment of a high court of patents, trade marks, and copyrights. This court would consist of one chief justice and six associate justices, and would be a court of record, with appellate jurisdiction, to review by appeal or writ of error final decisions in the United States district courts and the existing circuit courts in all cases arising under the patent and copyright laws, and in all cases involving the ownership, violation, and construction of trade marks and the question of unfair competition in trade.

A Large Inductor Machine.—Mr. E. M. Archibald, writing on "Canadian Water-Power Electric Plants" in the *Electrical World*, treats in a recent issue of the Chambley transmission plant, which is situated on the Richlieu River about 15 miles from Montreal. The company owning these works have taken over the steam plant of the Royal Electric Company, which previously lighted Montreal. It was found after careful calculation when these works required extension that the actual cost of water and steam power for an additional 8,000 h.p. was almost equal, but that if the power increased, water power became cheaper. In the equipment of this water-power plant, four 2,000-kw. two-phase inductor alternators have been employed. These machines run at 153 revolutions per minute and generate at 12,000 volts direct, with a frequency of 66 cycles per second. Using the inductor type, all the electrical circuits are, of course, stationary, and hence the insulation troubles become less. Great care was taken in making the joints in the armature coils, which are all former-wound. An india-rubber-covered joint was adopted which was vulcanised by being soaked in boiling paraffin wax. Some idea of the size of these machines can be obtained from the statement that the base-plate of them consists of a hollow rectangular frame 17ft. long by 11ft. wide. The armature is 15ft. in diameter and 6ft. 6in. wide. The single field coil, resting on the armature in a slot especially prepared for it, has a slightly smaller diameter than the armature, and is wound, not of wire, but of bare copper strip insulated with japan and impregnated linen. The joints in this strip are butted together and soldered with a special solder, thus producing a joint, no thicker than the copper strip, which possesses a greater tensile strength besides an equal conductivity. The inductor, built of laminated iron, and weighing 30 tons, is the only revolving element in the whole construction, and is built up very solidly, the poles each being securely bolted to the spider. The air-gap between the inductor and armature is ½in. The field excitation is very small, being only three-fourths of 1 per cent. of the total output of the machine. The shaft to which the spider containing the inductor is attached is 12in. in diameter, and is coupled directly to the turbines. It is interesting to note that the cables connecting this large machinery to the switchboard are indiarubber-covered.

Liverpool Engineering Society.—On Thursday last week the annual dinner of the Liverpool Engineering Society was held at the Adelphi Hotel, Liverpool, the president, Mr. A. Bromley Holmes, in the chair. The Lord Mayor was present, and, in reply to the toast of his health, made some interesting remarks on the growth of Liverpool, which, he said, was due to a very large extent to their engineers in perfecting the Mersey Docks and removing the bar at the mouth of the river. He also spoke highly of the overhead electric railway, which had done such good work, and which now was to be competed with by the municipal trams. He suggested, however, that an extension of the overhead railway right round the city would enable it to hold its own. He also referred to the proposed lightning express between Liverpool and Manchester in hopeful terms. He proceeded to compliment Liverpool on the able staff of engineers they had at their command, and the work of Mr. A. Bromley Holmes both with respect to the electric light undertaking and to the tramways was suitably acknowledged. The Hon. J. Boyle, in proposing "The Liverpool Engineering Society," said that he considered the true test of civilisation was the quantity and quality of mechanical devices made and operated, and the amount of engineering genius of a people. In reply to this toast, the President spoke of the growth of the society from 51 members in 1876 to practically 500 members in 1900. He alluded to the fact that the society was a branch of the Institution of Civil Engineers, and to the help which they had received from the parent society. At the conclusion of his speech Mr. Holmes regretted that we were losing our position in the world's markets as the leading manufacturers of machinery. In analysing the causes of this, he alluded to our manufacturers being unable to compete in certain markets, mentioned our labour troubles, and stated that while contentions of labour were quite legal and right when properly used, they were exceedingly harmful when employed to limit the freedom of others, or to prevent the full use and development of the machinery and resources of the country. A combined effort on the part of both employers and employed was needed to enable the English nation to resume its position as head of the world's machinery markets.

Lectures on Polyphase Machinery.—On Monday last Mr. A. C. Eborall delivered the first of a series of lectures on polyphase machinery at the works of Messrs. Crompton and Co., of Chelmsford. The course of lectures will be continued every Monday evening until Feb. 26. The syllabus of the first lecture was as follows: First, single-phase circuits (inductive and non-inductive), with the work done in each case and its estimation. A graphical representation of alternating currents and E.M.F., and the explanation of the various terms peculiar to all alternating-current circuits, such as frequency, power factor, idle current, etc. The general effects of inductance were shown, together with the production of single and polyphase currents and a comparison of single-phase and polyphase generators. The other lectures will treat of the following subjects: Thus Lecture II. will treat of polyphase generators (inner and outer pole types), armature windings, with the relative arrangements of armature coils and field poles, and the usual proportions in practice. The shape of E.M.F. waves will also be touched on, and the effect of coil and pole width on these, following which will come the comparison and discussion of wave forms and the rating

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of generators for power work. Lecture III. will deal with polyphase circuit (two and three phase), and the relations between current, pressure, and power in the various phases. The various arrangements of circuits, lamps, and motors, with two-phase and three-phase installations, will be shown, and also the construction of polyphase motors. These latter machines will occupy the whole of Lecture IV., when the principles underlying the working of them will be explained, and also the performance, running, and testing of polyphase motors. In Lecture V. faults in polyphase motors and their treatment will be explained, together with the transforming of polyphase currents, and the construction of and principles underlying polyphase transformers. Polyphase switchboards will also be explained. Polyphase machinery is again met with in Lecture VI., the subjects being the regulating and running polyphase power plants, and the general principles underlying the laying-out of such plants. The choice of a system and the calculation of conductors and line material are also to be gone into in this lecture. The seventh and final lecture, which takes place on Monday, Feb. 26, will be devoted to the construction and use of rotary converters and motor-generators for polyphase circuits, and also starting, running, and regulating these machines.

Large Steam-Engines.—Mr. C. A. Hague continues, in the January number of the *Engineering Magazine*, his series of articles on the "Steam-Engine for the Electric Power-House." The article in question is devoted to the design and erection of the large units which are now commonly employed for such work, extending up to engines capable of dealing with emergency loads of 7,000 h.p. While the author writes principally about American practice, he also describes engines which have been used on the Continent. He states that in America the system of condensing with these large plants has yet to be perfected, as although surface condensers are generally used, in very few cases is the condensed water returned to the boilers. He explains in detail one of the largest engines for driving electrical machinery which as yet been made. This engine is capable of developing 5,000 h.p. with steam at 165lb. pressure. The engine consists of two tandem compound engines coupled in a four-cylinder cross-compounded by means of a common shaft. This shaft is of forged steel, 27in. in diameter, between the bearings which carry the dynamo. The valves in this case are of the grid-iron type, while the cut-off is controlled by a shaft governor. The author points out the extreme severity of traction work, as a breakdown between these large engines gives a great interference with the traffic in a large town, whereas the stopping of a marine engine for a few hours has, as a rule, no disastrous effect. He then proceeds to describe in detail the construction of some of these large machines, and pays special attention to the forging of the crankshaft and cranks. He points out that the erection of such huge engines away from the shop and with only temporary facilities presents tasks of serious moment. In a recent case of the kind a rather novel but entirely successful method was employed in the use of hydraulic jacks applied through the medium of an electrical pressure pump for forcing into place upon the shaft the spider of the generator and the cranks. The fluid employed was oil, under a pressure of a little less than 10,000lb. per square inch, requiring about 11 h.p. to do the work. The time required to do all of the forcing was only a few hours when once the apparatus was ready for work. The shaft weighed 68,000lb., the 16ft. diameter spider 35,000lb., and the cranks 25,000lb. each. The final assembling of the parts of the flywheel, and the securing together of the same by cold riveting under pressure of a hydraulic jack riveting apparatus capable of exerting a pressure of more than 450 tons, is another expedient brought about by the exigencies of the situation. This system of cast-iron hub, arms, and a central portion of rim with plate-steel laminations secured to the outer surfaces of the sides of the rim, is beginning to be regular practice for the large heavy wheels of these great high-powered engines, suggested, no doubt, by the danger of using cast iron alone where strains of such magnitude occur in the attempted acceleration and retardation upon so enormous a scale.

Phosphorescence.—Mr. H. Jackson, on Wednesday, Jan. 10, delivered his second and final juvenile lecture on "Phosphorescence" at the Society of Arts. An abstract is given of the lecture in the *Journal* of the Society of Arts, and which reads as follows: In this lecture, Mr. Jackson dealt principally with phosphorescence produced by means of the electric discharge in tubes exhausted to a very low pressure. The lecture commenced with an illustration of the passage of an electric current through gases. Air, hydrogen, argon, and helium were shown, and their different spectra referred to. It was suggested that the light in these gases could be considered as closely related to that given out by solids made to phosphoresce under electrical excitation. The attraction of pith balls towards a piece of electrified sealing-wax, and their subsequent repulsion after touching the wax, was shown as a rough illustration of the idea that the particles of a gas might be considered to be first attracted to, and then repelled from, an electrode at high potential. Such particles might be thought of as rapidly traversing the space in a partial vacuum between the electrode and the phosphorescent substance in a state of statical charge. When they reached the substance they were discharged, and the oscillations set up at such a moment gave rise to rapid movements in the particles of the solid to which the phosphorescence could be ascribed. Examples of such phosphorescence in high vacua were then shown, and the nature of the phosphorescent light itself was next considered. The spectra of calcium and strontium, either from their salts in a flame or in the electric arc, were described and shown, and then specimens of phosphorescent lime and strontium compounds were exhibited to illustrate the idea that the glow from them was closely related to their spectral colours. In some the red part predominated, while in others the orange, green, or blue were most marked, the result being that some specimens of lime gave red, some orange, some green, and some blue phosphorescence, and apparently in equally pure specimens. It was then shown that the phosphorescence induced in such specimens was the same, whether light or electricity were used as the exciting cause. This was done by exposing them to the light of a jar spark and intensifying the glow by heat. Thus lime, which gave an orange glow when excited electrically, yielded a similar colour when dusted over a hot plate after exposure to actinic light. So also for green and blue glowing limes. The response of barium platinocyanide to X-rays was shown, and the effect of sudden discharge, which might, perhaps, be considered to give rise to pulses rather than periodic undulations, was illustrated by two globes, each containing only one internal electrode. In one the external electrode was an acid solution of quinine, which phosphoresced more brilliantly when a spark was allowed to pass, so as to afford a path for the discharge of the whole system as a Leyden jar. In the other, the outside electrode was tinfoil, and sticks of lime were inside the globe. These sticks were shown to glow brightly as soon as a path was made for the oscillations of the globe as a jar.

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ACCUMULATOR TRIALS.

The preliminary report of the committee appointed to conduct the tests of electrical accumulators for the Automobile Club of France has been published in *L'Electricien*, being signed by Mr. E. Hospitalier, the recorder to the committee. We have in previous issues referred to the conditions of this trial, which was commenced in April, 1899. The tests were particularly conducted to determine the durability of the batteries submitted, and the commercial efficiency of the same for a considerable period. Arrangements were also made to subject the batteries to mechanical shocks while under trial, but owing to defects in the apparatus for this purpose the jolting was only given to the accumulators during some 122 hours of the whole time of test. This corresponds to about one-fifth of the whole period of the trial. Each battery consisted of five cells, and was subjected to a charge and discharge every day. The particulars of these charges and discharges will be found in our issue of Nov. 24. Eighteen sets of accumulators were presented for trial, but a good number of these were soon found to be unable to fulfil the rigorous conditions as to the drop of pressure after a given discharge had been taken from them. The accumulators in question were finally reduced to eight, and the results obtained for these eight are given in the report in tabular form, which we reproduce. We have in every case converted French units of length and weight into English, and have in certain cases omitted columns which seemed to us to be somewhat redundant. The first cell in the list, No. 1, was made by the Société Anonyme pour le Travail Electrique des Métaux of Paris, and had its positive plates of the Planté type and the negative plates of the Faure type. The second cell was manufactured by the Compagnie Générale Electrique of Nancy, with plates of the Pollak type which are made on the Faure system. The accumulators for which the figures are given in the third column were of the Tudor type with Planté positive plates and Faure negative plates. The figures in the fourth column relate to an accumulator made by the Societa Italiana di Elettricità gia à Cruto, and here again Faure plates of the Pescetto type were used. The fifth column contains figures for a cell manufactured by the Compagnie des Accumulateurs Blot of Paris, and had plates of the Blot-Fulmen type. The Société de l'Accumulateur Fulmen presented the cell in the sixth column, and in the seventh column the figures relate to a battery by the Société d'Etudes des Accumulateurs Phenix. The eighth and final column represents the results obtained by a cell sent in by Messrs. W. Pope and Son, and which had plates of the Sherrin type. The total number of official charges and discharges made in connection with the trials was 153, spread over 26 weeks. The theoretical duration of these 153 charges and discharges would be 765 hours for each of the operations, made up as follows: 26 discharges without jolting, corresponding to 130 hours, and 127 discharges with jolting, being equal to 635 hours. According to the rules, all the batteries were submitted every Saturday to a steady discharge of 24 amperes, after which the voltage was tested to see if it had fallen below 8·5. When it had come short of this for four times, the accumulators were definitely struck out of the trial. The full list is given in the report of the dates at which the various batteries failed to fulfil the above conditions, but the notes on the cause of their failure is reserved to a fuller report. It is seen from the list that a certain number of the batteries were not from the first able to withstand the conditions of test, and the committee will not report on any of these batteries which have not given at least 60 complete discharges before their failure. The eight batteries of which we give details are thus the only ones which will be definitely reported

Details of construction and working.	1 Métaux.	2 Pollak.	3 Tudor.	7 Pescetto.	10 Blot-Fulmen.	11 Fulmen.	12 Phœnix.	22 Pope.
Battery.								
Weight, in pounds, with containing box	230	243	276	282	241	169	225	242
,, ,, without ,, ,,	210	242	237	234	216	149	203	220
Dimensions of the containing box, length	2ft. 5½in.	2ft. 10½in.	3ft. 2½in.	3ft. 9½in.	2ft. 4⅝in	1ft. 11¼in.	2ft. 1in.	2ft. 11½in.
,, ,, ,, ,, breadth	8½in.	9½in.	7½in.	8½in.	9in.	8in.	6in.	10in.
,, ,, ,, ,, height	1ft.	1ft. 2in.	1ft. 1in.	1ft. 2in.	1ft. 2in.	1ft. 1in.	1ft. 11½in.	1ft. 3in.
Volume in cubic feet	1·7	2·73	2·28	3·17	2 1	1 4	2 08	3·18
Number of official charges and discharges during the life of battery	82	82	141	141	135	100	103	135
Number of actual charges	82	82	139	141	135	100	103	135
,, ,, discharges	71	77	135	128	132	98	102	135
Number of complete discharges	61	61	105	68	112	56	99	132
,, partial ,,	10	15	30	60	20	42	3	3
Total energy absorbed, in kilowatt-hours	136·05	133 75	226·65	228 8	210·85	154·7	180·9	220 75
,, ,, given out ,, ,,	76 4	79·55	135·85	130 6	143·9	101 9	118 85	155 5
Energy given out during complete discharges	66·5	65·8	110 95	75 8	124 0	64·1	116 35	152·55
,, ,, ,, partial ,,	9 9	13·75	24·9	54·8	19 9	37·8	2·5	2·95
Average charge, in kilowatt-hours	1·66	1·63	1·6	1·62	1 56	1·55	1·75	1 63
,, discharge ,, ,,	0·93	0 97	0 96	0 93	1·06	1 02	1·15	1·15
Elements.								
Weight of electrolyte, in pounds	9·9	7·7	6 6	8·8	6 6	4 8	10 6	5·5
,, containing vessel	4·2	3 35	4·4	4·4	2·5	3·75	2·64	2·8
,, plates	27 2	34 4	35·	32 4	32·7	20·5	26·4	33·6
,, complete cell ready to work	42	48	47	46 5	43	29 7	40 5	44
Total number of plates	15	13	11	15	17	21	1,080	17
Height of plate	8in.	7in.	7in.	6·4in.	7 8in.	7 2in.	2·75in.	8in.
Breadth ,,	4 8in.	6 7in.	6·4in.	5 6in.	4·9in.	4in.	·23in.	4·5in.
Thickness of positive plate	0·31in.	0·2in.	0 24in.	0·24in	0 31in.	0·16in.	0·24in.	0 5in.
,, negative ,,	0.16in.	0·2in.	0·31in.	0·22in.	0·16in.	0·16in.	0·24in.	0·2in.
Weight of positive plate, in pounds	2·44	2·75	4	2·11	2·46	0 98	0·26	2·47
,, negative ,, ,,	1·1	2 53	2·54	2 28	1·32	0·97	0 26	1·32
Total energy given to battery in kilowatt-hours / Total weight in pounds	3·1	2·67	4·6	4·75	4 27	5	4·3	4·75
Total energy in discharges in kilowatt-hours / Total weight in pounds	1 76	1 6	2·78	2·7	2·92	3·34	2 82	3·41
Average energy in watt-hours per charge / Weight in pounds	38	32·5	32·7	33·7	31 6	50	42	36
Average energy in watt-hours per discharge / Weight in pounds	21·3	19·2	19 6	19·2	21·6	33	27·5	21·2
Energy Efficiencies, per cent.								
Maximum efficiency per week	76·5	68·5	67	67·5	76	77	73	74
,, ,, month	73	65	66	60·5	74	76	70	73
Minimum efficiency per week	18	42	28	47	31	49	33·5	62·5
,, ,, month	36·5	43	49 5	48	30	55	51	62·5
Mean efficiency	56	56 5	60	57	68	66	66	70

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on. One factor in this table requires explanation. The interval of time elapsing between the first charge of a certain battery and the time when it gave its last discharge is called the official life of the battery. During this official life the whole of the batteries have received a certain number of charges and an equal number of discharges which the given battery ought to have taken part in. It is this number of operations which the committee have designated in the tables by the official number of charges and discharges during the life of the battery. This is the maximum limit to which the actual charges and discharges approach as nearly as the accumulators will allow, and it will be seen that in the table only one of the eight survivors missed a charge, while a good number of them did not give the same number of discharges. We are further promised a complete report by the committee which will be of great interest to accumulator manufacturers. We believe this is the first time that so many different types of accumulators have been tested under similar conditions over such a length of time, and we are pleased to note that an energy efficiency as high as 70 per cent. has been obtained. It is, of course, gratifying to know that an English maker heads the list in this respect, and that the accumulators so tried, even in their least efficient week, did not give less than 62·5 per cent. of the energy put into them. The figures for the energy in watt-hours per discharge per pound of plate show wonderful accord, while, of course, the columns devoted to the total charge and discharge in kilowatt-hours per pound of accumulator vary much more owing to the different life of the cells. The equality of the first-mentioned figures tend to confirm the belief that the maximum weight efficiency of the lead accumulator is practically known, and that it is only towards securing durability with this weight efficiency that we have to look in the future for success in electrically-driven motor vehicles propelled with lead accumulators.

TWIN-CARBON ARC LAMPS.

Several of our German contemporaries describe a type of twin-carbon arc lamp, recently introduced by Messrs. Körting and Mathiesen, which has already found some favour on the German market. As Mr. W. Mathiesen, the writer of the description, remarks, many endeavours have been made by inventors to produce a satisfactory arc lamp having two arcs in series. The advantage offered by such a lamp would be, of course, that it might be connected singly across a 110-volt circuit.

A few years back there appeared on the market an enclosed type of arc lamp which so far met this requirement in that it took about double the normal pressure sufficing for an open arc—that is to say, about 80 volts, and could, therefore, be connected to a 110-volt circuit — the lamp, however, failed to completely solve the problem pertaining to high-potential arc lamps, since the well-known hissing of the enclosed light does not permit of the long-burning arc being always employed, besides which the low efficiency of the arc constitutes a further obstacle to its use. These disadvantages can only in a comparatively few cases be neglected.

The lamp introduced by the above-mentioned firm, and which is designed to overcome these difficulties, is shown in Figs. 1 and 2. It may be described as a combination of two independent regulating devices which are attached to a common base-plate. The regulating mechanism belongs to the well-known type in which a magnet provided with a hinged armature actuates the regulating clockwork. The arrangement is apparent from the accompanying sketches, which clearly show almost every detail. This regulating mechanism consists of the shunt-wound magnet, *a*, and the clockwork, *b*, which latter is connected with the magneto armature, *m*, by the tongue, *o*. The necessary opposing force to the magnet is afforded by the spiral spring, *n*. The corresponding parts of the second regulating apparatus, so far as they are visible in the sketch, are denoted by similar letters, with the addition of the number 1—for instance, a_1, b_1, and so on. The escape wheel, *p*, of the clockwork, *b*, is governed by a catch attached to the tongue, G, which in turn is carried by the two-armed lever, *v*, and this, together with the second tongue, G_1, is subjected to the common influence of the heat compensator, K, which, according to the temperature attained by the lamp mechanism with constant regulating tension, compensates the backward movement of the pivoted armature, *m*, by pushing back the lever arm, thereby maintaining the regulating tension of the spring approximately constant.

The variation in weight of the carbon-rods is rendered a negligible quantity by the method used of pivoting the clockwork, so that the regulating tension is not influenced thereby. In order to prevent the jerky movement of the clockwork, air pistons or dash-pots, T, are provided. The potential to the arcs may be regulated by adjusting the screw, *s*, whereby the pull of the spiral spring, *n*, is controlled. The advantage which this type of lamp offers is that it may be connected singly across a 110-volt circuit, as mentioned above, or in pairs across a 220-volt circuit.

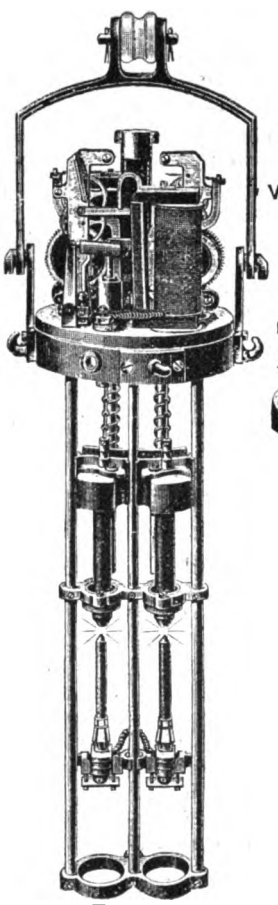

FIG. 1.

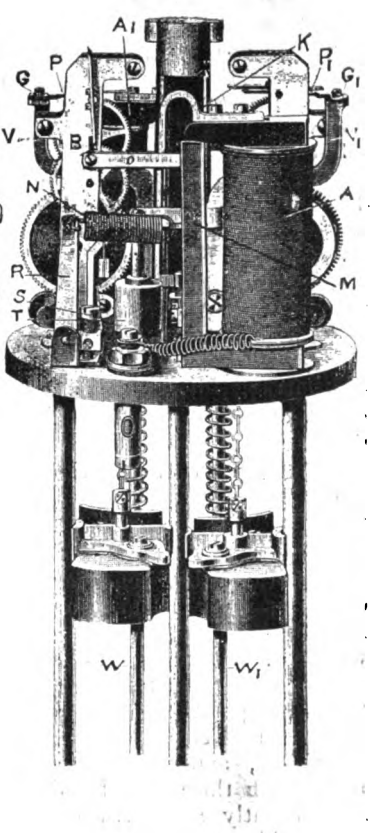

FIG. 2.

This advantage is very apparent where the latter pressure is in question, since it is not every consumer who can employ four to six of the ordinary type of lamp. The twin-arc type of lamp, like the Nernst lamp, therefore facilitates the general endeavour to increase the pressure of current supplied to the consumer. It certainly offers a disadvantage with regard to working cost, which is greater in the case of twin-arc lamps than with single arcs, since instead of one pair of carbons it requires two, which, though of somewhat less diameter, cost more for the two pairs. Further, the intensity of light given by the two arcs is not so great as that of one arc consuming an equal amount of energy, for the efficiency of arc lamps increases under normal conditions with the current strength. The enclosed arc type of lamp, compared with the twin-arc type as regards intensity of light, is still considerably its superior. But even if the working costs of the twin-arc lamp are higher than those of the single-arc lamp, argues the writer, the advantage offered by the first type is still so great as to make it of considerable importance in connection with central stations supplying at 220 volts.

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AN AMERICAN PACIFIC CABLE.*

BY GEORGE OWEN SQUIER.

(Continued from page 23.)

Electricity the Ideal Medium for Transmitting Intelligence.

The triumphs of science in the last half century have been nowhere more exemplified than in the enormous strides made in the facility of transmitting intelligence. The mails, the telegraph, and the telephone are civilising the world. Perfect as is the mail system of to-day, a monument to organisation, yet its swiftest messenger, steam, is so far outstripped either on land or sea by the practically instantaneous electric current, that the tendency year by year is to put more of the world's business "upon the wire." The time is fast approaching, let us hope, when a telegraph and cable letter service at rates comparable with present postage rates will be realised throughout the world, with its consequent revolutions in business and social methods. Time has an international money value. The fastest mail express, or the swiftest ocean mail ship, are as naught compared with the velocity of the electrical impulse which practically annihilates any terrestrial dimension. As the distance increases, electricity surpasses steam in a continuously increasing ratio. In the case of a message to be sent across the street, probably there is no more efficient and satisfactory method than by a mail delivery messenger, but if this message is to be sent half-way around the earth, the minutes required by the telegraph run into weeks and months by the slow process of the mails. Steam time is directly a function of the distance to be traversed, and from the nature of things must require twice as long to go two miles as one. If, then, the cable saves six days between Europe and America, it will save more than twice this time between America and the East, and is from this point of view correspondingly important and necessary. Since electricity so far outstrips any other known vehicle for transmitting intelligence, it must eventually carry all the important information, and practically take from the present mails more and more of the most urgent letters.

Continuous Use of the Cable Proposed.

With a Pacific cable in operation, and possessing such immeasurable advantages over the mail, how can any management be entertained which does not aim at the use of the cable continuously to its fullest capacity? Cable property is peculiar in that it does not, like mechanical machinery possessing moving parts, deteriorate with use, and its life is not therefore dependent upon the amount of traffic transmitted. The ordinary manufacturing plant is usually not operated continuously, because the coal consumption, the wear and tear of machinery, and the extra expense of employés—combined with the state of orders received—do not present a sufficiently attractive economical proposition. But a large cable property presents unique conditions from a purely business standpoint. The bulk of the capital invested is buried under the sea, and much the largest item to be earned is the interest on the capital. A 2,000-mile line requires but two operating stations, and the annual expense of a few clerks who actually operate the plant forms a comparatively insignificant part of the total annual expense.

In the estimate of Mr. Alexander Siemens upon the British Pacific cable in a paper at Ottawa in 1894, but 12 per cent. of the total annual expense was for operating staff proper, and this also provided for more than double the usual wages, in consideration of the isolated positions of the mid-ocean stations. Add to this the fact that what ordinarily corresponds to coal consumption, here consists of a few electric batteries, and is therefore practically nil, and also the fact that using the plant causes no deterioration, and the logical business conclusion is reached that ocean cables should be kept busy continuously. Every hour they remain idle is so much service absolutely lost. Present cable tariffs are so high as to force to idleness for a considerable portion of each 24 hours all of the long cables of the world. In addition, the Atlantic cables are practically silent one day in seven.

In defence of the present management, too often unjustly criticised, it is submitted that cable property, on the whole, has been particularly hazardous and uncertain, repairs often most expensive, and a prudent management has required large sinking funds and reserves. Furthermore, the necessary traffic arrangements required with co-operating or competing companies establish precedents and form obligations not easy to suddenly change. The whole of cable history does not yet cover 50 years, but the skill and experience of the large cable manufacturers in England have brought this industry to such a state of perfection that the laying of a 2,000-mile ocean cable, or its repair, in 3,000 fathoms, is no longer considered a particularly hazardous undertaking. In fact, in the beginning, cable rates had to be high, and although there has been a steady decrease in rates to the present, as the technical side of the business has become more stable and certain, yet it is believed that the time has now arrived when a more extensive classification and reduction can be inaugurated with advantage both to patrons and to revenues earned.

As a practical means for operating the cable continuously, it is a natural suggestion to classify the traffic offered and establish differential rates therefor, as is now universally done on land lines. The same causes which have established night rates on land are much more potent in case of ocean telegraphy, where the time gained and the capital invested per mile is enormously greater. It is simply a matter of paying for time. The Stock Exchange message, where minutes are valuable, should be charged the highest rate, while the Press and less urgent business messages should be classified and paid for according to the time limit called for in delivery. Since the only other competitor in the Pacific is the mail steamships, where the minimum time is over two weeks, it should be easy both to create new business and to draw from the mails as desired. In handling certain classes of messages it can be distinctly agreed to deliver only within a certain number of hours or a week or even establish a low Sunday rate for certain classes of matter, and still arrive much ahead of letters sent by mail. If we have no less than four classes of matter in the present mail system by steam train, why not a classified service for an ocean cable postal system, where the reasons for it are more potent?

For the fiscal year ending June 30, 1898, the amount of mail matters, letters proper, excluding all other forms of mailable material, carried in mail steamers from the United States across the Pacific Ocean for Japan, Hong Kong, Shanghai, Manila, Singapore, Cochin China, Java, and Siam was about 10,948,651 grm., representing about 1,156,176 letters. From the United States for Hawaii 3,495,442 grm., representing about 369,072 letters. This reveals the appreciable proportion of the Pacific traffic which stops at the Hawaiian Islands, being, from the above figures, about 25 per cent. of the entire traffic which in 1898 left the United States for these countries. These figures are instructive as indicating that in considering the through trans-Pacific cable the Hawaiian traffic is not entirely to be ignored, and that of the entire length of the cable, the span between California and Hawaii will continuously be required to carry a materially greater portion, and will therefore be the first span requiring duplication.

Assuming, as above, that the carrying capacity of the proposed cable be equal to that of the best Atlantic cables for corresponding lengths, it is of interest to obtain in a general way the amount of traffic which can be handled across the Pacific under a management which ensures the cable being used continuously. The proposed cable should possess a carrying capacity each way per annum of about 5,900,000 code words of eight letters, and this allows 30 per cent. of the entire amount as waste, or non-paying traffic. This means of the 1,156,176 letters which in 1898 were transmitted to Japan, Hong Kong, Shanghai, Manila, Singapore, Cochin China, Java, and Siam, this entire number could have been transmitted by cable, allowing for each communication about five words of eight letters each. Since the use of code books for cable messages has so much increased that practically all cabling is now trans-

* Paper read at the one hundred and thirty-eighth meeting of the American Institute of Electrical Engineers, New York and Chicago, Dec. 27, 1899.

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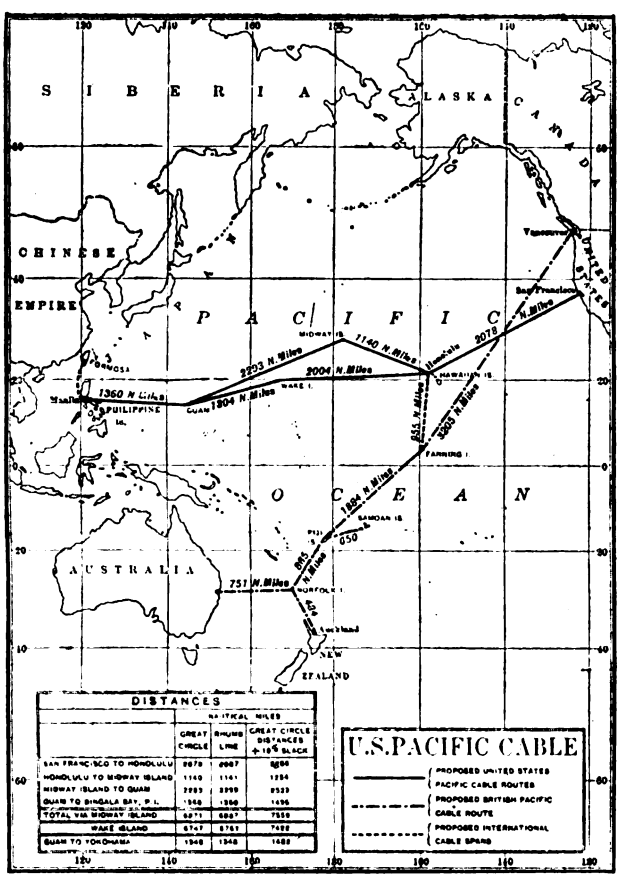
mitted in this manner, we can reasonably take one word equivalent to five by their use, so that each communication above referred to is equivalent to 25 words of average length.

Means for Duplication.

All important submarine cables should be duplicated as soon as possible. Cables are always liable to interruption from a variety of causes, and the interruption of a single line necessarily suspends all communication. The protection of the patronage requires duplicate lines if for no other reason. An adequate plan for a Pacific cable should consider means for the duplication of the line. In this connection an examination of the Pacific Ocean, and the route, of the proposed British Pacific cable from Vancouver to Australia, suggests a span of cable of international value. Reference is made to the desirability of connecting Hawaii and Fanning Island with an Anglo-American cable, operated by the Governments concerned, under rules mutually acceptable. A common interest should lead to the linking together of these two great ocean telegraphic routes in the mid-Pacific. With this single span of cable



laid, which is but about 950 nautical miles in length, or but 13 per cent. of the length of either of the main lines, it results that each country has practically ensured its line against a total interruption until such duplicate lines can be laid as the growth of the business will undoubtedly warrant. Thus in case the British cable between Canada and the mid-Pacific should be interrupted, it would only be necessary to route the British business for Australia, arriving at Vancouver, over the United States land lines to California to be transmitted over the United States cable to Hawaii, thence over the international span to Fanning Island, and on to Australia, *vid* the British line; or in case the American span to Hawaii is interrupted, the United States can likewise reach these islands and the East by routing traffic to Vancouver for transmission to Fanning Island, and thence to our trans-Hawaiian cable, also *vid* the international cable span. In a similar way, in case any section of either through cable is interrupted beyond the Hawaii-Fanning span, the urgent United States traffic can be routed from Hawaii westward *vid* Australia and thence to the East, or the urgent British business can reach Australia *via* Manila. It is believed that such a living and equitable arrangement can be effected in the working of these Pacific cable systems as would afford security to each and result in mutual traffic advantages to both enterprises. Thus there is no reason why the present Atlantic cable system and the United States land systems should not eventually serve as material feeders to and from Australasia, and likewise the British and Canadian systems supply an appreciable traffic to the Philippines and the East.

Cable Connection with the Samoan Islands.

The interests of the United States in Samoa will be more clearly defined by the acquisition of sovereignty over the island of Tutuili now reported probable. In this connection another branch of cable is suggested, which the United States could properly assist. As shown upon the accompanying map, a span of cable but 650 miles in length connecting Fiji with Apia, would thus join the Samoan group to the main British-Pacific cable route and furnish cable connections for the three Governments interested—viz., England, Germany, and the United States.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution last week, before the discussion on the report of the Swiss Visit Committee,

The President (Prof. S. P. Thompson) said he had a rather pleasant announcement to make. A letter had been received from Messrs. Binswanger Byng and Hugo Hirst, stating that in a copyright action with respect to their catalogue they had received the nominal damages of 100 guineas. A cheque for this sum they enclosed with the letter, the money to be devoted to the building fund. There had also been arranged to take place on the 18th inst. a meeting of the local members in Glasgow with respect to the formation of a branch of the Institution. He regretted that he himself would be unable to attend that meeting, but two of their prominent members, Prof. Perry and Mr. A. Siemens, had decided to go, and any other member, associate, or student who went would no doubt be welcomed by the Glasgow members. With regard to the albums of photographs taken by the members when in Switzerland, they would find them in the room below, the accepted ones being marked with a red disc. There were to be 72 photographs in the album, 12 being of a large size (12in. by 10in.), 24 being half of that size, and 36 smaller still. The price of the whole album would be 27s., post free, and forms could be obtained to be filled up for the book. Mr. Crompton had acted as president of this album committee, and Mr. R. Erskine as secretary.

Mr. R. E. B. Crompton then said the Council had kindly permitted him to take that opportunity of thanking the Institution for the handsome response made by them to the circular which he had sent out asking for funds for the men of the corps of Electrical Engineers who were going to the Cape. The primary object of this corps was to place at the disposal of the Government men who were thoroughly well up in electrical engineering work, and who had become acquainted also with the technical drill, which they had learnt during the past three years. The corps was accepted provisionally, and they were still waiting for instructions from Lord Roberts as to what plant and apparatus would be needed. He could not give them any information on this subject, and, indeed, he did not know that it would be wise to do so, as even in that room they could not be too careful. It was necessary for them to develop the bump of caution to a much greater extent than they were accustomed to do in their discussions. The Government would no doubt supply the men with all the equipment of a definite kind they required, such as dynamos, engines, etc., but there was other apparatus which the Government would not supply, and the personal wants of the men, and it was for this purpose that funds were asked. Up to the time of his coming from home that evening over £900 had been given in, and he had hopes of getting £1,500. He was amazed at the generosity and public spirit displayed by some of the members. The corps was not going out as a fighting party, but as a body having for its object the saving of the large waste of life experienced.

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Thus, work which could only be done in daytime at present could be by their aid done at night. The fault so far, he thought, had been the depending too much on British bulldog pluck rather than on the mechanical talents of Englishmen when brought face to face with difficulties.

Mr. CROMPTON, in opening the discussion, said that he thought the Institution ought to be congratulated, not only on the way in which the visit was carried out, but on the able report which the committee had prepared on that visit. This report would in time to come be very valuable, as showing the state of electricity in Switzerland at the present time. Basle being the place of assembly, it was there they came across their first electric tramway. Some three years ago he had been laid up in a house very close to this tramway, and it was then that it was first impressed on him what a wonderful thing an electric tramway was. It was so very silent, the only noise being the slight hissing of the contact running on the wire. They next proceeded from Basle to Rheinfelden, and it was here that their individual idiosyncrasies first began to assert themselves. Mr. Ferranti led the way across a bridge, which was shown, which they called the Bridge of Jeroboam, and took a large party the wrong way. When they reached Rheinfelden they found the rest of the party sitting outside the power station cooling themselves, and they only then could inspect the interior. The first thing in which the difference of Swiss practice from English practice was noticed was in this station, and consisted of coupling dynamos on the vertical shaft of the turbine. Swiss engineers were almost the first to start using machines with vertical axes, with which the English engineers were unaccustomed. A very noticeable thing in the Swiss stations was that the Swiss engineers were not afraid of a certain rise of temperature with their machines, which English engineers would not at all like. Entering Rheinfelden they noticed that puff of warm air which afterwards became quite familiar to them on their journey. This rise of temperature they were led to believe was the right thing, and he thought that it was right practically, as with it the machines were efficient enough, and it did not make their insulation faulty. After leaving Rheinfelden they went to Zürich, and during the time spent there they had an opportunity of visiting the various fine electric manufacturing works in the district. They visited the works of Messrs. Brown, Boveri, and Co. first, but he thought it better to take them out of order. One thing, however, which struck one in all these works was the energy of the Swiss electrical engineer, who because coal was dear had made use of the water power which was plentiful in Switzerland. As early as 1882 Mr. Sulzer put in a pair of dynamo machines at Schaffhausen. This was the first pair introduced into the country, and these he had been informed had been supplied by him (the speaker). These machines had given 65 per cent. net efficiency, and this was considered so satisfactory that it was the humble means of inducing other firms in Switzerland to take the matter up. The electricians at Basle were especially fortunate in having alongside them such good mechanical engineers as the founders of the Winterthur Locomotive Works, and especially Mr. Sulzer, a prince in the mechanical engineering world. He also called their attention to the wonderful winding work done in Messrs. Brown-Boveri's shops. Whatever kind of winding was to be done, it was all done with the utmost care, and the work was beautifully finished off, and must have been a revelation to many of the English electrical engineers viewing it for the first time. The Swiss work was, as a rule, so uniformly good that he always said in his own works that if machinery were finished as well as the Swiss it would do. As regards the finish also, when passing through Sulzer's shops, he was never more astonished than to see that large engines which had been some months in the shops could be finished without even a scratch. One point, however, was that, although the engines were so well finished, they were not rapidly produced. One great disadvantage in England was that everybody wanted a machine named after himself, and consequently there were very many machines of different standards on the market. In Switzerland the engineer was taught to believe that the Sulzer engine was the acme of engineering, and in consequence these engines were always made up to the highest standard. Another difference between Swiss and English practice was that the Swiss began with little lighting work and much power, and in England, owing to the fogs and dark weather experienced, lighting took the first place. Thus, while our shops were filled with wonderfully high-speed machinery, the majority of the Swiss engines were slow-speed. The Swiss engineers had quite recognised the value of the three-phase current, with the result that they were ahead of England in that particular class of work. He, however, did not think they were ahead in the usual English type of machinery. During the past few days he had seen at Manchester some 2,500-h.p. dynamos, which certainly could not be surpassed in Switzerland. He considered the Swiss engineers had reaped great advantage from the condition of things which pressed them into high-pressure work, and if electric railways were to be worked at all it must be by high pressure. It had been very easy for them to carry a little further the work already done in other countries. One of the greatest features of their practice was the simplicity of the electric railways. English engineers had always considered that to work an electric railway by a double trolley would involve too much complication, but this was used at Stansstad, and where was the complication? [Slides were then shown of the rack electric railway at Stansstad, which in some places had a 25 per cent. rise, a rack being employed on the grades. Pictures were also shown of the Burgdorf-Thun line and switchboards at Burgdorf and Engelberg.] With regard to views in the Oerlikon Works, Mr. Crompton said that here the good taste of the members was exhibited, as, although everything was open to them, they took no photographs of special machinery except that which they were invited to take pictures of. The heavy cranes (of which a slide was shown) made at the Oerlikon Works were a very special line, as were also the huge vertical standard dynamos for coupling direct to turbines. (Other views were shown, including pictures of the ropework used at Schaffhausen.)

Mr. R. HAMMOND said that one might gather from the pictures which had been shown that the whole of their time had not been occupied in scientific pursuits. This was rather an erroneous idea, as they had really worked very hard during the tour. They would, however, all feel that Mr. Crompton had given them a splendid *résumé* of what they had seen. Truly, as Mr. Crompton had said, Switzerland had had before it a good example in the works of Sulzer, and one could not dwell too much on that point as showing how such splendid engineering shops influenced the whole industry of a nation. In Messrs. Escher, Wyss, and Co., also they had before them a firm who had been making turbines for generations. In looking through their rooms he had seen pictures of turbines of 100 years ago. At all events, the machines they were now supplying were the outcome of the experience of many generations. He did not agree with Mr. Crompton in saying that better machines were turned out in Switzerland than in England. In England, the temperature rise spoken of was less than in the Swiss machines owing to the better design of the windings. He himself was not so much impressed with the dynamos, although there was great care shown in their manufacture. He felt that they were all thankful to the gentlemen who inaugurated these visits, and thought they had all brought away some new ideas. The big thing was undoubtedly the utilisation of water power. At Rheinfelden they had seen 16,000 h.p. being distributed, this power being entirely obtained from waterfalls, and some of them thought, "Oh! if we only had this water in England." But if they had not the water, they had the coal. Steam could be utilised almost as cheaply as water. He had seen it stated in one of the technical papers that in Switzerland they were able to produce electricity by water power and sell it at a profit at ½d. per unit. A thing he had noticed in Switzerland was the absence of information as to cost per unit, as in England they would have had it thrown at their head everywhere. One member on the tour made enquiries as to the costs, but could not obtain any information. From this he gathered that Swiss engineers concerned themselves only with engineering. Some of the members also had come back with the idea that consulting engineers were

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unnecessary, but at the first works that they came to they kept a consulting engineer, and, what was more, he resided on the premises. The engineer was Dr. Fry, who was one of the best kind of consulting engineers, who did his best for both the machinery manufacturer and for the buyer, and saw that the latter got good value for his money and the former for his machinery. Coming back to water power, in England they had something which could take the place of water, and he thought the coal bill would not make steam so much more costly than water power. Taking Kensington as an example, the total cost per unit generated was 3·04d., of which the cost of coal was only ¾d. Also in substituting water for coal they had something which entailed heavy capital expense. The question of the use of steam or water power was not so much the substitution of water for coal as the distribution of load, which was the real element in the relative cost.

Mr. SWALLOW, who was introduced by Prof. Carus-Wilson as representing the Swiss engineers, thanked them for the great interest they had taken in Swiss engineering. He agreed with Mr. Hammond that the most remarkable feature of Swiss electrical engineering was the utilisation of water power for long-distance transmission. He could not give any particular details of distribution of power. He was greatly interested in comparing the electric railways of England with those of Switzerland. He had been enabled to look over the Central London Railway, and was astonished to find that the three-phase current was not used direct to propel the trains. He must confess that he thought it fulfilled all the requirements for a railway, even when that railway had a large traffic to cater for. He was very sorry he had no further remarks to make, as he had been very interested in seeing the English work.

Prof. CARUS-WILSON said it must be astonishing to the Swiss railway engineer to see on the Central London Railway direct-current motors on the locomotives as well as three-phase current in transmission. He quite agreed that the Bergdorf-Thun Railway was the most remarkable thing that they saw on the tour. This was a broad-gauge railway connected with ordinary railways. That the promoters had undertaken to equip this with three-phase motors and generators, was an example of their confidence in the three-phase system. The financial success of this railway had yet to be demonstrated. The other electric railways in Switzerland also afforded them a striking example of three-phase work. One of the most interesting comparisons was between the locomotives supplied for the Jungfrau Railway by the Oerlikon Company and Messrs. Brown, Boveri, and Co. There were several points of difference between these engines. The Oerlikon motors weighed 19 tons as against 13 tons of the Brown type, the Brown motors running faster. One difference also was the jerking on the Brown type of car, which he thought was caused by the resistances of the locomotive being coupled in parallel on a single rotor resistance. The Oerlikon Company had managed to avoid this by having separate rotor resistances. One of the chief objections to the polyphase system was the small clearance allowed, on the Burgdorf line there being only a clearance of 1½mm. on motors running at 1,600 revolutions per minute. As to the question of the overhead conductors with the three-phase work, he would point out that on the Swiss railways the third-rail system could not be used, as all the places where the roads were crossed were on the level. If the overhead or underground wires were optional, they would soon do away with the overhead altogether. The system used on the Burgdorf line seemed to adapt itself to the running of these railways, and the Burgdorf Railway had only a drop of 2 per cent. at full load, with perfect regulation of speed. By having an efficient rotor resistance the extreme limit of speed could be obtained. The Engleberg train, going down a 25 per cent. grade, was held only by the return current, with only an increased speed of 5 per cent. He did not know this at the time, or he should have felt rather nervous.

Mr. L. BIRKS said that the Hageneck power station was a good example of Swiss work. This was a small village near the Jura Alps, and there was a canal from Lake Guienne to the river. Two years ago a scheme was formed for using this canal water for power, and a weir was thrown across, giving a fall of 5m. in 7m. These works were almost finished. The power would be generated by five turbines of 3,500 h.p. at a speed of 100 revolutions. The regulation would be automatic and hand-controlled. The plant generated 1,000 kw. at 8,000 volts. The exciters were placed under the alternators, and these were excited by secondary exciters. There was also separate plant for the secondary exciters, which were driven by turbines.

Mr. MARK ROBINSON said he was pleased at the compliment which Mr. Crompton had paid to the Swiss work, and especially to the Sulzer shops. He himself had been there recently, and thought that the highest praise was due to these engineers for the admirable accuracy which was obtained in their work, more particularly because the conditions in Switzerland were not so favourable as in this country. He was also greatly struck by the amount of three-phase work. With regard to a remark by Prof. Carus-Wilson on a motor only having 1½mm. clearance, he thought that was very large.

Prof. CARUS-WILSON explained that he referred to a locomotive motor, which was liable to get dirt, etc., in the clearance.

Mr. J. RAWORTH said they were greatly pleased to have Mr. Crompton addressing them again. He would like to make one remark apart from the discussion. This referred to the Electrical Engineer Corps, and he thought that some members had not contributed owing to the fact that they thought the contributions were towards the equipment of the force, which they thought should be equipped by the Government. He would like all to understand that the funds were for providing comforts, etc., for the individuals of the corps, and not for equipment. As to the Swiss tour, when over in Switzerland one would hardly have thought they were electrical engineers, as their time was consumed in telling their Swiss hosts how pleased they were with all their works. If they had the pleasure to invite those gentlemen over to this country they would probably be the same. In the third paragraph of the report they had omitted one thing, as it did not say that Herr Rathenau came all the way from Berlin to give them a very warm invitation to go to Berlin.

The PRESIDENT stated that this invitation had been accepted.

Mr. RAWORTH said there was only one man worthy of blame at all, and that was Mr. Hammond, who took a squeeze of the actual rail of the rack railway.

Mr. SWINBURNE said he was one of the few unfortunates who were unable to go to Switzerland on the visit, but he had seen some of the works there and also some in Germany and France. One thing he noticed on the Continent was that on going into the engineer's office a pile of technical journals met the eye, including usually every journal one knew of and a great many one did not. The Continental engineer was an enormous reader, and knew everything that was going on in all countries with repect to electrical work. In England, he thought, not much attention was paid to reading up in this way. With regard to the uniformity of the practice on the Continent, the plant was usually known by the name of the firm only, and the engineers were anxious to have the best machinery possible. The originality thus done away with was replaced by the finding out of other people's ideas. They were ahead of England, in that they sacrificed neatness and efficiency to mechanical strength; also, in England the owner of a works considered the works as a nasty thing to put in a dirty corner of a town. He took no workman's pride in his works, but on the Continent the manager's or owner's house was usually on the works, and the whole thing was beautifully kept. The same principle was carried out right through the works on the Continent, they being perfectly clean and orderly. This meant that with clean works the men took more interest in the work. Trades unions also were not so strong in Switzerland as here. The workmen also were widely different from the English, being either good mechanics or else very dull, there being hardly any intermediate stage. Then as to the law of electric lighting here and abroad. Abroad the local authorities generally gave concessions, and companies were much less hampered than here. In Germany also the financial arrangements were different, the banks supplying

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the capital. This was a sounder means than the ordinary company promotion. Various Continental firms had manufacturing places in different countries, and spread out in that way. He protested against Prof. Carus-Wilson saying he was afraid on going down a gradient only on the electric current. It showed, he thought, a great lack of confidence in electricity. Surely if the torque was sufficient to pull the car up, it would hold it on the much less strain coming down.

Mr. SELLON then moved that the discussion should be adjourned till Jan. 25.

[The list of candidates balloted for at this meeting is unavoidably held over until next week.—ED. *E.E.*]

ELECTRIC TRANSMISSION OF POWER.

At a meeting of the Glasgow University Engineering Society, held on 11th inst., a paper on "Electric Power Distribution as applied to Factories and Workshops," was read by Mr. G. H. Bowden, of Messrs. D. Selby Bigge and Co. The lecturer began by pointing out the advantages derived from the use of electric power in large cities, which, great as these were, shrank into comparative insignificance when compared with the application of electricity to industrial purposes. These advantages were due to saving in fuel, labour, and repairs.

The conditions found in many industrial concerns showed that the waste due to driving isolated tools and groups of machines by small steam-engines and long lengths of shafting were very great. A consumption of from 20lb. to 30lb. of coal. per horse-power hour was quite a common figure, while a well designed electric power plant reduced this to 3lb. or 4lb. A typical instance was given—that of a large engineering works on the North-East Coast, where the capital expenditure was £8,000, and the annual saving exceeded £3,000 per annum. Another example was that of Messrs. Furness, Whithy, and Co., where the capacity of the electrical plant was double that of the old steam system, yet the power costs were less than before. Many other instances could be cited; all, however, told the same story.

Works equipped with shafting well lined up and efficiently loaded, such as some types of machine shops and textile factories, did not present the same inducement for their owners to apply electric power. Although such places could show some saving by its adoption, that saving was not great enough to pay interest on the capital expenditure. Proceeding, the lecturer dealt with the size of the power-house units, and the conditions which determined their selection. The size of unit depended on local conditions, but a good arrangement (for instance, in a works requiring, say, 300 h.p.) would be to put down two units, one of 200 h.p. and a second unit of 100 h.p. During the day the 200-h.p. set would meet the demand; as the lighting load came on, the 100-h.p. set could be started up and put in parallel. For a night shift, which generally affected only a few departments, the 100-h.p. set would probably prove ample. Thus all units would generally be run at an economical load. Circumstances, of course, modified these points, and where the plant was very large, units all one size were preferable. As an example, one large plant near Middlesbrough had three sets of 750 h.p. each.

In most cases the generator capacity need not exceed 60 to 65 per cent. of the motor horse-power installed. At Messrs. Furness, Whithy, and Co.'s works the generating plant was even smaller, there being 800 h.p. in motors and only 450 h.p. of generating plant, yet no signs of overloading had been noticed. For outputs up to 200 h.p. the lecturer preferred high-speed engines; over that, and especially for units of 400 h.p. to 500 h.p., the preference lay with medium-speed engines of the marine type. In illustration, Mr. Bowden threw on the screen several slides showing the power-houses of various works installations. The shipyard of Messrs. Workman, Clark, and Co., Belfast, had slow-speed horizontal engines driving multipolar dynamos by ropes. The National Small-Arms Factory at Liège had slow-speed horizontal engines directly coupled to a multipolar dynamo of the flywheel type. Messrs. Furness, Whithy, and Co. had marine-type engines driving the dynamos by link belts. The same applied to Messrs. Furness, Westgarth, and Co., who had almost a duplicate plant. Messrs. Scott and Co., Greenock, had their three shipbuilding yards recently equipped with electric power. In this generating station there were three units, having an output of 200 e.h.p. each, coupled to high-speed engines. The hydraulic and compressed-air plant were located in the same engine-room, thus saving labour.

Speaking of methods of distribution, the lecturer advised the splitting of works into sections, and supplying these from panels on the switchboard. At the end of these feeders distribution boards supplied the various lamp and motor circuits through fuses placed on these boards. It was always best to use bare wire for feeders when possible, carrying them on insulators along the shop walls. This had been adopted in many cases with success, the insulators being generally of the double petticoat type.

Proceeding, the lecturer dealt with the chief characteristics of motors, and the various methods adopted in driving from them. Punches, shears, etc., could often be easily fitted with an enclosed motor on the top driven by means of a belt. Where cranes were fitted to the machines such a method was of course impossible, and the motor had to be placed underground. There were many cases where a belt drive could be used instead of more costly gearing. In driving a number of small machines judicious grouping to a small countershaft was best. In this connection it was desirable to place the motor so that it would drive on to the middle of the shaft and not at either end. If circumstances permitted, all motors should be of one or two standard sizes, thereby reducing the number of spare parts necessary. For instance, 10-h.p., 15-h.p., and 20-h.p. motors might be used instead of several odd sizes. It would even be desirable to use only one size if possible, a case being cited where 20-h.p. motors only were employed. Shunt motors generally gave best results, though series and compound motors were often rendered necessary by special circumstances. It was the lecturer's opinion that current should always be left on the shunt coils. Against the small amount of energy so used could be placed the fact that the motor was always kept warm and free from damp, while risk of breaking down due to self-inductive E.M.F. was avoided.

Speaking of polyphase machinery, Mr. Bowden said he was unfavourable to its use for local power distribution; the chief advantage of such motors was the absence of commutators, while the disadvantages were many. Applying them to cranes was difficult, variations of speed were only got at great cost in auxiliary apparatus, they could not stand overloading, and their power factor was so low when starting that he had seen a 100-h.p. generator overloaded (in current capacity) when starting a 20-h.p. motor.

After an interesting discussion, Mr. Bowden was awarded a very hearty vote of thanks for his paper.

THE DYNAMICABLES.

We have to record a meeting of this old society at the Whitehall Club on Wednesday night, Major R. E. Crompton occupying the chair. Among those present were Messrs. Albright, D'Alton, Belshaw, Biggs, Crawley, Esson, Gorham, McFarlane Gray, Heaphy, Ince, Wallis-Jones, Lorrain, Thomson-Lyon, Martin, Manville, Meik, Prof. Perry, Pendred, S. Rawson, Reeves, Mark Robinson, Raworth, Siemens, Holroyd Smith, and S. Sharp. An exceedingly pleasant evening was spent, and the club steward is to be congratulated upon the excellent dinner provided, as well as upon the attendance to the creature comforts of the "Dynamicables." It was unanimously agreed to recommence the social evenings after the long adjournment, the members of the old committee being asked to continue their labours, adding to their number other names to replace those who have fallen by the way. No doubt the committee will soon get to work, and will revivify a society whose object is to bring about good-fellowship and *camaraderie*. The feature of the evening was in that it resolved itself into a hearty send-off to Major Crompton and his merry men.

Walsall.—The Board of Trade have renewed the license of the South Staffordshire Tramways Company for the use of electricity for four years.

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THE ECONOMICAL GENERATION OF STEAM POWER.

BY BENJN. A. TAPP.

(Continued from page 53.)

Messrs. Proctor, Hodgkinson, Meldrum, and others, manufacture stokers from which very similar results to the

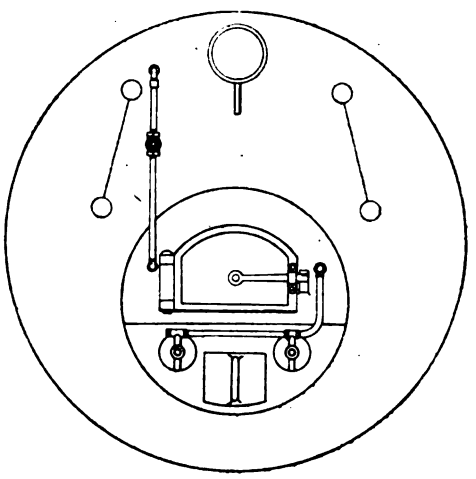


FIG. 6.—Front View of Boiler fitted with Meldrum's system of Forced Draught.

foregoing have been obtained, and the last-mentioned firm has gained considerable note for their system of forced draught which they apply in conjunction with their "Koker" stoker. Meldrum's forced-draught and waste-

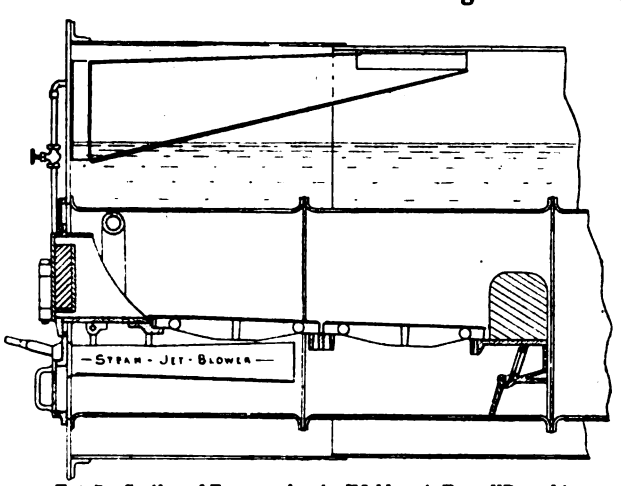


FIG. 7.—Section of Furnace showing Meldrum's Forced Draught.

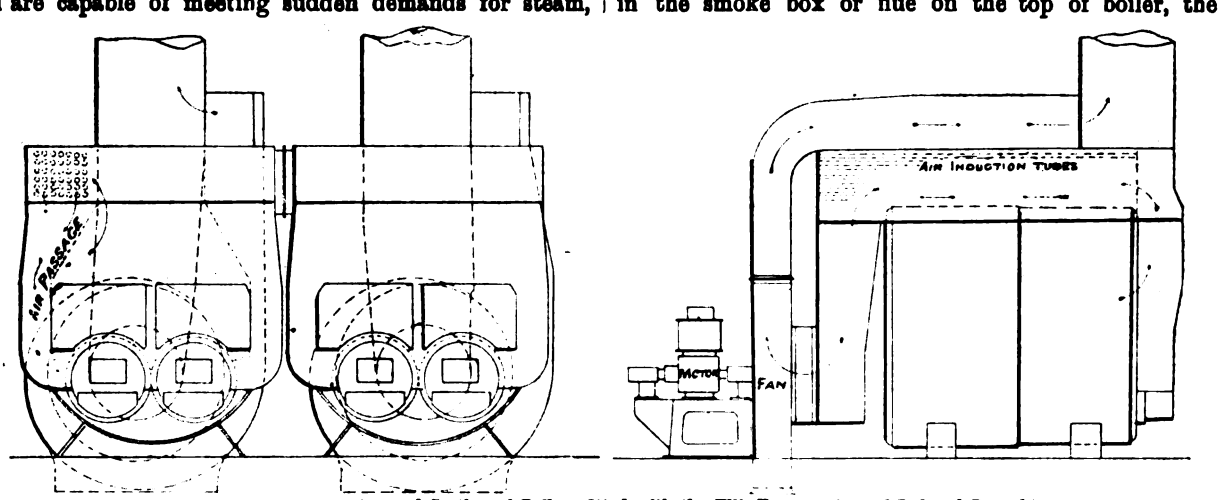
fuel furnace is largely used for burning coal and coke dust and other cheap and usually non-efficient fuels, which it will do without producing excessive smoke. Boilers thus fitted are capable of meeting sudden demands for steam, such as frequently occur in electrical installations. The arrangement consists of an airtight ashpit, provision being made for drawing the ashes through an airtight door. A current of air is drawn into the ashpit by means of small steam-jets, which blow under the grate through air-tubes fixed to the furnace front. The steam-jets can be varied in intensity by means of cocks on the furnace front. The flow of air and steam through the narrow spaces (about $\frac{1}{16}$in.) in the firebars has a cooling tendency, which prevents the adherence of clinker, etc. The general outlines of this furnace will be gathered from Figs. 6 and 7. It should be noted that the actual economy to be obtained in any particular instance will depend on the kind of fuel used, etc., and the appended tables give some results obtained from actual work:

Place.	Type of furnace.	Kind of fuel.	Cost of fuel per ton d/d.	Water evaporated per lb. fuel.	Cost of fuel for evaporating 1.000 gallons.
Manchester	Ordinary	Steam coal	10s.	8	5s. 6d.
,, ...	Meldrum	Coke dust	4s.	6½	2s. 9d.
,, ...	Meldrum	Pan breeze	Nil.	3	Nil.
Blaydon-on-Tyne.	Ordinary	Steam coal	10s.	8·9	5s.
,, ,,	Meldrum	Coke dust	1s. 8d.	5·5	1s. 4d.
Birmingham	Ordinary	Steam coal	5s. 6d.	7·5	3s. 3d.
,, ...	Meldrum	Coke dust	4d.	4	5d.
Leicester	Ordinary	Steam coal	9s.	6·8	5s. 11d.
,, ...	Meldrum	Slack	5s.	7	3s. 2d.

TABLE SHOWING INCREASED EFFICIENCY.

Place.	Type of furnace.	Kind of fuel.	Gallons evaporated per hour.	Water evaporated per lb. of fuel.	Increased fuel efficiency	Increased evaporation.
Blaenavon	Ordinary	Small Welsh	515	8·6	—	—
,,	Meldrum	Small Welsh	840	8·75	1·74%	63%
Hartlepool	Ordinary	Durham small	126	7·87	—	—
,,	Meldrum	Durham small	196	8 83	12%	55%
Marple	Ordinary	Burgy	621	9·75	—	—
,, ...	Meldrum	Burgy	844	9·89	1·4%	35%

Several other systems of forced draught similar in principle to that just described are in operation. We might mention the "Perfect" system, Gosling's patent, the "Loidis" system, manufactured by the Horsfall Furnace Syndicate, Leeds, etc., and also John Brown and Co.'s induced-draught system. The latter merits a description, as the author believes it to possess many novel features. The installation with which the author is acquainted consists of six marine boilers, every two of which is connected to a steel chimney about 60ft. high. On reference to the diagram it will be seen that a fan is interposed in the connecting flue between the furnace and chimney; also that air is drawn through horizontal heating tubes placed in the smoke box or flue on the top of boiler, the air entering at the back of boiler and passing through the tubes and down passages constructed in the smoke-box casing in the front of boiler to inlet valves placed on either side of the furnace door, and being heated considerably



FIGS. 8 AND 9.—Elevation and Section of Boilers fitted with the Ellis-Eaves system of Induced Draught.

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TABLE E.—J. Brown and Co., Limited, Sheffield. Marine Boiler. Serve Tubes and Retarders.

Coal burnt in lbs. Averages in 6½ hours per hour.	Water evaporated in lbs. per hour.	Tempera-ture of feed water. (F.)	Steam pressure in lbs.	Revolu-tions per minute of fan and motor.	Temperature of gases at base of chimney. (F.)	Temperature of air at side valve. (F.)	Vacuum under grate bars.	Vacuum over fires.	Vacuum at base of chimney	Speed of air in feet per minute under grate bars.	Speed of air in feet per minute through heating tubes.	Temperature of air entering heating tubes. (F.)	Thickness of bars.	Air space.	Remarks.
No. 1 boiler—			All hot	air above	grate.										Height of water in gauge-glass = 6in. Bars cleaned and tubes swept before starting, also heating boxes cleaned. cwt. qr. lb.
1,361lb.	10,330lb.	56·8deg.	171lb.	472	469deg.	319deg.	·687in.	·91in.	5·56in.	2,416	1,046	108deg.	⅜in.	⅛in.	Ash from smoke-box..... 0 1 6 Ash from under grate ..... 0 3 5 Clinker out of grate..... 3 0 14 4 0 25 = 5·2 per cent. of ash.
No. 2 boiler—															cwt. qr. lb.
1,344lb.	10,330lb.	56·8deg.	171lb.	471	484deg.	317deg.	·68in.	·89in.	5·41in.	2,433	1,041	108deg.	⅜in.	⅛in.	Ash from smoke-box..... 0 1 6 Ash from under grate ..... 0 3 5 Clinker from grate ..... 2 3 12 3 3 23 = 5 per cent. of ash.

No. 1. No. 2.
40lb. ... 9·53lb. coal burnt per square foot of grate per hour.
7·58lb. ... 7·68lb. water evaporated per lb. coal.
9·19lb. ... 3·39llb. water evaporated per lb. coal from and at 212deg. F. (average = 9·25lb.).

The horse-power at 20lb. per indicated horse-power from and at 212deg. F. = 626 each boiler.

before its delivery over the burning fuel assists greatly in smokelessly consuming it.

There is no doubt but that this apparatus allows great facility for forcing a boiler in emergency, and enables it to attain its full steaming power in a very short space of time. Appended is a copy of some working tests of a pair of these boilers. (See Table E.)

Before leaving that part of our subject dealing with the greater efficiency of furnaces, etc., it is necessary to record particulars of an American type of self-stoking furnace, which is practically untried in this country, although it is being introduced by one firm. The "Murphy" automatic smokeless boiler furnace can lay claim to some popularity in the States, 170,000 h.p. being installed, one firm alone employing furnaces for the production of some 23,000 n.h.p. This furnace is essentially different from all other furnaces, and is specially adapted for the use of small-sized bituminous coal and slack, it having sufficient coking capacity to feed 50lb. of fuel per square foot of grate per hour, slowly, and with smokeless combustion.

The diagrams (Figs. 10, 11, 12) illustrate the peculiarities of this furnace, and it will be noted that its construction necessitates some additional brickwork (to receive the furnace) in front of the ordinary Lancashire or Galloway boiler. The fuel is fed into magazines at the sides of the combustion chamber, falling through on to coking plates, against the edges of which it will be seen in the sectional diagram the upper ends of the inclined grate-bars rest. The lower edges of the grate rest on bearing bars, and at the bottom of the V formed by the inclined side a clinker breaker grinds up refuse and deposits it in the ashpit. In connection with the coking plate before mentioned, on to which the coal falls from the magazine, a contrivance is fitted for feeding the fuel into the grate. This consists of a "stoker" box, provided with a rack under each end, geared on to pinions on a shaft worked from the furnace front, and imparting a to-and-fro motion to the stoker at an adjustable speed, which motion pushes the coal over the edge of the coking plate on to the grate. It will be noted that a heated air supply is introduced over the coking plate to promote complete combustion of the volatile gases emitted by the coking fuel. By this arrangement it is claimed that the production of dense smoke is avoided. On the side of a battery of boilers, an engine with automatic governor and proper gearing, or a suitable motor and speed-regulating resistances, the motor properly geared, is arranged to operate a reciprocating bar across the outside of the entire

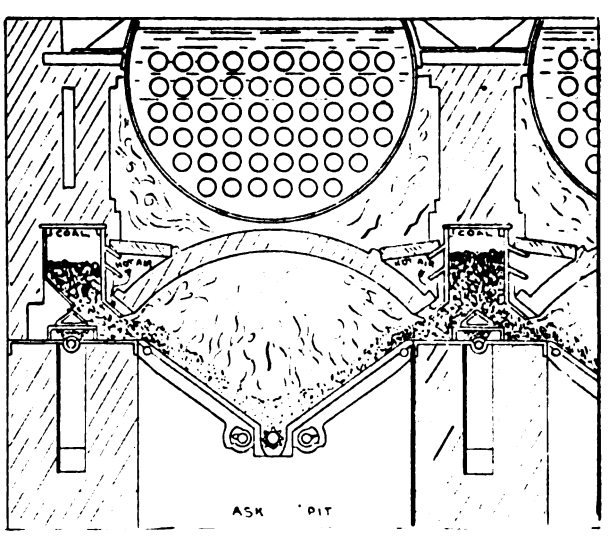

Fig. 11.—Section of the Murphy Automatic Furnace as applied to a Horizontal Tubular Boiler.

front, and to which all the working parts are attached by links, which may be detached or attached at will. It is claimed that this is the only fully automatic furnace—*i.e.*, one that is both fed and cleaned automatically—and Prof. Ripper, in reporting on it from tests, gave, as some of his conclusions, that the furnace will burn the cheapest coal smokelessly and efficiently; that the prevention of smoke is due to the following special points of construction: The length of the opening through which the green coal is fed to the furnace is more than five times that available with the usual arrangement of furnace, thereby spreading fresh coal over a large area in a thin layer. The combina-

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tion with the above of a mass of hot brickwork and a hot-air supply at the point where the smoke-making gases are being distilled off from the green coal, thus securing complete combustion. The adoption of inclined bars increases the effective grate area by 25 per cent. over that of the horizontal fire. The automatic removal of clinker, etc., minimises labour in attendance, and obviates the necessity

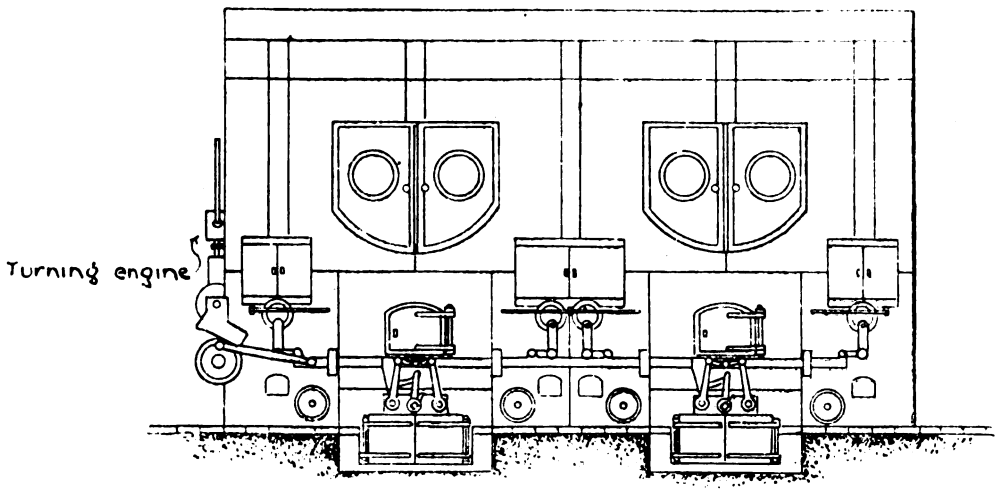

FIG. 10.—Elevation of Tubular Boilers fitted with the Murphy Automatic Smokeless Furnace.

of opening the furnace door. The heat storage in the brickwork is very great, and the cost of evaporating 1,000lb. of water with fuel at 3s. 6d. per ton is 2¾d.,

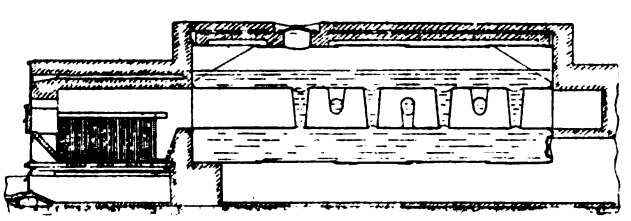

FIG. 12.—Longitudinal Section of the Murphy Automatic Smokeless Furnace as applied to a Galloway Boiler.

which, allowing 30lb. steam per indicated horse-power hour, equals 12 h.p. per hour per 1d.

(To be continued.)

THE INSTITUTION OF ELECTRICAL ENGINEERS' WIRING RULES.

We have received from the secretary of the Institution of Electrical Engineers a copy of a circular, with a list of questions, that is now being sent out to all those who replied favourably to a notice previously issued on the same subject. We understand that a copy of these questions, which we reprint below, will, on application to the secretary, be sent to any electrical engineer who may be willing to assist the Institution in the attempt to promote uniformity in wiring rules.

Questions.

1. Do you consider that regulations of some kind are necessary to ensure safe and durable wiring?

2. Presuming that you consider that there should be one set of standard regulations for ordinary risks for the United Kingdom, do you think that those which have been issued by the Institution cover sufficient ground? If not, in what direction do you suggest that they should be added to? Please give the suggested additions in the form you consider they should take.

3. Do you consider that the Institution regulations cover too much ground? If so, which portions should be omitted? Please give your reasons for suggesting their omission.

4. Do you agree with the general arrangement of the Institution rules?

5. Do you consider that any one regulation should be altered? If so, please say on what ground, and suggest in what way it can be improved.

THE TELEPHONE QUESTION.

The third monthly dinner of the London Chamber of Commerce was held on Wednesday last at the Trocadero Restaurant. Mr. F. Faithfull-Begg, M.P., presided, and there was a good attendance, including Major-General Webber, R.E., Messrs. H. Kimber, M.P., A. D. Provand, M.P., C. Charleton, E. C. Williams, and Kenric B. Murray (secretary.

After "The Queen" had been duly honoured, a discussion took place on "The Telephone System of the United Kingdom."

Mr. F. FAITHFULL-BEGG, in opening this discussion, said he preferred to keep his remarks to the end of the evening, but he trusted that the points raised in a paper circulated by Mr. Murray would be freely discussed. He then called on Major-General Webber to give his views on the telephone question generally.

The following were the suggested points for discussion: (1) That the London Chamber of Commerce endeavour to elicit from the Post Office for public information a description of the telephone system which they propose to establish in London, its areas, rates of charges, whether regional or not, and the facilities that will ultimately be provided, and when it may be expected to be "in full swing." (2) That similarly some information is due to the public as to when it may be expected that all head post offices in the United Kingdom will contain call offices, so that communications by previous appointment between persons resident in any two places may be provided by means of the trunk wires alone. (3) Consideration of the probable extent to which municipalities will take advantage of the Act of 1899, with any information as to the actual steps taken by municipalities in the matter. (4) That the terms of the form of telephone license lately issued by the Post Office under the Act of 1899 may be modified in respect to the making it compulsory that all telephone circuits shall have metallic returns, and that the existence of a class of subscribers to exchange systems be recognised who may for the lowest rate of subscription be connected with an exchange without the right to talk outside the area of that exchange, and that an earth return may be allowed with all such connections. (5) That the Post Office should be asked if they intend to provide facilities, and, if so, when, for all telephone exchange subscribers (whether of the Post Office or of any license of the Post Office) sending telegrams, express letters, etc., by telephone when the local post offices are closed. (6) Whether steps should not be taken to diminish the delays which frequently occur in switching on from the Telephone Company's lines to the Post Office lines. (7) Whether the Post Office intend, and, if so, when, to take advantage of the arrangements which they made with the National Telephone Company in 1896 and open call offices at all their post offices on the exchanges of the company. (8) Is the time limited allowed for conversation over the trunk lines sufficient? (9) Is there no means of obviating the annoyance constantly caused to subscribers by their being cut off in the middle of a conversation? (10) Why should

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the National Telephone Company enforce a new regulation upon their subscribers by which they demand a cash deposit from such subscribers before they are allowed to make trunk calls?

Major-General WEBBER, in opening the discussion, said he would try to speak generally, but that it was somewhat difficult to do so without knowing the policy of the Post Office with respect to the telephone question generally in London and the provinces. The Post Office had been empowered by the Government to spend £2,000,000 on telephone work, and it was not easy to rightly value the vast undertaking that they had in hand. For instance, in the London area no less than 600 square miles would have to be equipped with telephone wires and exchanges. The difficulty of the work was enhanced by the fact that they were not starting the work *de novo*, as the National Telephone Company were already in the field. He hoped that the policy of the Post Office would be to start local exchanges first in the outlying districts, and by degrees to connect these local exchanges with the central areas until a complete system had been obtained. In this way they would establish a *clientèle* not touched by the National Company. With respect to the country generally, he would urge on the Post Office the importance of having a telephone call office in every local post office of importance. These post offices being connected together by trunk wires it would then be possible for the general public to converse over long distances from post office to post office, the necessary appointments being made by telegram. This would be a very great convenience to the general public, but would not affect so much the rural areas. Major-General Webber proceeded to describe the system of rural telephones which he has advocated for some years, in which single-wire connections with earth returns would be carried out at a low cost per subscriber, under £30, by which the tariff would also be kept as low as from £2. 10s. to £5 per subscriber. He believed that if this were done the demand for connections for purely local services would grow, and when subscribers wished to use a trunk line they could go to a call office. On the same exchange a higher class of subscriber could also be connected who could use the trunk mains, paying, of course, more per annum for the privilege. Dividing the subscribers thus into two classes would, he maintained, simplify matters, and enable a cheap telephone service to be given to farmers and others in rural districts. He did not think that the difficulty of intercommunication over long distances was understood by the general public. So many operations had to be made in getting connection, that in view of the limited number of trunk wires delay was inevitable.

Mr. COLLINS, of the Common Council of the Corporation of London, strongly advocated that the whole telephone system of the country should be under one control. He had attended a large number of conferences on the subject, and the conclusion had always been arrived at that the telephone system throughout the country could only be worked effectively if it was a monopoly. He therefore advocated that the National Telephone Company should be bought out by the Government. If a perfect, prompt, and effective service were then given, the cost of the buying out of the company would be amply justified. With respect to any telephone system, he believed that it could be much improved if female operators were replaced by male labour. He quite understood that this would entail extra cost, but he considered that the present operators were responsible for much delay, and that subscribers would get what they wanted more quickly if these operators were replaced by men.

Mr. HENRY KIMBER agreed with the last speaker that such a great commercial engineering undertaking as the telephone should be in one strong hand, but it did not matter so much who had the actual control. He considered the well-abused National Telephone Company to be unjustly hampered by difficulties imposed by the very authority which had created them. In fact, the history of the telephone question in this country showed a great amount of blundering on the part of the Government. Mr. Kimber proceeded to review the various policies of granting licenses since the law courts decided that telephones were telegraphs, which had resulted in the National Telephone Company buying up all the licenses in the country with the sanction of the Government. As regards the repurchase of the company's works, he believed that all could have been easily arranged on fair and remunerative lines when the matter was under discussion last year in the House of Commons. The capital of the company was about four millions, on which 6 per cent. was earned, the shares standing at par. He believed, from a conversation with Mr. G. Staats Forbes in the lobby, that the company would have taken £110 for each £100 worth of shares. The Government could then have issued telephone consols at 3 per cent., which would have commanded practically face value, so that there would have been an annual profit of over 2½ per cent. He personally did not believe in a competition such as was now to be entered into, in which the Post Office would compete with a concern paying them royalties, nor in a competition in which maximum and minimum prices were fixed beforehand. The system of rural exchanges brought forward by Major-General Webber had his cordial approval.

Mr. ALBERT MURRAY suggested that the London Chamber of Commerce should receive and tabulate complaints as to the faults in the trunk-line connections, so that representations to the Post Office could be made as which district the messages were most congested for want of more trunk lines. Such representations would have much more weight than isolated complaints of subscribers. He did not agree with Mr. Collins on the labour question, as he believed the female operators were more efficient than men or boys would be. He did not consider the present price of £17 high for business houses, but more encouragement was needed to induce private houses to come on.

Mr. DANE SINCLAIR, the engineer of the National Telephone Company, said he would try to explain a few of the points raised from his personal experience, but that he did not speak on behalf of the company. He agreed with Major-General Webber that increased telephone service was needed in rural districts, but he differed with him in the way it should be obtained. Starting with cheap instruments and a single-wire line subscribers would be obtained who in a few years would demand extended facilities, and then the cheaper instruments would have to be replaced and the metallic return provided. This had been the actual experience in several places. He believed that the work could be thoroughly and well done only as a monopoly, and if the commercial men of the country do not demand the best, and get it, they should not blame the National Telephone Company. There was no doubt that the commercial business of the country had outgrown the telephone facilities in the shape of trunk wires, and, on the other hand, all the permanent officials of the Post Office were quite willing to increase the number of trunk wires. This was only a question of getting the money for the work. As regards the question of the deposits asked for trunk-line messages, the 5 per cent. allowed the company for collecting the tolls did not cover the cost of collecting, and the deposit was found necessary from the disputes arising over forgotten calls or for calls made by unauthorised servants of the subscribers. As regards the complaints of subscribers being cut off, this was largely due to the continued alterations necessary with the overhead wires in London, which were a disgrace. In other large town in England where the company had been allowed to put their wires underground, the same complaints were not received. The lady operator had been proved to be best, and this was so in all countries. It had been shown that a man was physically incapable of working a telephone board.

Mr. A. D. PROVAND, M.P., thought that the girl operators were in every way to be preferred to male operators. He had noticed in Scandinavia that girls of a much higher class socially were employed in the telephone exchanges, they being nearly all daughters of professional men, and he considered that with higher pay and shorter hours the standing of the English telephone girl would be raised. He believed in the scheme advocated by Major-General Webber, and instanced the rapid progress which State telephony had made in Guernsey, where they had now 431 subscribers after 18 months' working,

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and applications for 100 more connections. The effect of establishing the exchange in Guernsey had been to reduce the price charged by the National Telephone Company in Jersey from £10 down to £6. He did not agree with Mr. Kimber's statement that the National Telephone Company's capital represented assets. More than half of this capital had gone in promotion and other expenses not connected with the equipment of the exchanges. Mr. Provand then referred to the work about to be undertaken by Glasgow, and promised that the competition with the National Telephone Company should be effective.

Before the chairman closed the debate, a few speakers asked questions of Mr. Sinclair respecting certain points in the National Telephone Company's exchanges in London.

In reply to these, Mr. SINCLAIR said that the Stock Exchange system was worked quite independently of the other exchanges, with separate wires to each subscriber, and that in consequence of the comparatively small number connected an exceedingly efficient service could be given. The difficulties always increased with the increase in subscribers, so that comparisons between London and the Channel Islands were absolutely valueless. He defended the lady operators against the charge of neglecting subscribers, and explained that the reply, "Engaged," could refer to either the trunk wires or to the subscriber who was being called. He also explained that the reason why speech over trunk lines to Glasgow was better than when, say, speaking to Sevenoaks was because the commercial men of Glasgow were provided with the very best instruments, as they were likely to speak over long distances. The small local exchanges, such as Sevenoaks, were not at present so well provided in this respect.

Mr. F. FAITHFULL-BEGG, in closing the discussion, said that it had been an exceptionally profitable evening, due largely to the presence of Mr. Sinclair, who was able to speak from absolute knowledge. He agreed with Mr. Kimber in his method of estimating the value of the National Telephone Company's undertaking on the revenue which it was able to earn. He also thought that the residual value of the patents which the company had owned, and which had now lapsed, should be taken into account. As commercial men they were not so much concerned with the cheapest system as with obtaining a good and efficient service for their business intercommunications.

The meeting closed with a vote of thanks to the chairman.

ST. MARYLEBONE LIGHTING.

On Wednesday afternoon last Mr. Ritchie, President of the Board of Trade, received at his offices a deputation from the inhabitants of St. Marylebone parish to complain of the failure of the Metropolitan Electric Supply Company to supply them efficiently with current. A joint memorial on the subject, signed by about 600 persons, had previously been sent to the right hon. gentleman.

Dr. FLETCHER LITTLE introduced the deputation, and stated that the object of the deputation was to inform the Board of Trade of the many failures experienced in the electric lighting of Marylebone recently. These had been constantly taking place for a considerable time past, but lately were greatly increased. Another danger was the enforcement of the higher voltage on consumers. Although these failures were so many, the company were yet applying to the Vestry for permission to extend its mains in the parish in order that it might supply other outside districts. They more especially felt themselves badly treated from the fact that they were paying a very high price for their light, much more so than in Shoreditch, Hammersmith, and other parishes, where a good supply was given. The Vestry had not appointed inspectors and fixed meters according to their agreement. The Vestry was very apathetic about the case, but recently, under pressure, took out a summons against the company for breach of contract, the result of which was standing over. Even, however, if damages were awarded, it would not recompense them for the loss they had suffered. Damages, also, would not probably be granted, as, although the Act provided for damages being obtained by public bodies, none could be claimed by private persons. Thus he would ask the Board of Trade to place in the provisional order or Bill of the company a clause placing the company in the same position as other trading companies, and giving the public the right to claim damages against the company for breach of contract.

Dr. E. A. FARDON, of the Middlesex Hospital, said the number of lights in the hospital amounted to about 2,000, and they were therefore large consumers. They had been put to serious inconvenience during the past 12 months owing to the light being bad in quality, and, a much more serious thing, owing to its frequent total extinction. Owing to the bad quality, they had been obliged to use a much larger number of lamps in order to obtain the same light as at first. Total failure was a very serious thing in a hospital, and on more than one occasion the light had gone out in the middle of an operation. The grave danger to the person being operated on under these circumstances could easily be imagined. They had always notified the company of these failures, and had always received apologies and explanations, but the occasions were now so frequent as to make one think that sufficient care was not taken to avoid them.

Mr. RITCHIE asked if the light had failed since Dec. 15, and Dr. FARDON replied that it had on separate occasions—viz., Dec. 20 and 23 and on Jan. 7.

Mr. T. W. BAKER, consulting electrical engineer, said that in his capacity as consulting engineer he had heard many complaints as to the bad quality of the light and as to its failure. In one case a voltmeter was fixed, and this often registered as low as 92 volts and sometimes went up to 110 volts.

Mr. PAXTON and Mr. J. LEWIS also spoke as to failures in the light on various dates, these, however, being before Dec. 15.

Mr. RITCHIE then said that the members of the deputation were fully justified in the complaints they had made, both as to the inequality of the supply and the frequency of its failures. Many other complaints of a similar nature had reached the Board of Trade, who had communicated with the company more than once. The company replied that since Dec. 15, when the extension of their works at Willesden had been completed, there had been no ground for complaint. In spite of this letter, however, he had just heard from Dr. Fardon that the light went out on Dec. 20 and 23 and Jan. 7. Mr. Baker had spoken of interruptions on the 8th and 9th inst., and of one on Tuesday. There were also complaints of the quality of the electric light down to a late date. According to admissions made by the company, they were greatly to blame for not having foreseen the development of their business. Inadequate light brought the company as much revenue as a proper supply would, and therefore the consumers had reason to complain. The company had incurred great expense in their new works, but it would be his duty to communicate with them respecting the deputation's contradiction of their statement that the supply had been satisfactory since their completion. Dr. Little had asked the Government to propose a Bill making electric lighting companies liable to damages for breach of contract, but such companies were already as liable as any other trading association. With regard to excessive charges a remedy existed. If complaint were made by a local authority, the Board of Trade could reduce such charges if it saw fit. The Board's regulations required a constant supply, and if it was not given any aggrieved person might take action. Summonses against the Metropolitan Company had been taken out by the Vestry and the Guardians, the cases having been adjourned for three months in order that the company might have time to provide remedies. The Board had not power to compel the company to take a particular course, except as regarded excessive charges. The only real remedy for faults in quality, quantity, regularity, and even price of electricity, was competition. It was never intended that an electric supply company should have a monopoly. Competition might be established either by another company or the Vestry. He was aware that a proposal by the St. Marylebone Vestry to compete with the present company had been rejected in Parliament, but he believed that such complaints as this deputation made were not laid before the committee. Had the facts now known been presented the result would probably have been different. At the present time there was an application to the Board for a provisional order to authorise the formation of another electric supply company in Marylebone, but the Vestry objected on the ground that the space under the streets was already sufficiently occupied with pipes, mains, and sewers.

Dr. FLETCHER LITTLE explained that the real object of the Vestry was to take the electric supply in its own hands, buying out only one company instead of two. The letter to which Mr. Ritchie referred did not correctly represent the Vestry's objection.

Mr. S. CHICK, however, said the majority of the Vestry wanted competition.

Mr. RITCHIE remarked that, whatever might be the true position of the Vestry, this deputation would have done some good by showing how burdensome was the existing state of things, and how necessary it was to find a remedy.

Calvert's Mechanics' Almanack.—The thirty-seventh issue of this almanack is no way behind its predecessors in value—in fact, each year it increases in usefulness. The daily and monthly notes are instructive and interesting, as are also the various essays, tables, and notes on technical matters.

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THE

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TO THE FRONT.

Truly we are a Berserk nation. It is in the blood, and the depth of the country's extremity is the height of her sons' opportunity. If we were to give an opinion of England's greatest need at the present moment, it would be that we require a militant poet, also a militant statesman. We want speakers whose words will stir the hearts and strengthen the spirits—jubilant, fire-eating words, if you like, but naught that is of the croaking or lamely explanatory or excusing nature. So far as inspiring strains from poet or statesman are concerned, all we have had might be calcined in the furnace so far as rousing the national spirit is concerned. The present position is due solely to the temperament of the Anglo-Saxon, and that the country sounds with warlike din is because of the characteristic delight in battle that belongs to the race, and not from any action or word of leaders. The sinew of the country comes forward in the crisis and offers its services—nay, compels its services, though administrative efficiency at the War Office is unknown, nor is that effete establishment able to arm or control the masses of raw material at its command. This is left to private enterprise, to private organisation, and mostly to private purses. However, something more is wanted than mere heads and hands, and at length the officials have accepted the proffered aid of hands controlled by educated brains. If any of the volunteers of the country can claim to be sufficiently educated and capable of utilising the sciences of the century in the interests of the nation, surely the corps is that of the Electrical Engineers. We therefore congratulate the country in that a first detachment of fifty men and five officers have been accepted for the front, and leave as soon as the two sets of apparatus, including signalling and search-light, are complete. The apparatus is specially designed, and will include all and the best of everything that can be of service. Major Crompton is also to be congratulated at the fine body of scientifically-trained men he will have under his command; and now a word for these men, who are leaving home and business to serve their country. They will do all that men can do; and may they be successful in their undertakings, returning safely and with credit to us who are left behind, and who have no greater delight than to be able to call them friends.

OPEN DISCUSSION.

The after-dinner debate on the telephone question at the London Chamber of Commerce dinner on Wednesday last was a great success, and this success was mainly due to the fact that grievances were discussed openly with the engineer of the National Telephone Company. What was needed to make the discussion more complete was a representative engineer from the Post Office, who could have been cross-examined as to the schemes which have been promised since the middle of last year and since kept in the background. We also missed any reference to the supervision by the Post Office of

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the equipment of municipal exchanges. This supervision is practically enforced by the second section of the repurchase clause, No. 29, in the model license. This reads: "No plant shall in any case be considered suitable for the requirements of the telephonic service of the Post Office which has been brought into use without the sanction, in writing, of the Postmaster-General." Subject to such sanction, in writing, of the various parts, the Post Office authorities are obliged to buy up all the municipal exchanges at the expiration of the licenses. The model regulations as to apparatus to be used have as yet not been publicly issued, but at Glasgow considerable friction has been caused by them. Returning to the dinner, the most unanimous decision was the acquittal of the telephone young lady from the charge brought against her of being less efficient than a man would be. On most other points speakers agreed to differ, but all agreed as to the need of more trunk wires throughout the kingdom. The cry for cheaper telephones in London was shown to be subservient to good service, as the subscribers to the model and private telephone station at the Stock Exchange readily pay higher rates than is charged on the larger exchanges. We believe that lower rates are possible with efficient service, but shall strongly oppose any attempt to keep down the first cost by using cheap instruments and a single-wire system. With the extensions of electric tramways and light railways, such a practice cannot be too strongly condemned.

FORTHCOMING EVENTS.

FRIDAY, JAN. 19.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., at Newcastle. Presentation of awards for the fifteenth session; Mr. F. W. Jennings's reply to discussion on his paper on "The Working Stress of Materials used in British Locomotive Construction"; discussion on Mr. C. H. Innes's paper on "Screw Fans"; and paper on "Receiver Drop in Multiple-Expansion Engines," by Prof. R. L. Weighton, M.A.

MONDAY, JAN. 22.

Society of Arts.—At 8 p.m., Cantor lecture, "The Nature and Yield of Metalliferous Deposits," by Mr. Bennett H. Brough.

TUESDAY, JAN. 23.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper on "Swingbridges over the River Weaver at Northwich," by Mr. J. A. Saner, M.I.C.E.

THURSDAY, JAN. 25.

Institution of Electrical Engineers.—At 8 p.m., further discussion of "Report on Institution's Visit to Switzerland"; and, time permitting, a paper on "An Electrolytic Centrifugal Process for the Production of Copper Tubes," by Mr. Sherard Cowper-Coles.

FRIDAY, JAN. 26.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "The Simplon Tunnel," by Mr. C. B. Fox.

Royal Institution.—At 9 p.m., lecture on "Motive Power—High-Speed Navigation—Steam-Turbines," by the Hon. C. H. Parsons.

Institution of Mechanical Engineers.—At 8 p.m., annual meeting. Paper on "Water-Meters of the Present Day," by Mr. W. Schönheyder.

Physical Society.—At 5 p.m., papers on "Some Developments in the use of Price's Guard Wire in Insulation Tests," by Prof. Ayrton and Mr. Mather; "Reflection and Transmission of Electric Waves along Wires," by Dr. E. Barton and Mr. L. Lownds; and "The Frequency of the Transverse Vibrations of a Stretched Indiarubber Cord," by Mr. T. J. Barker.

Electro-Harmonic Society. — At the Café Monico, Smoking Concert.

SATURDAY, JAN. 27.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., at Glasgow, paper on "Dynamo Testing and the Care of Dynamos," by Mr. N. C. Woodfin.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

237. Give the result of actual tests showing the relative fusing currents of copper and tin wire in air and in insulating oil.

238. How would you proceed to work out the area of the cables for a three-phase traction plant, say, for a line 14 miles long, power-house centrally situated, and a sub-station with rotary transformers two miles from each terminus. Provide for a four minutes' headway of eight-ton cars on average gradients of 1 in 50.—MAGNET.

ANSWERS.

Question No. 231.—State the causes of injectors refusing to work properly, and the points to be considered in selecting the proper size.

Best Answer to No. 231 (*awarded* 10*s.*).—In replying to this question it will be better to take the latter portion first—viz., the points to be considered in selecting an injector and fittings of a suitable size. Having settled this point, we will deal with their erection and connection, and finally discuss probable causes of failure and how these may be avoided.

Size of an Injector and Fittings.—The injectors must be of such a size as to ensure the requisite quantity of water being delivered to the boilers under any unfavourable conditions, and therefore must not be selected indiscriminately from a maker's price-list as delivering so many gallons per hour at such and such a steam pressure, but due consideration must be given to any unfavourable circumstances under which this delivery has to be maintained. For instance, in one case the water supply may be obtained from a tank situated at some considerable height above the injectors, whereas in another case the feed may have to be lifted from a depth some feet below the injectors. It is quite clear that a size which would answer admirably in the first case would give, to say the least, but indifferent results in the second. The effect that having to lift as well as deliver the water has upon the delivery of an injector, may be seen from the following figures. An injector delivering a certain number of gallons per hour when working non-lifting, or with only a very small lift, would have its delivery reduced about as follows: for a lift of 6ft., 10 per cent. reduction; for a lift of 12ft., 25 per cent. reduction; for a lift of 18ft., 35 per cent. reduction. Warm feed will considerably reduce the delivery of an injector, as will also the use of wet steam. It is thus evident that the condition under which an injector is working will affect to a great extent its ultimate delivery, and in increasing its size to provide for unfavourable conditions, the size of fittings and pipes must also be increased and care taken to make the latter as short and direct as possible.

Having settled upon the size of fittings, the number required is the next item. The valves for operating the injector are usually self-contained with it, and sometimes, as in the case of the Sirius injector, only one handle is used, which not only turns on steam and water, but also regulates the supply for any pressure. It is advisable to have stop valves in the steam and water supply pipes. These are essential when several injectors are working from common steam or water pipes. A back-pressure valve must be placed on the boiler side of the injector, and a stop valve is also desirable in case of failure of back-pressure valve or removal of injector. When working lifting a foot valve should be employed, as the injector will not then have to lift its water every time it starts, as the

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suction pipe will always be full. A strainer should be placed at the end of the suction pipe when the water is at all gritty. These are the fittings generally required, but some of these may be dispensed with or others required as special circumstances demand.

Erection.—Perhaps the most important point is to select the source of steam supply. This should always be taken direct from the boiler, for, as stated above, wet steam has a most prejudicial effect on the work of an injector. The connecting pipes must be as short and direct as possible, so that the steam may reach the injector at full boiler pressure. All valves, pipes, etc., should be carefully examined to see that they are clear from obstructions, and they should be blown through with steam to remove all grit, scale, etc., before being finally connected up. All joints must be absolutely airtight, and care must be taken in the use of red lead, as if used too generously it is liable to protrude in the inside of the pipe, there causing an obstruction. Care should also be taken to see that washers, etc., do not overlap the passages. The suction pipes, as with the steam-pipes, should be as free from bends and sharp elbows as circumstance will permit. The overflow pipe should be short, so as to allow the overflow to escape freely, although this is not necessary, excepting in the case of high lifts or wet steam. Fig. 1 is a suggestion for connecting up an injector. Of course, these connections must not always be made in the manner shown,

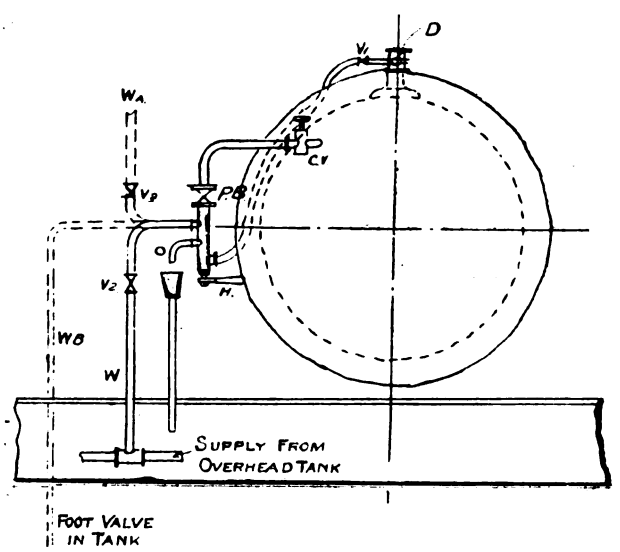
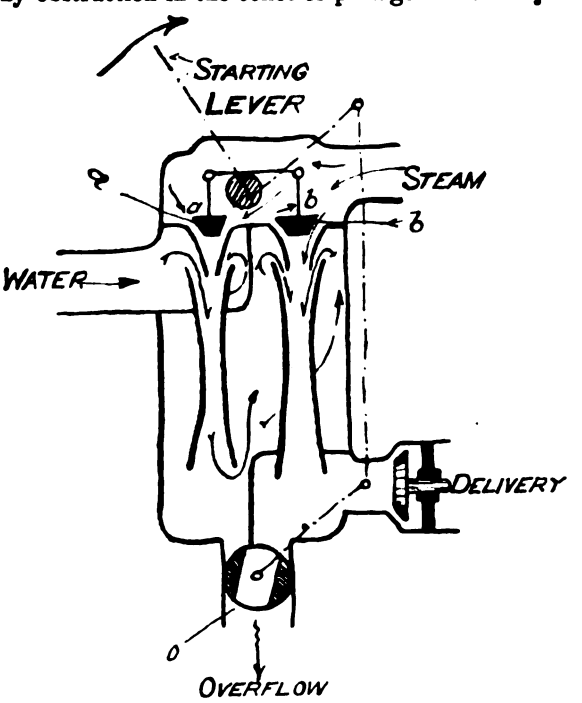


FIG. 1.

the sketch being merely intended as a rough diagram illustrating the necessary valves, etc. In the sketch D is a distance piece, which may be placed under the safety valve at front end of boiler or other convenient position, thus ensuring a dry steam supply. S is the steam-pipe; W, the water-supply pipe, which may be connected, as shown, to a common pipe supplied from an overhead tank, or as W_A, also supplied from an overhead tank, or as W_B, when lifting from a tank underground. O is the overflow pipe, which may be connected as shown, or taken straight down into the pipe, trench, drain, or other position. The advantage of using a short pipe and a funnel as shown is that not only is there a free escape for the overflow, but the boiler attendant is able to see when any overflow is taking place. B P is a back-pressure valve; V, V_2, C V are steam, water, and boiler check valve.

Causes of Failure.—(1) The injector may refuse to work when first connected up, when the reason may be that it has been wrongly connected up, or there is some obstruction in the pipes, or it is not of sufficient size for the work it has to do; (2) the injectors may stop after working some time—one most probable cause, especially if the injector has been working any length of time, is the accumulation of sediment on the cones. Should this be the case, on no account must the sediment be removed by means of emery or a file, as considerable damage may be done to the cones in this way. The sediment should be first of all softened (a solution of muriatic acid will accomplish this) and then removed by a piece of wood. Another cause of failure is due to particles contained in the feed water getting into the suction pipes, and possibly into the injector itself. As stated above, when there is any sign of this a strainer should be used in the tank. The strainer itself sometimes gets stopped up; it may be cleaned out by sending steam through the suction pipe. A leak will sometimes cause trouble; this can be detected by closing the suction and overflow pipes and turning on steam. The foregoing, which are the principal causes of failure, apply equally well to exhaust as well as live-steam injectors.—F. A.

Answer to No. 231 (*awarded* 5*s.*).—Of the various faults which occur in injectors, some are common to all types, whilst others are peculiar to the particular class of apparatus used. The faults to which all injectors are liable are: pitting and choking of nozzles, due to bad water; stoppage of cones, through passage of scale or grit along with the water or steam; throttling of steam, due to badly arranged pipe connections or insufficient opening of valves; steam supplied to the injector too wet; or temperature of feed water too high. Closing the delivery and water valves, and opening steam and overflow valves, thus blowing steam through the apparatus, will usually get rid of any obstruction in the cones or passages of the injector.



If the feed water is too hot, the steam-jet will not be condensed, and steam will blow through the overflow, the injector knocking off.

Lifting Injectors.—Lifting injectors—that is, injectors which have to suck the feed water—will refuse to *start* if the steam and check valves are not tight, as the continual leakage of steam so heats up the apparatus that when steam is turned on the jet cannot create the necessary vacuum to lift the water. If the injector should knock off at any time, steam will blow down the suction pipe and heat up the water lying there. Provision should, therefore, be made for discharging such water, or this may be another cause for the apparatus refusing to start.

Automatic Restarting Injectors.—These will occasionally knock off if the flap valve (if they are of the flap nozzle type) should stick.

Double Tube Injectors.—These apparatus are virtually two separate injectors in series, with the nozzles, cones, and valves placed for convenience in one body, as shown in the diagrammatic sketch. This type of apparatus is made both lifting and non-lifting. The non-lifting type is simpler, as the steam-valves, *a* and *b* (see sketch), are not required. The lifting type is liable to all the before-mentioned troubles, and the steam-valves and overflow valve, *o*, which are all simultaneously controlled by the starting lever, may not move in their proper sequence; but this is a question of adjustment only which depends on the make of injector. When the apparatus is once properly at work, the overflow is permanently closed, and no air passes from this to the boiler, a point of some

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importance, as injectors with open overflows have been known to pass such quantities of air along to the boiler as to vitiate the vacuum on a condensing engine worked off that particular boiler.

Exhaust Steam Injectors.—These have no special faults except where a supplementary live-steam injector is used, where the introduction of moving parts renders them liable to troubles of the nature of those previously described.

As regards the second part of the question, the selection of size is an easy matter, as if the boiler evaporation is known, or can be calculated, reference to any maker's list will indicate the size to take. Most makers recommend the adoption of injectors of such capacity as to leave ample margin, to the extent of one and a-half to twice the maximum evaporation of the boiler. In deciding on the size, the question of type is of some importance, and this depends on the working conditions. The chief points are: required capacity of apparatus; working steam pressure; temperature of feed water; height of suction, if any. If the temperature of the feed water is high—say, 150deg. F.—the water must enter the apparatus with a slight head, and a double-cone injector should be used. With a temperature of from 130deg. to 140deg. F., an injector of this class will, with a suction of 6ft., work satisfactorily. If the height of suction is greater than 6ft. the temperature must be proportionately lower, and a good injector will suck up to 24ft., but the water must then be cold. For locomotive or traction engine work an automatic restarting injector should be employed, as if the action of this apparatus is stopped through jolting it immediately starts again, whereas a non-automatic injector would require manipulation to restart.—H. H. H.

Answer to No. 231 *(awarded* 5*s.).*—Injectors may be divided into two classes—those that work by live steam, and those that work with exhaust steam. Live-steam injectors are of two types—viz., (1) adjusting injectors, in which the cones themselves can be regulated; and (2) non-adjusting injectors, in which the cones are fixed, and the regulation done by external cocks. There is also a self-acting injector which lifts its feed water from depths varying from 4ft. to 18ft. according to the steam pressure and temperature of the water; this class of injector is sometimes termed automatic—they are also made automatic on the lines of the original Giffard type. This last type of injector will only lift their feed if specially made to do so, and are generally found to be provided with a steam spindle. Exhaust injectors may be used in the place of the feed heater, but great care must be exercised to prevent any oil or greasy matter from the engine cylinders being carried into the boiler. If the back pressure of the exhaust is greater than the atmosphere—such as in express locomotive work—an oil separator is necessary between the exhaust pipe and the injector, but if the back pressure is not greater than the atmosphere the separator is not necessary. In fixing injectors, it is imperative that the different pipes shall not be less in diameter than that specified by the makers, and easy bends should be use whenever possible. The steam should be as dry as possible to give the best results, and if the steam-pipe is long, it should be protected against radiation.

Great care should be given to ensure that the cocks and valves are tight, as leakage into the injector is sure to cause a deposit of sediment in the cones, which very quickly chokes up the channels. This is hastened by a steam leakage, as the heat from the steam evaporates the water, and the deposition of sediment goes on at a much more rapid rate. A few weeks of leakage will often completely choke up the cones. Another important point to be considered is the overflow channel, which should be periodically examined and cleaned out if necessary. Should these channels become choked, as they are liable to do with bad water, the injector will not start. The delivery pipe sometimes gets choked up with incrustation when the feed waters are impregnated with salts of lime and magnesia, as boiler feed waters frequently are. Injectors are often returned to the makers when the only fault is that the delivery pipe requires cleaning. When the feed waters are very sedimentary, it is desirable to have injectors fitted with nozzles that can be easily removed for facility in cleaning. The cones should be taken off periodically—internally—but on no account should the metal be removed or the cones filed or dented in any way. A good plan is to soak the nozzles in a solution of one part of muriatic acid to ten parts of water.

If the injector has to lift its water supply, care should be taken to make all joints perfectly airtight. Inattention to this is a frequent source of trouble, as the leakage of air destroys the vacuum, and interferes a great deal with the lifting powers of the injector. All injectors work best and give their highest efficiencies when supplied with cold water, though the best injectors will take their feed water up to 150deg. F., according to the steam pressure. Ordinary or non-automatic injectors cease to work if the water supply be momentarily interrupted or broken, in which case the steam and water supply require to be shut off and the injector readjusted by hand. In the automatic type no readjustment is necessary, as they commence working with full steam on; they therefore require less attention than the ordinary injector.

In selecting a size for an injector it is always desirable to have it large enough; it is better to have it too large than too small, as occasions occur when it is required to fill a boiler up quickly. Relatively a large injector does not require more steam than a small one; in other words, it is as economical at a lower rate of discharge as a small injector. If a large variation in the quantity of feed is desired, an adjusting injector should be employed; non-adjusting injectors can only be relied to give the delivery quoted at the particular steam pressure for which they are made. All injectors fixed to lift their feed give a less delivery according to the height of the lift; a slight lift, such as 3ft., makes very little difference, but with higher lifts the reduction is as follows: a lift of 6ft. reduces the delivery about 10 per cent.; a lift of 12ft. reduces the delivery about 25 per cent.; a lift of 18ft. reduces the delivery about 35 per cent.

It is good policy to fit up two injectors, as the range of any injector is small compared to that of a feed pump, the object being to use one of them only during light and steady work, and both when filling up quickly. This arrangement also provides a stand-by. With pressure below 25lb. there should be no lift, and at low pressures the pipes—steam especially—should be short and free from bends, and of full area throughout. It is well in such cases to describe when ordering. If it is desired to work the injector with exhaust steam from an engine, in order to get the size required first find the quantity of exhaust steam given off by the engine in cubic feet per minute. This is obtained by multiplying the area of the piston in square feet by the piston speed in feet per minute; next refer to the table of quantities of steam required by exhaust injectors—given in text-book—find the size of injector that requires not more than three-quarters of the steam given. This will be the largest size of injector that should be worked by the engine in question. The quantities given in the text-book tables giving the maximum delivery in gallons per hour are only calculated to give that quantity when not lifting; when lifting, correction must be made according to the height of the lift. After the required number of gallons per hour delivered by the injector has been found, refer to the tables, and under the column of the steam pressure you require find the nearest number of gallons to that in question, opposite to which is marked the size of injector and fittings.—J. H. J.

Question No. 232.—In a shop where drum armatures (with bars and end connections) are often brought in for overhaul and repair—maybe rewinding—what is the best method, or methods, for localising defects, particularly that of short-circuited coils or of wrong connecting, before opening up?

Best Answer to No. 232 *(awarded* 10*s.).*—Commencing with the faults of most likely occurrence, we should subject such an armature to the following tests: test for (1) insulation breakdown; (2) short-circuit; (3) loose or badly-connected joints (especial attention should be paid to this when armatures have butterfly type end connections); (4) broken circuit; (5) cross couplings; (6) unequal conductivity of copper. Passing on to the question of how to carry out these tests:—(1) Insulation breakdown: with

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double the running volts of armature, either direct or alternating, test first from commutator to spindle, then from each armature band to commutator; 2, 3, 4, 5, and 6 can be dealt with together. Pass a direct current through the armature under test from side to side (as shown in Fig. 1) with variable resistance in series, measure drop across adjacent (if single-circuit winding) segments with a high-resistance low-reading galvanometer. The necessary current through armature is dependent on the sensitiveness of galvanometer and resistance of armature; if a Weston milli-

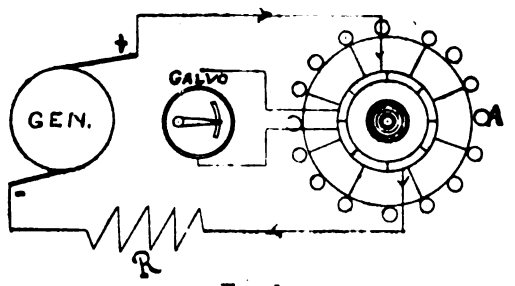

Fig. 1.

voltmeter is used, a very few amperes will suffice to give a good deflection. The drop across the adjacent segments will give all information required about faults (2), (3), (4). If majority of coils give a deflection of, say, six or seven divisions on scale of galvanometer, while one or two others show none, or one or two, these coils, by reason of their having no appreciable drop, have no appreciable resistance, which means they are short-circuited. If, on the other hand, certain coils give much higher deflections than others, it points to loosely-connected end connections, or badly-sweated joints. There is another fault which should be mentioned here, however, which causes trouble in large armatures where stranded or made-up conductors are used. These bars sometimes vary in their relative resistances, and when being tested by the method under discussion show a variation in galvanometer deflection of perhaps only 1 or 2 per cent. This is often put down to bad sweating, which is not the case; so in a large armature of this type, when a fault of this kind is found it is advisable to attach the galvanometer leads to a pair of sharp-pointed awls, which can be pressed through the insulation of the bars at each end without doing any damage, while the relative drop across each bar can thus be taken independent of end connections.

In the case of a broken circuit the current will pass round one side of the armature, but not the other; also, if by mischance the coil with broken circuit was attached to the segments first bridged by galvanometer, the full volts of the circuit would be put across instrument, and if the precaution of having a light fuse attached to galvanometer had not been taken the instrument would probably have been damaged. Wrong couplings in certain cases can be

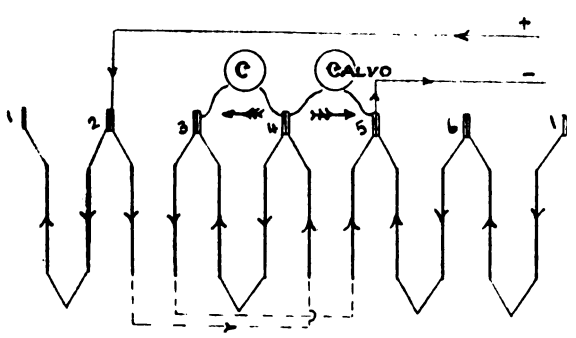

Fig. 2.

found by this method. Such a case is shown in Fig. 2, which gives the coupling of a drum armature spread out flat—with wrong coupling up shown by dotted lines. It is not possible to deal here with all the effects (which may show themselves on the galvanometer) due to wrong connections, especially in a drum armature. In Fig. 2 current enters at 2 and leaves at 5 (commutator segments). The results of wrong connections as shown can best be observed by noticing the deflections that would be given across various segments of the commutator. Notice, also, that when leads are shifted the results will be different, thus making it difficult for operator to spot the points of wrong connection. When the fault consists of a simple cross

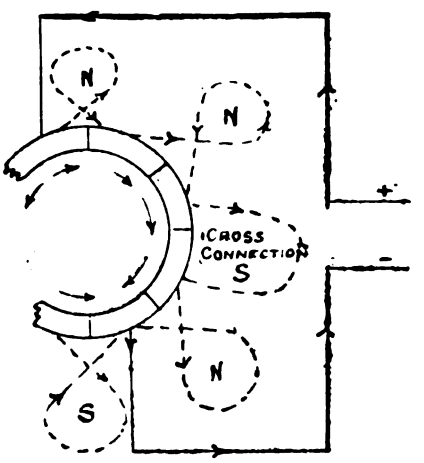

Fig 3.

coupling, as shown in Fig. 3, it cannot be located by this method, and a bottle of glycerine and iron filings must be resorted to, which, if laid along each conductor while carrying current, will show the direction of flow.

With regard to double-circuit armatures and patent windings, the potential drop method described is usually the best for fault location. In the case of a parallel winding, where the insulation between the two has broken down in one or more places, the results on the galvanometer readings are many and varied. The above gives the general lines on which the tests are carried out, however, and the rest must be left to the operator. Finally, one point ought to be mentioned about the galvanometer. This should be of a very high resistance, so that the ratio of the contact resistance (necessarily variable) to the whole should be small; otherwise the accuracy of the readings will be greatly reduced.

Passing on now to the last item, sometimes an armature is sent in for repairs, and there is no field in which it can be run before sending it out again. In such a case it is possible that this armature may pass the galvanometer test, but break down the first time it is run owing to insufficient insulation between conductors. This difficulty is easily overcome by the following method: Pass a low-tension alternating current through the armature with variable resistance in series. The armature will act as a sort of choking coil, and if a suitable current is put through, and it is not designed for a machine of excessively high speed, it can be made to choke back the terminal pressure for which it is designed, which is equivalent to running it in its own field, for if its insulation breaks down from the pressure induced in it a short will occur, which will warm up the coil or coils, which can then be marked and repaired.—L. M.

Answer to No. 232 (*awarded* 5*s.*).—When an armature is sent to be repaired it is often accompanied by only the scantiest description of the fault, and the first thing to do is to find out exactly what is wrong. If a suitable field is obtainable, the best plan is to run the armature for a short time at no load and fully excited, and note whether there is any sparking, and whether any particular sections heat up more than the rest. Also, by making intermittent contact from first one and then the other brush to the frame, see if a serious earth exists. Failing a suitable field, the following test will serve the same end. Pass a current, approximately equal to the full-load current, through the armature from one neutral point on the commutator to the other. Then note the deflections given on an ordinary galvanometer connected across every pair of adjacent commutator plates in turn. If there is no short-circuit (or partial short-circuit) all the deflections will be very nearly equal (provided the current is maintained constant during the test), but a short-circuited section will be at once detected by the greatly reduced throw obtained across it. Another simple method of discovering short-circuits is to pass an alternating current (of about the same voltage as that for which the armature is wound) through the winding from

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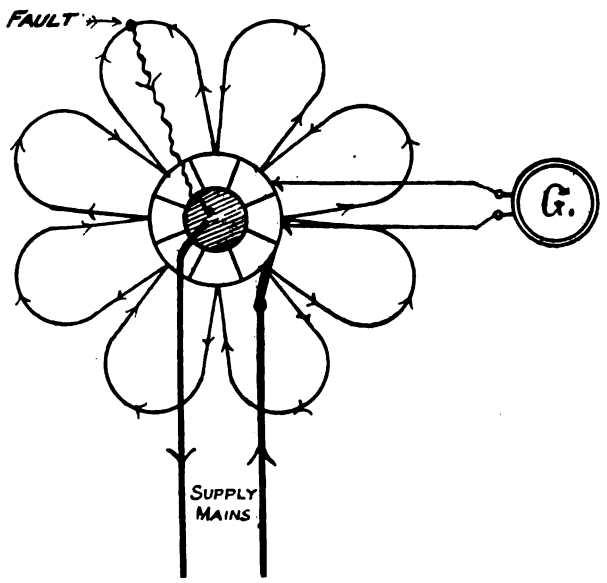
brush to brush for a few minutes. The alternating flux passing through the core will very soon heat up any short-circuited sections sufficiently to make them noticeable by hand. The General Electric Company of America obtain the same result by means of a special laminated magnet excited by alternating current. The poles of the magnet are placed close against the armature winding, at positions at which the magnets would occur when running in its own field, and an alternating flux is passed through the core.



None of the above tests will disclose a "cross-coupled" section. To discover such a fault, if it exists, pass the full-load current (continuous) through the winding, as in the first test above; then pass a small compass needle (or, better still, a glass bottle containing some iron filings held in suspension in glycerine) slowly round the armature over the conductors. The needle will point in one constant direction while passing over all the conductors lying between one neutral point and the next, and will then reverse and remain reversed over all the conductors lying between the next two neutral points. Should a cross-coupled section exist, the needle will also reverse when over that section, and thus serve to detect it.

The above tests will be found explained in more detail in the answers to Question 188 in the *Electrical Engineer* for Aug. 18, 1899, p. 215. If an "earth" (or connection from the winding to the core) is found to exist, it can be located before opening anything up by passing a small continuous current from some external source from any point on the commutator through the fault to the core or spindle of the armature, and taking the deflections over each section with a galvanometer, as in the above first-mentioned test. The deflections will reverse after the point at which the earth occurs has been passed. (See the figure.)—Q.

TELEPHONE LICENSE.

MODEL FORM.

The following is the full text of the general form on which all telephone licenses to local authorities will be granted:

This indenture, made the ....., between the Most Noble Henry, Duke of Norfolk, Earl Marshal and Hereditary Marshal of England, K.G., her Majesty's Postmaster-General (who and whose successors in the office of her Majesty's Postmaster-General for the time being are intended to be hereinafter included in the term "the Postmaster-General") on behalf of her Majesty of the one part, and ..... (who and whose successors for the time being are intended to be hereinafter included in the term "the local authority") of the other part.

Whereas the local authority are desirous of carrying on the business of constructing, manufacturing, maintaining, working, and using within the area defined in the schedule hereto (which area is hereinafter referred to as the "licensed area"), telegraphs, the transmitting and receiving instruments of which consist of telephones, and of letting on hire such telegraphs as aforesaid for the purposes of such working and user as aforesaid (which business is hereinafter referred to as "telephonic business").

And whereas by reason of the provisions of the Telegraph Acts, 1863 to 1897, such part of the telephonic business as is intended to be hereby licensed cannot be carried on without the license or sanction of the Postmaster-General:

And whereas, at the request of the local authority, and in order to enable them to carry on telephonic business in manner hereinafter authorised, the Postmaster-General has agreed to grant to the local authority the licenses, powers, and authorities hereinafter expressed and contained for the period upon the terms and subject to the stipulations and conditions hereinafter appearing:

Now this indenture witnesseth that in consideration of the premises and of the matters hereinafter appearing, it is hereby agreed and declared between and by the parties hereto and the local authority (as to the covenants and agreements hereinafter contained on their part) do hereby covenant and agree with the Postmaster-General and the Postmaster-General (as to the covenants and agreements hereinafter contained on his part) in exercise of all powers and authorities enabling him in this behalf doth hereby covenant and agree with the local authority in manner following—that is to say:

1. In these presents the following words and expressions shall have the several meanings hereinafter assigned to them, unless there be something either in the subject or context repugnant to such construction—that is to say:

The word "telephone" means and includes any telegraphic transmitting or receiving instrument used or intended to be used at any office for the purpose of transmitting or receiving spoken messages or communications by means of electricity.

The expression "telephonic message" means a spoken message or communication transmitted by telephone.

The word "office" means and includes any building or part of a building or any place which is telegraphically connected or intended to be connected either permanently or temporarily by a telegraph wire or telegraph wires with some other building, part of a building, or place (whether such buildings, parts of buildings, or places respectively be occupied or used by any person solely or jointly with any other person), and in which telephones are, or are intended, to be used for the purpose of enabling any person to transmit from and receive at such building, part of a building, or place such telephonic messages as are hereinafter authorised.

The word "exchange" means and includes any building telegraphically connected or intended to be so connected with two or more offices by telegraph wires and used, or intended to be used, for the purpose of enabling telephonic messages to be transmitted direct between such offices by means of, or with the aid of, such wires and by appliances placed in the exchange.

The expression "exchange subscriber" means any person with whom the local authority, the Postmaster-General, or any other person working an exchange has entered into an agreement for the purpose of enabling such person to communicate with other persons through the medium of an exchange.

The expression "exchange system" means an exchange or group of exchanges worked by the Postmaster-General, or situate within an area within which the Postmaster-General has licensed telephonic communication to be carried on by some other person, together with the lines connecting any such exchange with the offices of subscribers or call offices, or in the case of a group of exchanges connecting such exchanges with each other.

The expression "exchange area" used in connection with the National Telephone Company, Limited, means an exchange area as defined by an indenture dated March 25, 1896, and made between the Postmaster-General on behalf of her Majesty of the one part, and the National Telephone Company, Limited, of the other part.

The expression "trunk wire" means a telegraph wire used for telephonic communication and connecting the exchange system of the local authority with another exchange system, no part of which is within the licensed area.

The expression "trunk line" means and includes a trunk wire and all posts, cables, tubes, or other works supporting or containing such wire.

The expression "call office" means an office open to the public for the purpose of the transmission therefrom of telephonic messages over an exchange system or over trunk lines.

The expression "establish telephonic communication" between two offices means to connect such offices with each other by telegraph wires, and the telephones connected therewith, in such manner that telephonic messages may be transmitted from one of such offices to the other, and such expression includes the maintenance of such communication where it already exists.

The expression "on an exchange" when used in relation to an office, means that such office is telegraphically connected with such exchange for the purpose of enabling telephonic messages to be transmitted direct between such office and other

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offices similarly connected with such exchange, or with any other exchange in the same exchange system.

The word "plant" includes works, materials, and plant.

The word "person" includes the local authority and also any other corporation and any joint-stock company and any other association or aggregate of individual persons.

2. (1) Subject to the provisions of this indenture, the local authority shall during the term or period commencing on the ..... day of ..... and terminating on the ..... day of ..... have license and permission from the Postmaster-General (subject as hereinafter provided) to work and use within the licensed area telegraphs of which the transmitting and receiving instruments shall be telephones (but no other kind or description of telegraphs) for the purpose of enabling any person to transmit direct from and receive at any office to and from any other person at any other office telephonic messages (but no other description of telegrams) relating to the business or private affairs of such persons respectively or one of them, and the local authority shall (subject to the provisions of this indenture) have license and permission to receive from all such persons for or in respect of the purchase or hire or maintenance or working or use of the said telegraphs or any part or parts thereof for the purpose aforesaid or for or in respect of the right or permission to transmit or receive, or otherwise in respect of the transmission or receipt of such telephonic messages as aforesaid by means of the said telegraphs, such sums of money or other valuable considerations as shall be agreed upon between the local authority and the said persons respectively. (2) The term "business" used in this article shall not be construed or held to mean or include the business of collecting, receiving, or delivering messages or other communications transmitted, or intended for transmission, by telegraph or any other business of a like kind. (3) All telegraphs used for the transmission of telephonic messages under this indenture shall consist of complete metallic circuits, and shall be of such character and so constructed in all respects as the Postmaster-General may from time to time direct or approve. (4) The local authority may establish telephonic communication between an exchange of the local authority within the licensed area and an exchange subscriber's office situate outside that area, provided that such office is, in the opinion of the Postmaster-General, situate within a reasonable distance of the licensed area. (5) The local authority shall not establish any exchange, or, save as provided in the sub-clause immediately preceding, transact any other kind of telephonic business outside the licensed area.

3. (1) Neither any office, whether in the occupation of the local authority, or of any other person, nor any such telegraphs as aforesaid, nor any part thereof, shall be used by the local authority, or by any other person either on their behalf, or by their permission, for the transmission or receipt of telegrams of any kind, except such telephonic messages as are hereinbefore expressly authorised. (2) No office, or part of any office, in the occupation of the local authority, either solely or jointly with any other person, shall be used by the local authority, or any other person, or be permitted or suffered by the local authority to be used by any other person for the purpose of making any copy, transcript, memorandum, or note of any telephonic message, or of the contents, substance, purport, or effect of any such message received at such office by means of the said telegraphs, or any part thereof—it being the express intention of these presents, and of the license and permission hereby given that no written messages or communication, or any written copy, memorandum, or note of any message or communication, or of the contents, substance, purport, or effect of any message or communication transmitted to any such office as aforesaid by means of the said telegraphs shall be made or taken at, or conveyed from, any such office by any person whomsoever for any purpose whatsoever. (3) The local authority shall make due provision and take all necessary and proper precautions for the observance of the conditions contained in this article by each and every person who may be from time to time or at any time entitled or permitted to use any office in the occupation of the local authority or any part thereof, or the said telegraphs or any part thereof. (4) Nothing in this article contained shall prevent either the sender or receiver of any telephonic message from making a note or memorandum of the purport of such message for the purposes of the business or private affairs of such sender or receiver.

4. (1) No office, whether in the occupation of the local authority or of any other person, shall be used by the local authority or any other person for the collection or delivery of telegrams of any kind. (2) No written message or communication, or written copy, memorandum, or note of any message or communication, or of the contents, substance, purport, or effect of any message or communication transmitted to any office by means of the said telegraphs, shall be delivered from such office or any other office. (3) Subject to the provisions of this indenture no money or other valuable consideration shall, in respect of the transmission or receipt of any telegram by means of the said telegraphs or any part thereof, be or be promised to be paid or given to any person (other than the local authority) entitled or permitted to use the said telegraphs by any other person whomsoever. (4) The local authority shall take all necessary and proper precautions for the observance of the conditions stated in this article, and shall, in entering into every contract or agreement with any person or persons in relation to the aforesaid business of the local authority, make due provision for the summary determination by the local authority of such contract or agreement on breach of any of such conditions by any such person or persons.

5. Where the charges for the establishment of telephonic communication with the office of any exchange subscriber are made with reference to the number of messages transmitted, such subscriber may (notwithstanding anything contained in this indenture) allow the telephones supplied to him to be used by any other person, and may charge for the use of such telephones.

6. In case any person or persons with whom the local authority may make any contract or agreement in relation to telephonic business, or who may be for the time being permitted by the local authority to use at any office the said telegraphs or any part thereof for the purposes hereinbefore authorised, shall at any time during the continuance of these presents use any office or the said telegraphs or any part thereof respectively for any purpose or by any means or in any manner other than as hereinbefore expressly authorised and according to the conditions hereinbefore declared, the following provisions shall apply: (1) the local authority shall forthwith determine any such contract or agreement with or withdraw such permission from any and every such person so using such office or the said telegraphs or any part thereof; (2) if such office belong to or be occupied by such person either solely or jointly with any other person or persons, the local authority shall forthwith disconnect such office from any other office which is or may be telegraphically connected therewith by means of their aforesaid telegraphs; (3) the local authority shall give notice forthwith to the Postmaster-General of such determination of contract or agreement or withdrawal of permission as the case may be, together with full particulars of the reasons for the same; and (4) the local authority shall not without the special license and authority of the Postmaster-General re-establish telephonic communication between such office and any other office or enter into any other contract or agreement with such person in relation to telephonic business or permit him to use the said telegraphs at any other office.

7. (1) The local authority shall not at any time use or permit or suffer to be used for any of the purposes of these presents or any of the licenses, powers, or authorities hereby granted any telegraph of the kind or description hereby licensed, or any part of any such telegraph (*a*) which has been supplied to, or has come into the possession of any person otherwise than by purchase, hire, or loan from the local authority; or (*b*) in respect of which, or of the purchase, or hire, or maintenance, or working, or user, or right of user of, or permission to use, which any money or other valuable consideration has been given or agreed to be given to the local authority before such telegraph or part of such telegraph as aforesaid was telegraphically connected with the aforesaid telegraphs of the local authority, or has been given or agreed to be given to any person other than the local authority either before or after the execution of these presents, unless and until the local authority shall have given notice in writing to the Postmaster-General of their desire to use such telegraph or part of such telegraph as aforesaid three clear days at least before the user thereof. (2) Until such notice has been given, no such telegraph or part of such telegraph shall be deemed to be within the license and permission granted by these presents, and from and after the expiration of such notice the local authority may work and use such telegraph or part of such telegraph as aforesaid in the same manner as any other telegraph or part of any telegraph hereby licensed, subject on the part of the local authority to the payment of the royalty hereinafter mentioned in respect thereof, and to the observance and performance of the several covenants and conditions herein contained affecting the same.

8. (1) Unless unable (after exercising all powers in that behalf vested in them) to execute and maintain the necessary works in that behalf, the local authority shall at any time and from time to time at the request of the Postmaster-General and at the cost and expense of the local authority establish telephonic communication between any exchange of the local authority and any post office (situate within a radius of one mile from such exchange) which the Postmaster-General may from time to time specify in that behalf (which post office is hereinafter referred to as a "prescribed post office") and shall maintain such communication until otherwise requested by the Postmaster-General. (2) The number of telegraph wires and of telephones necessary to establish telephonic communication under the preceding subclause of this article shall be such and telephonic communication shall be established in such manner as the Postmaster-General may from time to time prescribe. (3) The Postmaster-General may at any prescribed post office establish a call office on any exchange of the local authority, provided that the use of such call office for communications to subscribers to the exchange of the local authority shall be subject to such charges

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as are for the time being made at other call offices of the local authority.

9. (1) Where and so long as telephonic communication is established between an exchange and a prescribed post office the Postmaster-General and the local authority shall respectively do all such acts and things as may be necessary to enable telephonic messages to be transmitted—(*a*) between any two offices on such exchange; and (*b*) by means of the trunk wires of the Postmaster-General between any office on such exchange and any office on any other exchange system (whether belonging to the Postmaster-General, to the local authority, or to any other licensee of the Postmaster-General). (2) Where and so long as telephonic communication is established between an exchange and a prescribed post office, the Postmaster-General will receive a telephonic message from any office on such exchange: (i.) at the prescribed post office for any of the following purposes—that is to say (*a*) for transmission over the postal telegraphs and delivery as a telegram; or (*b*) for delivery as an express letter; or (*c*) for conveyance and delivery as an ordinary letter; and (ii.) at any post office with which the prescribed post office is telephonically connected for delivery as an express letter. And the local authority and the Postmaster-General will respectively do all such acts and things as may be necessary to enable such telephonic messages to be received at such post offices as aforesaid, and to be so transmitted, conveyed, and delivered as aforesaid. (3) Where and so long as telephonic communication is established between an exchange and a prescribed post office, the Postmaster-General will receive at such post office any message from an exchange subscriber calling for the service of a Post Office express messenger, and the local authority and the Postmaster-General will respectively do all such acts and things as may be necessary to enable such messages to be received and to comply with such requests respectively. (4) Where and so long as telephonic communication is established between an exchange and a prescribed post office, the local authority shall, if and when required by the Postmaster-General, and on such conditions as may from time to time be prescribed by him, do all such acts and things as may be necessary to enable telegrams received at the prescribed post office over the postal telegraphs, and addressed to an exchange subscriber to be telephonically transmitted (in lieu of delivery by messenger) through the medium of the exchange to the office of such subscriber provided such subscriber desire such transmission, but the Postmaster-General shall not be bound to transmit any such telegrams in manner aforesaid.

10. The transmission of all telephonic messages over trunk wires or exchange systems of the Postmaster-General, or over any other postal telegraphs, the receipt of telephonic messages at post offices in accordance with the provisions of this indenture for the purposes therein specified, the transmission and delivery of telephonic messages (whether as telegrams or as letters) and the supply of Post Office express messengers in compliance with telephonic messages in that behalf, shall be subject in all respects, both as to charges and otherwise, to the regulations made by the Postmaster-General with the consent of the Treasury and in force for the time being in respect to the several matters aforesaid, and in such other rules and conditions not inconsistent with such regulations as the Postmaster-General may from time to time prescribe.

11. The prices to be charged by the local authority for the services hereinafter in this article mentioned shall not exceed the maximum sums or fall below the minimum sums hereinafter mentioned with respect to such services respectively (that is to say):

Service.	Maximum charge.	Minimum charge.
For the establishment of telephonic communication between any exchange and the office of any exchange subscriber ...		
For the transmission of messages of the subscriber to any office on an exchange in the exchange system of the local authority—		
For the first ..... messages		
For every subsequent message		
For the transmission of a message from a call office to any other office on an exchange in the exchange system of the local authority.....		

Provided always that the local authority may with the consent in writing of the Postmaster-General charge other prices than those specified in this article.

12. If the local authority at any time under the powers conferred by the Telegraph Act, 1899, and the order of the Postmaster-General made thereunder with the approval of the Treasury, and dated Sept. 26, 1899, requests the National Telephone Company, Limited, to afford facilities for the transmission of messages between persons using the system of the local authority and persons using the system of the company in the licensed area, or between persons using the system of the local authority and persons using the system of the company in the whole of the company's exchange area, of which the licensed area is part (as the case may be), then (*a*) the local authority shall afford similar facilities for such transmission; and (*b*) the local authority may make such terminal charges where the message originates on an exchange of the company as are prescribed by the aforesaid order of the Postmaster-General, but shall not make any higher charges.

13. In case the Postmaster-General should hereafter establish an exchange system within any part of the licensed area, and the Postmaster-General should request the local authority to afford facilities for the transmission of messages between persons using the system of the local authority and persons using the system of the Postmaster-General, the local authority shall afford such facilities on such terms and conditions as may in case of difference be settled by arbitration.

14. (1) Where a telephonic message is transmitted over the trunk wires of the Postmaster-General between an office on an exchange of the local authority and an office on an exchange of the National Telephone Company, Limited, such message shall be subject to the following charges (hereinafter called "terminal charges"), in addition to the Postmaster-General's charge for the use of the trunk wires—viz.: (*a*) where the message originates on the exchange of the local authority to such charges (if any) as the company may from time to time fix; and (*b*) where the message originates on the exchange of the company to such charges (if any) as the local authority may from time to time fix: provided that the charges fixed by the local authority shall in no case exceed the following charges—that is to say: where the Postmaster-General's charge for the use of a trunk wire does not exceed 1s. 6d., a charge of 3d.; where the Postmaster-General's charge for the use of a trunk wire exceeds 1s. 6d., but does not exceed 3s., a charge of 4d.; where the Postmaster-General's charge for the use of a trunk wire exceeds 3s., a charge of 6d. And provided that if at any time the National Telephone Company, Limited, abstain from making terminal charges on messages originating on the exchanges of the local authority, the local authority shall so long as such abstention continues make no terminal charges on messages originating on the exchanges of the company. (2) Where a telephonic message is transmitted over the trunk wires of the Postmaster-General between an office on an exchange of the local authority and an office on an exchange of the Postmaster-General, no terminal charge shall be made by the local authority or by the Postmaster-General in respect of such transmission. (3) Where a telephonic message is transmitted over the trunk wires of the Postmaster-General between an office on an exchange of the local authority and an office on an exchange of some licensee of the Postmaster-General other than the local authority or the National Telephone Company, Limited, no terminal charge shall be made by the local authority in respect of such transmission.

15. (1) Where, in establishing telephonic communication between an exchange of the local authority and a prescribed post office, the local authority have erected any wires upon or supplied any wires or apparatus for use within such post office, all such wires and apparatus shall be under the sole care and management of the Postmaster-General, but the local authority shall reimburse the Postmaster-General the expense of all such repairs of such wires and apparatus as he in his discretion may think necessary from time to time, and the local authority shall at the request of the Postmaster-General from time to time renew such apparatus. (2) The Postmaster-General shall make no charge to the local authority for working the wires and apparatus of the local authority placed in prescribed post offices for the purpose of establishing telephonic communication with exchanges of the local authority.

16. (1) Except where such sums as hereinafter mentioned are in the first instance paid at a prescribed post office, the local authority shall pay to the Postmaster-General all sums due to him in respect of telephonic messages transmitted through an exchange belonging to the local authority to a post office and thence transmitted, conveyed, or delivered as telegrams or letters and in respect of the use of the Postmaster-General's trunk lines, and of communications with any subscriber on an exchange of the Postmaster-General, and of the services of Post Office express messengers rendered in pursuance of any such messages, and shall also pay to the Postmaster-General all sums due to any licensee of the Postmaster-General other than the local authority in respect of telephonic messages transmitted from an office on an exchange belonging to the local authority. (2) The Postmaster-General shall collect and account to the local authority for all charges payable at any call office established at a prescribed post office so far as such charges relate to communications with subscribers to the exchange of the local authority, and the Postmaster-General shall also collect and account to the local authority for all sums payable by any subscriber on an exchange of the Postmaster-General, or by any licensee of the Postmaster-General other than the local authority, in respect of telephonic messages transmitted from an office on an exchange of the Postmaster-General, or of such licensee to an office on an exchange of the local authority, but the Postmaster-General shall not be responsible for any such charges or sums as aforesaid which he is unable to collect. (3) The Postmaster-

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General shall allow to the local authority and the local authority shall allow to the Postmaster-General (as the case may be) a commission of 5 per cent. upon all sums paid by the local authority to the Postmaster-General or collected by the Postmaster-General on behalf of the local authority respectively as provided by this article. (4) Any such sum of 5 per cent. may be deducted either by the Postmaster-General or by the local authority from any sums payable to the local authority or to the Postmaster-General as the case may be. (5) In reckoning the commission payable to the local authority every telephonic message transmitted as a foreign telegram shall be reckoned as though it were an inland telegram not exceeding 12 words in length, and the sum upon which commission is allowed to the local authority in the case of a telephonic message transmitted to any place abroad shall be the sum to which the Postmaster-General is entitled in respect of such message in account with any foreign government. (6) All accounts between the Postmaster-General and the local authority relating to the provisions of this article shall be rendered and settled monthly, and the first accounts shall be rendered at the expiration of the first calendar month after the ..... day of ..... and shall include the whole period which has elapsed from that day until the end of such month.

17. In addition to all other moneys which may become payable to the Postmaster-General under these presents, the local authority shall pay to the Postmaster-General the following moneys, hereinafter called royalties (that is to say): (1) The local authority shall pay to the Postmaster-General a royalty equal to 10 per cent. of the gross amount of every sum of money paid or payable by any person to or on behalf of the local authority for or in respect of any telegraph of the kind or description hereby licensed, or for or in respect of any office occupied by the local authority or otherwise in respect of telegraphic messages transmitted by means of any such telegraph or otherwise howsoever in relation to any such telegraph, and whether such sum of money be a gross sum or be payable periodically or by instalments, and every such royalty shall become due so soon as the sum of money in respect of which it is payable or by the amount of which it is regulated shall be paid or shall by virtue of any express or implied contract or otherwise be payable whichever event shall first happen. (2) (*a*) In case any person should give to or confer upon the local authority any valuable consideration or benefit (not being money, or a contract solely for the payment of money) for or in respect of any such telegraph, or for or in respect of any office occupied by the local authority, either solely or jointly, or otherwise in respect of telegraphic messages transmitted or received by means of any such telegraph, or otherwise howsoever in relation to any such telegraph, the local authority shall pay to the Postmaster-General a royalty equal to 10 per cent. of the value in money of such consideration or benefit; (*b*) for the purpose of estimating the amount of such last-mentioned royalty, the value in money of such consideration or benefit shall be determined by the certificate of such officer of the Post Office as the Postmaster-General shall appoint for that purpose, or in case of dispute by arbitration, as hereinafter provided; (*c*) such royalty shall be payable and paid at such time or times, and by such instalments, and generally in such manner as the Postmaster-General shall appoint, and shall be payable, in addition to such royalty or royalties (if any) as shall be payable in respect of such person under the stipulations hereinbefore contained. (3) In case any sum of money be paid or payable to or other valuable consideration or benefit be given to or conferred upon the local authority by any person or persons for or in respect of any telegraph maintained or used solely for the transmission of telegrams which are by law excepted from the exclusive priviloges of the Postmaster-General (hereinafter for brevity styled a "private telegraph"), in addition to any sum of money paid or payable or other valuable consideration given to or conferred upon the local authority by the same person or persons for or in respect of any telegraph of the kind or description hereby licensed, the Postmaster-General may at his option apportion such sums or other valuable considerations respectively either in whole or in part between the said private telegraph and such other telegraph as aforesaid in such manner or in such proportions as he may deem fit and proper, and thereupon such sums or other valuable considerations respectively as he shall apportion accordingly shall, as between the local authority and the Postmaster-General for the purposes of these presents, be deemed to be the sums or valuable considerations respectively paid or given by such persons as aforesaid in relation to such private telegraph and such other telegraph as aforesaid respectively in lieu of the sums or valuable considerations actually paid or given by such persons in relation to such telegraphs respectively. (4) In case the local authority shall, as hereinbefore provided, use or permit or suffer to be used for any of the purposes of these presents or any of the licenses, powers, or authorities hereby granted any telegraph of the kind or description hereby licensed or any part of any such telegraph (*a*) which has been supplied to or has come into the possession of any person otherwise than by purchase, hire, or loan from the local authority, or (*b*) in respect of which any money or other valuable consideration has been given or agreed to be given to the local authority before such telegraph or part of such telegraph as aforesaid was telegraphically connected with the aforesaid telegraphs of the local authority, or has been given or agreed to be given to any person other than the local authority either before or after the execution of these presents, the local authority shall pay to the Postmaster-General such a royalty in respect thereof as under all the circumstances of the case shall be fair and reasonable, and the amount thereof shall be determined by the certificate of such officer of the Post Office as the Postmaster-General shall appoint for that purpose, or in case of dispute by arbitration as hereinafter provided, and shall be payable and paid at such time or times and by such instalments and generally in such manner as the Postmaster-General shall appoint. (5) Nothing herein contained shall entitle the Postmaster-General to receive any royalties from the local authority on any money or other valuable consideration received by the local authority on the sale of any telegraph which the local authority after such sale do not work or use under this indenture, it being the intention of these presents that all royalties payable to the Postmaster-General in respect of any such telegraph shall be paid by the person working or using the same: provided always that the local authority shall seven days, at least, before any such sale of any such telegraph as last aforesaid deliver a notice in writing of such intended sale at the General Post Office in London, and such notice shall contain the name, address, and occupation of the intended purchaser or purchasers of such telegraph and also full particulars of the offices intended to be connected by means thereof. (6) In this article payments made or considerations or benefits given "for or in respect of any telegraph" mean and include payments made or considerations or benefits given for or in respect of the purchase, or hire, or maintenance, or working, or user, or right of user of, or permission to use, any such telegraph or any part thereof; and payment made or considerations or benefits given "in respect of an office" mean and include payments made or considerations or benefits given in respect of the user, or right of user of, or permission to use any such office or any part of such office.

(*To be continued.*)

COMPANIES' MEETINGS AND REPORTS.

BLACKPOOL, LYTHAM, AND ST. ANNES TRAMWAYS.

An extraordinary meeting of shareholders was held on the 16th inst. in Manchester, for the purpose of approving a Bill now pending in Parliament, the objects of which are to authorise the Company to construct tramways in substitution for the existing tramways, and for other purposes.

Mr. A. W. Carrington, who presided, said it was intended to obtain parliamentary powers to double the existing line throughout the whole length from the boundary of the borough at Blackpool to the termination of the line at Lytham, and to increase the rate of speed from eight to twelve miles per hour, or any medium rate that might be sanctioned by Parliament; further, to make arrangements with the Blackpool Corporation for running powers over the Corporation lines up to the present terminus at North Shore; also to obtain powers to substitute the present motive power with any other power the directors might think fit. It was not anticipated that the cost would be great, and as to the desirability of obtaining powers to carry out the scheme he thought there could be no two opinions.

Mr. J. C. Walker, solicitor to the Company, in reply to questions, said opposition from the Corporation was anticipated, but the Company hoped to be able to overcome it. No notice of opposition had yet been deposited, but ample time yet remained. It was not intended to lay any other lines in the borough of Blackpool; they only proposed to lay double lines outside the borough.

On the motion of the **Chairman,** seconded by **Mr. Higginbottom,** a resolution was adopted unanimously consenting to the promotion of the Bill in Parliament.—*Leeds Mercury.*

SALFORD TRAMWAYS.

The Tramways Committee of the Salford Town Council are pushing forward as quickly as possible a scheme for a service of electrical tramways on the present horse tramways, and also for necessary extensions. Mr. E. Hatton, of Liverpool, has been appointed tramways engineer, and has prepared a report, which appears in the *Salford Chronicle* as follows:

In accordance with the resolution of your committee of Dec. 5, I have, after due and careful consideration, prepared the following estimate of costs for extending and reconstructing the present tramway routes and electrically equipping same, such electric equipment terminating at the section boxes.

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Estimate of Capital Outlay.—Cost of Track Construction per mile.

160 tons of 102lb. girder rails at £7. 10s. per ton...	£1,200	0	0
234 joints, including fish and sole plates and bolts, at 13s. 3d. each	155	0	6
528 tie-bars at 2s. 1½d. each	56	2	0
602 copper bonds	98	15	0
Fixing ditto	22	10	0
Bending, cutting, and drilling rails, etc.	100	0	0
Laying, lighting, watching charges, and use of tools	307	12	6
Cost per mile	£1,940	0	0
34·4 miles of single track at £1,940 per mile	£66,736	0	0
Special work—*i.e.*, points and crossings for the whole route..	7,000	0	0
Special work—*i.e.*, built diamond and square crossings for the whole route	2,750	0	0
Cost of shed at rail depôt, inclusive of tools	2,700	0	0
Three miles of macadam roads replaced with paving—*i.e.*, excavation and foundations	3,390	0	0
Paving (new setts)	7,800	0	0
31·4 miles of existing paving taken up, redressed, and relaid with new setts where necessary, including new foundations—*i.e.*, excavation and foundations	32,970	0	0
Repaving, etc., with new setts where necessary	47,100	0	0
5·7 miles setting back kerbstones, and flagging, etc., as per borough engineer's estimate, £800 per mile	4,560	0	0
Allow for cost of temporary tramways and other incidentals	4 000	0	0
	£179,006	0	0
Add for contingencies, 7½ per cent.	13,425	0	0
	£192,431	0	0
Credit value of old material	5,070	0	0
To summary (No. 1)	£187,361	0	0
500 centre poles and brackets with provision for electric light, at £16	£8,000	0	0
900 side poles for span wires or side arms at £14	12,600	0	0
Fixing 1,400 poles	2,800	0	0
Span wires, insulators, trolley wires, guard wires, pull-offs, junctions, sections, connections, etc., erected complete	16,500	0	0
Add for contingencies, 7½ per cent.	2,992	0	0
To summary (No. 2)	£42,892	0	0
100 motorcars now purchased, at £540 per car	£54,000	0	0
50 motorcars, at £600	30,000	0	0
Six rail-cleaning and watering cars adapted to be used for snow-ploughs, if necessary, at £350	2,100	0	0
Two ladder and crane cars for overhead repairs, £150	300	0	0
One breakdown car, with fittings	250	0	0
	£86,650	0	0
Add for contingencies	8,665	0	0
To summary (No. 3)	£95,315	0	0
Land for central depôt, and for shed at Weaste, 12,600 yards	6,360	0	0
Land for extensions, 5,000 yards	2,500	0	0
Land for workshops at central depôt, 3,000 yards..	1,500	0	0
Land for rounding off corners	4,000	0	0
Car-shed, to accommodate 180 cars	40,000	0	0
Workshops at central depôt	9,000	0	0
Tools and fittings in workshops	6,250	0	0
Waiting-rooms, offices, and messrooms	6,250	0	0
	£75,800	0	0
Contingencies, etc., 10 per cent.	7,580	0	0
To summary (No. 4)	£83,380	0	0

Summary.

No. 1. 34·4 miles of tramways, as herein set forth.	£187,361	0	0
No. 2. Poles, span wires, etc.	42,892	0	0
No. 3. Tramcars	95,000	0	0
No. 4. Land and buildings	83,380	0	0
	408,948	0	0
No. 5. Legal and professional expenses	5,805	0	0
Total amount	£414,753	0	0

ERNEST HATTON, Tramways Engineer.

A supplementary report has also been drawn up by the chairman of the Tramways Committee (Alderman Linsley), and is as follows:

The above estimates have been carefully considered and approved by your committee, and are now recommended to the Council for adoption. The item No. 1 in the summary, £187,361, is a part of the sum of £250,000 already authorised to be borrowed by the Corporation by Section 82 of the Salford Corporation Act, 1899, "for and in relation to the construction of the tramways," without the sanction of the Board of Trade being applied for. The items Nos. 2, 3, 4, and 5 in the summary, amounting to £227,392, form a portion of the moneys authorised to be borrowed under the same section with the sanction of the Board of Trade, and the Council are therefore recommended to direct an application to be made for sanction accordingly.—HENRY LINSLEY, Chairman.

It may be mentioned that there are among the contracts entered into one for the supply of 100 cars, each containing two 25-h.p. electric motors from the Westinghouse Electrical Company, and one for the supply of 5,000 tons of steel rails, to be delivered monthly, from the Leeds Steel Company. The Tramways Committee have asked for the delivery of six cars for the Cross-lane route by the end of June next, by which time it is hoped that the trams on this route will be ready for running. Negotiations are proceeding with the Manchester Corporation with reference to the terminus in Deansgate, and the necessary running of the Salford trams in that portion of the city, and it is believed that an amicable and satisfactory arrangement will be made in this respect.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Sunderland.—The Corporation invite tenders for tramways switchboard. Tenders by Jan 26.

Wood Green.—The Urban District Council invite tenders for the construction of refuse destructor cells or furnaces. Tenders by Feb. 8.

Bechi (Province Castellon, Spain).—The Municipality invite tenders for the electric lighting of the borough for six years. Tenders by Jan. 25.

Tunbridge Wells.—The Corporation invite tenders for a 400-kw. steam alternator. Tenders by Jan. 25. Full particulars in our advertisement columns.

Aspeitia (Province Guipozcoa, Spain).—The Municipality invite tenders for the electric lighting of the borough for five years. Tenders by Jan. 25.

Tynemouth.—The Corporation invite tenders for the supply and delivery of electricity meters. Tenders by Jan. 31. Full particulars in our advertising columns.

Belfast.—The Electric Committee invite tenders for the supply and erection of 400-kw. steam dynamos. Tenders by Feb. 8. Particulars in our advertising columns.

Glasgow.—The Corporation invite tenders for the supply and fitting-up of a hydraulic or electric lift. Tenders by 29th inst. Full particulars in our advertising columns.

Tunbridge Wells.—The Corporation invite tenders for two Lancashire boilers for their electricity works. Tenders by Feb. 5. Full particulars in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply and erection of two overhead electric travelling cranes. Tenders by Feb. 5. Full particulars in our advertising columns.

Monforte (Province Alicante, Spain).—The Municipality invite tenders for the electric lighting of the borough for 10 years. Particulars may be seen at this office. Tenders by Jan. 23.

Stoke-upon-Trent.—The Guardians invite tenders for the proposed electric lighting of a portion of the workhouse premises. Tenders by Feb. 15. Full particulars in our advertisement columns.

Aberdeen.—The Electric Lighting Committee invite tenders for the supply of one 420-kw. direct-coupled continuous-current dynamo. Tenders by 22nd inst. Particulars in our advertisement columns.

Bradford.—The Tramways Committee invite tenders for the complete electrical overhead equipment of about eight miles of tramway. Tenders by Feb. 3. Full particulars in our advertising columns.

Hull.—The Electric Lighting Committee invite tenders for the supply and erection of 30 cast-iron street section pillars, each containing eight switch fuses, etc. Tenders by Jan. 24. Particulars in our advertising columns.

Great Yarmouth.—The Corporation invite tenders for the supply and erection of two water-tube boilers (Section A); three 200-kw. continuous-current steam dynamos (B) Tenders by Feb. 15. Full particulars in our advertisement columns.

Morecambe.—The Urban District Council invite tenders for the construction of a four-cell refuse destructor, to be erected adjoining the electric light generating station. Particulars can be obtained from the Council's Surveyor. Tenders by Jan. 23.

Barking Town.—The Urban District Council invite tenders for the supply and erection of two continuous-current transformers and switch gear and underground cables and roadwork. Tenders by Jan. 23. Full particulars appear in our advertising columns.

Yarmouth.—The Town Council invite tenders for the supply of about 800 tons, or thereabouts, of steel girder tramway rails, of from 80lb. to 90lb. per yard, deliveries to commence not later than June 1, and the whole to be delivered on or before Sept. 1, 1900. Tenders by Jan. 30.

Portsmouth.—The Corporation invite tenders for 12 months' supply of electrical goods, etc., from April 1 next. Tenders are to

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be endorsed "Stores Tender," and to be forwarded to the Superintendent, Electric Light Station, Gunwharf-road, Portsmouth, not later than Feb. 10.

West Hartlepool.—The Corporation invite tenders for wiring and fitting-up the public library for electric light. Plans, etc., may be obtained from Mr. H. F. Friedrichs, borough electrical engineer, Electric Light Station, Burn-road, West Hartlepool. Tenders by 23rd inst.

Newcastle-upon-Tyne.—The Corporation invite tenders for the laying down in Newcastle of about 11 miles of double-line tramway, the rails and fastenings and the poles being supplied by the Corporation. Specifications, etc., may be obtained from the City Engineer, Town Hall, Newcastle. Tenders by Jan. 24.

Keighley.—The Corporation invite tenders for the supply and erection of two Lancashire boilers, with mechanical stokers, economisers, feed pumps, etc.; and 120-kw. and 200-kw. high-speed direct coupled steam dynamos for continuous current. Tenders by Feb. 13 Full particulars in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of tramways switchboard. Specifications and forms of tender can be obtained of Mr. J. F. C. Snell, borough electrical engineer, at his office, Dunning-street, Sunderland, on payment of two guineas. Tenders to Mr. Fras. M. Bowey, town clerk, by 12 noon on 26th inst. Details in advertisement columns.

West Ham.—The Guardians of West Ham Union invite tenders for (1) supply and erection of the plant, etc., for the electric lighting of the workhouse and school premises at Union-road, Leytonstone, Essex, (2) erection of the engine and battery house for same. Plans and specifications may be inspected at the Clerk's Office. Tenders by 4 p.m. on Feb. 7.

Glasgow.—Tenders are invited by the Corporation for supplying and erecting electric motors and shafting for laundry machinery, as also electric motors and shafting for mechanical stokers, elevator, and conveyor required at Ruchill Fever Hospital. Specifications, etc., may be obtained at the Offices of Public Works, City Chambers, 64, Cochrane-street. Tenders by Jan. 24.

Middleton (Lancs.).—The Corporation invite tenders for the building of electricity works, in accordance with plans and specifications prepared by Messrs. Lacey, Clirehugh, and Sillar, electrical engineers to the Corporation, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Plans, etc., may be obtained from Mr. Frederick Entwistle, town clerk, Town Hall, Middleton. Tenders by Feb. 14.

Plymouth.—The Plymouth Corporation is prepared to receive tenders for 500 kw. high-speed steam dynamo and motor-generator; 500-kw. high-speed steam alternator (disc armature); 200 accumulator cells for 1,680 ampere-hours capacity; four Lancashire boilers, with mechanical stokers, piping, ejector condensers, valves, economiser; high and low pressure paper-insulated and lead-covered mains, etc. Tenders by Jan. 31. Full particulars in our advertisement columns.

Beira (Portuguese East Africa).—The Companhia de Mocambique invite tenders for laying down the necessary plant for lighting and supplying with electricity the town of Beira (Portuguese East Africa), including the monopoly for the working of same for a period of 25 years from the date of the signing of the contract. Full particulars with regard to terms, etc., may be obtained at the offices of the Company, 12, Austinfriars, London, 45, Rua do Alecrim, Lisbon, and 7, Rue Lafayette, Paris.

Melbourne (Victoria).—The Corporation invite tenders for the supply and delivery of the necessary plant, and the superintendence of its erection, and of the carrying out of the work in connection with the electric lighting of the city, to specifications as follows: (1) boilers (dry-back or water-tube type, with superheaters) and economiser; (2) steam-engines, dynamos, equaliser, booster, and switchboard; (3) feeders, mains, and arc light leads, with all bitumen or insulating material; (4) accumulators. Specifications, etc., can be obtained from the Agent-General for Victoria, 15, Victoria-street, Westminster, London, S.W., on and after the 28th instant, on payment of £1. 1s. for each specification, to be returned on receipt by the Corporation of a bona fide tender. The specifications and drawings may be seen at (but not obtained from) the office of Dr. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders by March 1. Full particulars appear in our advertising columns.

RESULTS OF TENDERS.

Walsall.—The following tenders have been accepted: Messrs. Bumsted and Chandler, for supplying an additional engine for the electric lighting works, £980; Messrs. Thomas Parker, Limited, for supplying a new dynamo, £924.

London.—The Metropolitan Asylums Board have received the following tenders:

Electricity meters.

Siemens Bros., Woolwich, Kent*	£30	0	0
General Electric Company, 69-71, Queen Victoria-street, E.C.	33	0	0
Nalder Bros. and Thompson, Limited, 34, Queen-street, E.C.	33	12	6

Engineer's approximate estimate, £40.

Electrical wall-plug covers.

Hayward Tyler and Co., 90 92, Whitecross-street, E.C.*	10	18	10
Tylor and Sons, 2, Newgate-street, E.C.	17	15	7
A. P. Lundberg, Bradbury-street, Kingsland, N.	20	18	6

Engineer's approximate estimate, £15.

* Recommended for acceptance.

Hammersmith.—The Vestry have received the following tenders for installing the electric light at Ravenscourt Park Public Library:

T. L. Hellyar (accepted)	£125	0	0
Russell and Russell	148	0	0
Spagnoletti and Crookes	149	0	0
H. Nash	150	0	0
Seth Bros.	163	5	0
A. Sweetland	172	10	0
Selden and Son	199	18	0

Gloucester.—The City Council have received the following tenders for the plant required for the extension of the municipal electricity works:

Section A.—Boiler-house plant.

E. Danks and Co. (Oldbury), Limited	£940	0	0
R. Taylor and Sons	950	0	0
Tinkers, Limited (accepted)	955	0	0
E. Chester and Co., Limited	959	0	0
Dutilh Smith, McMillan, and Co.	959	10	0
Yates and Thom	1,010	0	0
Tetlow Bros.	1,040	0	0
G. K. Stothert and Co.	1,256	0	0

Section B.—Engine-house plant.

Dutilh Smith, McMillan, and Co. (Paxman engine)	3,140	0	0
E. Scott and Mountain, Limited (own)	3,750	0	0
Ashton, Frost, and Co., Limited (Willans)	3,985	0	0
Mather and Platt, Limited (Willans) (accepted)	3,988	0	0
Easton, Anderson, and Goolden, Limited (own)	4,028	0	0
India Rubber, Gutta Percha, and Telegraph Works Company, Limited (Willans)	4,110	0	0
Johnson and Phillips (Willans)	4,130	0	0
India Rubber, Gutta Percha, and Telegraph Works Company, Limited (Belliss)	4,250	0	0
Crompton and Co., Limited (Willans)	4,353	0	0
Mather and Platt, Limited (Belliss)	4,434	0	0
Electric Construction Company, Limited (Willans)	4,508	0	0
Crompton and Co., Limited (Belliss)	4,740	0	0
Electric Construction Company, Limited (Belliss)	4,752	0	0
E. Chester and Co., Limited (own)	4,912	0	0
Brush Electrical Engineering Company, Limited (Belliss)	5,002	0	0

Section C.—Switchboard extension.

Electrical Transmission Company, Limited	210	0	0
Crompton and Co., Limited (accepted)	251	0	0
Electric Construction Company, Limited	270	0	0
Edwards Electrical Company	280	0	0

Section D.—Condensing plant.

E. Chester and Co., Limited (accepted)	493	0	0
Klein Engineering Company, Limited	536	0	0
Dutilh Smith, McMillan, and Co.	538	0	0
Blake and Knowle's Steam Pump Works, Limited	552	0	0
Ashton, Frost, and Co., Limited	590	0	0
Worthington Pumping Engine Company	618	0	0
Mirrlees, Watson, and Yaryan Company, Limited	660	0	0
Middleton Engineering Company, Limited	759	1	7

BUSINESS NOTES.

TRACTION.

Norfolk.—The County Council have expressed their general approval of the proposed Mid-Anglian Light Railway.

Higham Ferrers.—The Town Council have given their formal consent to the Wellingborough and district tramways scheme.

Cleethorpes.—The Council are urging the tramways company to make a start. It appears that there is a difficulty in obtaining rails at present.

Tynemouth.—Particulars of the routes with respect to the construction of the line in Borough-road for the new electric trams have now been settled.

Clydebank.—The Commissioners have decided not to approve of Mr. Murphy's scheme for a tramway from Whiteinch through Clydebank and Dumbarton to Balloch.

Farsley.—The Farsley District Council have accepted a draft agreement between the Bradford Corporation and the District Council as to the proposed branch tramway along Farsley Town-street.

Aberdare.—The Light Railway Commissioners have declined to consent to the application by the British Electric Traction Company, Limited, for powers to construct a light railway in the district.

Worcester.—At a meeting of the inhabitants on Monday a resolution was passed favouring the introduction into the city of electric trams and the provision of light railways in the surrounding districts.

Christchurch.—The Christchurch Town Council and the Winton Urban District Council have decided to support the Poole, Christchurch, Winton, and Bournemouth Company's Electric Tramways Bill.

Hove.—The Council will oppose the Brighton Tramways Bill, and also decline to accede to the Telephone Company's request for permission to lay underground tubes for wires in most of the main roads of the town.

Bangor.—A letter from the English Industrials, Limited, asking for the assistance of the Council to obtain a provisional order for

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the laying of tramways in Bangor and district is before a committee of the City Council.

Holborn.—A report on the London County Council Bills for the laying down of tramways along Rosebery-avenue and St. John-street-road is being considered by the Parliamentary Committee of the Board of Works.

Wellingborough.—The Urban District Council have given their formal consent to the Bill being promoted by the British Electric Traction Company, Limited, for the construction of a tramway through Wellingborough and district.

Blackpool and Lytham Tramway Co.—By the Blackpool, St. Annes, and Lytham Tramways Company's Bill power is sought to greatly extend the tramway systems under its control by doubling the existing lines at a cost of £53,616. 12s. 1d.

Cape Electric Tramways.—The directors announce an interim dividend of 4 per cent., free of income tax, payable to shareholders registered at 12 p.m. on 20th inst. The dividend will be payable after the receipt of transfer returns from South Africa.

Hull.—A start has been made with the laying of the electric tramway over the North Bridge on the Holderness-road route. The running on the Spring-bank and Prospect-street route will be commenced as soon as the Spring-bank section is finished.

Dundee.—The erection of conductors and standards for carrying electric current for the tramways will soon be proceeded with, and a sub-committee is preparing a report as to the style of standards so as to equip them for both tramway and lighting purposes.

Tramway across the Ribble.—In the Bill of the Southport and Lytham Tramroad Company, for constructing a tramway across the Ribble, the estimated cost of the works is given as £183,500, of which £53,154 is put down for a conveyor bridge.

Whitehaven.—At the last meeting of the Town Council it was decided to consent to the application of the English Industrials Company, Limited, of Manchester, for a provisional order authorising them to run electric trams from Cleator Moor through Whitehaven to the boundary of Workington.

Southport.—In connection with the laying of about six miles of electric tramways within the borough, the work has commenced in Ash-street, St. Luke's-road, and High Park-road, where electric standards have been erected. The estimated cost of the construction of the tramways is fixed at £19,668 in the Corporation's new Bill.

Norwich.—At a public meeting held on Monday evening a resolution was passed heartily supporting the proposal to promote a railway to serve this district under the Light Railway Act of 1896. A committee is to be appointed at once to co-operate with the rest of the district and the promoters in formulating a satisfactory scheme.

Cheltenham.—The Light Railway Commissioners have held an enquiry into the application of Mr. Thomas Nevins for an order authorising him to construct an electric tramway through the streets of the borough. As the Corporation and Mr. Nevins had previously come to an agreement, the enquiry was merely of a formal character.

Hammersmith.—An agreement has been prepared with reference to the Vestry's consent to the overhead trolley system of traction for the tramways in Goldhawk and Uxbridge roads. With regard to the carrying out of the works by the tramway company, a sub-committee is to be formed to supervise the work and report direct to the Vestry from time to time.

Bromley.—At a recent special meeting of the Urban District Council a discussion took place as to what course the Council should adopt with regard to the proposal of the South-Eastern Metropolitan Tramways Company to extend their tramway from Lewisham along the London-road and into Bromley parish as far as Bromley College. The opinions of the members were equally divided.

Stockport.—By the Corporation's Tramways Bill, 1900, power is sought to construct a large number of tramways for goods and passenger traffic in conjunction with the existing tramways now in the borough. Mr. Atkinson, the borough engineer, estimates the cost of construction of the new permanent way at £90,855, and the prospective revenue is given by Mr. Hyde, the town clerk, at £24,745 per annum.

Bristol.—The Sanitary Committee have granted an application from the Bristol Tramways and Carriage Company, who had been required by the committee to place centre poles at that part of West-street lying between Cannon-street and Albert-road, asking to be relieved from the engagement and allowed to substitute span wires, as in three cases out of five centre poles would come on top of a large water-main.

Coatbridge.—At a recent meeting of the Town Council, a discussion took place as to the Airdrie and Coatbridge Tramway Bill, as promoted by the New General Traction Company, Limited, and supported by the Airdrie Town Council, having passed the Standing Orders of the House of Commons without representation from Coatbridge. Eventually it was agreed to consult parliamentary counsel as to the further progress of the Bill, to which Coatbridge Council is opposed.

Greenock.—At a meeting of the Law and Finance Committee of the Police Board on Wednesday the offers for leasing the tramway lines were under consideration. They are three in number, and are made by the Greenock and Port-Glasgow Tramways Company, the Drake and Gorham Electric Power and Traction Company, Limited, London, and Mr. Murphy, London and Dublin. After some discussion, it was resolved to print the tenders and call another meeting next week.

Liverpool.—An experimental electric car has been run by Mr. Bellamy, the tramways manager for the Corporation, over the Cabbage Hall and Oakfield-road and Walton route. The Board of Trade has been asked to give the necessary permit for the new electric line from Cabbage Hall without delay, and prior, if necessary, to the formal inspection. It is considered that by October next the electric service of the city will be nearly complete. A beginning will be made next week with the Brunswick-road and Islington lines.

Halifax.—Representatives of the Sowerby Bridge District Council on Thursday last week waited upon the Tramways Committee with regard to the tramway facilities proposed to be provided by the Corporation for Sowerby Bridge district. The deputation asked that the King Cross line should be extended to Rishworth, also that a loop line should be constructed round by the back of Crow Wood to connect with the intended Rishworth line at Bolton Brow Board School. The Tramways Committee decided, before giving an answer on these matters, to view the district.

Leeds.—On Tuesday a deputation of the Corporation Tramways Committee visited Sheffield for the purpose of inspecting the electric system. The deputation was met by Alderman Clegg (chairman of the Sheffield Tramways Committee), Mr. L. C. Fell (electrical engineer), and some members of the City Council. After luncheon, to which they were entertained by Alderman Clegg, the visitors were conducted over parts of the new tramway system, visiting Walkley, the car-shed at Tinsley, and the power station on Kelham Island, and much information as to the working of the system was given.

Taunton.—At the last meeting of the Town Council a joint committee of the Streets and Highways Committee and the Electric Light Committee reported that they had gone through the draft order which the Taunton and Somerset Electric Railways and Tramways Company had lodged with the Board of Trade for the promotion of trams within the borough, and, subject to a satisfactory arrangement being come to with the promoters upon the several questions, the committee recommended the Council to approve of the scheme for the introduction of trams into the borough. This was agreed to.

Kingswinford.—A committee appointed to consider the by-laws and regulations proposed to be made by the Board of Trade with respect to the use of electric traction on the Dudley and Stourbridge tramways, reported at the meeting of the Rural District Council that they had ordered the clerk to make certain recommendations and observations as to speed at certain points of the route between Dudley and Kingswinford, and that the cars should not be overcrowded. The clerk was instructed to write to the British Electric Traction Company pressing them to take steps to get the line from Dudley to Kingswinford completed.

Finchley.—At the annual business meeting of the East Finchley Ward Ratepayers' Association last week the following resolution was adopted: "That this meeting is of opinion that any light railways constructed in the parish of Finchley should be under the control of the local road authority, and any revenue therefrom should be applied to improving and maintaining the highways and reducing the local rates. Further, that the secretary be instructed to forward a strong protest to the Light Railway Comsioners against the proposed combination of the Middlesex County Council with the Metropolitan Tramways and Omnibus Company."

Farnborough.—At the last meeting of the Council a letter was read from the Light Railway Commission, with a copy of the order which had been submitted to the Board of Trade authorising the construction of the Aldershot and Farnborough light railway. The Commissioners, referring to a letter from the Council of Nov. 27 last, were of opinion that the company should not be prohibited from using the railway for goods traffic, and suggested that any inconvenience might be avoided by regulating the hours of such traffic. The clerk was instructed to reply to the Commissioners stating that the Council only gave consent to the undertaking on the company promising to leave out the clause referring to the carriage of mineral or goods traffic.

Eccles.—At a recent meeting of representatives from the local authorities at Eccles, Worsley, Little Lever, Urmston, Little Hulton, Farnworth, Whitefield, and Barton Rural held at the Town Hall, Eccles, to consider the proposed suburban tramway scheme, it was resolved to support the South Lancashire scheme now before Parliament, subject to the insertion of a clause in the company's Bill undertaking to construct the line proposed by the United Kingdom Tramways Syndicate, if the latter do not obtain their powers in the session of 1901. It was also decided that a further clause should be inserted in the above company's Bill giving local authorities the power to run, or give running powers over the lines where the schemes are coterminous.

Folkestone.—A deputation representing the Sandgate and Hythe Electric Company, Limited, consisting of Mr. L. J. D. Brockman and Mr. Devonshire (a director of the company), waited upon the Folkestone Chamber of Commerce, at their monthly meeting, for the purpose of giving information as to the proposals of the company with regard to the projected Folkestone-Hythe tramway. Mr. Devonshire explained, with the aid of a large map showing the proposed line of route, how they could have a joint working of the tramway by the company and the Corporation. The feeling of the meeting was apparently in favour of the proposals of the company, but the matter is to be further considered at a future meeting of the Chamber.

Dewsbury.—At the last meeting of the Town Council, sitting as the General Purposes Committee, a sub-committee reported that the scheme of the Batley Corporation for the provision of tramways

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within the borough would, in one small portion near the western boundary, as devised, prevent the carrying out of the Ravensthorpe, Dewsbury, and Spen Valley tramway, sanctioned by the Light Railways Commissioners at the late enquiry in Dewsbury. Under these circumstances it was thought necessary to lodge a formal opposition to the Batley scheme, doing so with no unfriendly feeling towards the sister borough, it being the belief of the sub-committee that the difficulty can be easily adjusted. The action of the Tramways Sub-Committee was unanimously approved.

Hythe.—The Town Council will assent under seal to the Folkestone, Sandgate, and Hythe tramways when such protective clauses as may be agreed upon between the Council and the company have been inserted in the Bill. To an application of the solicitor of the Cinque Ports light railway asking the Council to state their objections, the Council have replied that, having assented to two schemes, they had no room for any others. It is suggested that, having given their assent to two Bills, they might find themselves in a very awkward position if both the companies elected to come down Market-street, unless the companies came to some agreement between themselves, as the width of the roadway will not permit two lines of metals.

Cardiff.—A special meeting of the Tramways Committee of the Cardiff Corporation was held on Tuesday to consider the report of the sub-committee as to electric tramway traction At the outset of the discussion it became evident that the main point of contention would be as to the adoption of a combined generating station for lighting and traction, or a separate station for traction only. The sub-committee have visited towns where both systems were being worked, and with considerable success in each case. After considerable discussion, a resolution was passed recommending the whole committee to visit Glasgow, Liverpool, Hull, and Bradford, and, after deciding the principle of generating stations, appoint an engineer at a salary of £500 per annum.

Huddersfield.—The time for the deposit of the memorials complaining of non-compliance with the Standing Orders in regard to the second hundred private Bills in the general list expired on Tuesday. There was no opposition to the Huddersfield Corporation Tramways Bill, which will accordingly be allowed to proceed in due course to the first reading stage. The Town Council on Wednesday confirmed the decision of the Electricity Committee to oppose the following Bills: Midland Electric Power Distribution and Lighting, the County and City of Dublin Electric Lighting, the Tyneside Electric Power, South Wales Electric Power Distribution Company, and the Lancashire Electric Power Bills. The Parliamentary Committee advised the Council to strike out from the parliamentary Bill the proposed double line of rails for the tramways along New-street and Buxton-road.

Southampton.—The Board of Trade have transmitted to the Town Council a copy of Mr. A. P. Trotter's report of his inspection of the Shirley route of the Corporation tramways, together with an order approving of the use of electrical powers thereon. Mr. Trotter in his report says: "The overhead trolley system is used with swivel trolleys, but with a practically centre-running trolley wire. A temporary generator and engine had been provided, but the bearings of the generator gave trouble on the day before the inspection, and two dynamos intended for lighting were coupled together temporarily. Provision is being made for extension of the generating plant and for a large battery. The electrical equipment of the line is satisfactory. The engineer agreed, pending further inspection, to a speed of six miles an hour east of Albert-road, and eight miles an hour to the west of Albert-road."

Bolton.—The cars on the whole of the 10 routes were stopped on Thursday last week for three hours. The public had, to a certain extent, been prepared for a more irregular service, but a complete stoppage was unlooked for, and considerable disappointment was experienced. According to a local paper, the stoppage was owing to a breakdown of the 1,000-h.p. dynamo, and, as ill-luck would have it, a spare dynamo was at the time dismantled, and in the hands of the makers, Messrs. Mather and Platt, Manchester, who were grinding the commutator. The firm were at once communicated with, and the "stand-by" was as quickly as possible put in a state of repair. By a quarter to 11 the generation of electricity was resumed, and the cars, which had been waiting for the motive power to proceed, were enabled to commence their journeys on the whole of the routes. It is hoped that more cars will shortly arrive, and that an improved service will then be supplied.

Bradford.—A meeting of a sub-committee of the Bradford Tramways Committee was held on Tuesday to consider the advisability of the immediate acquisition of the existing leases of the tramways now being worked by the Bradford Tramways and Omnibus Company, Limited, and the Bradford and Shelf Tramway Company, Limited. The *Bradford Observer* understands that there was on the part of the Bradford Tramways and Omnibus Company no distinct offer stating a particular sum for which they would part with their undertaking, but on behalf of the Bradford and Shelf Tramway Company an offer was made to part with their lease on the payment to the company of a sum representing three years' profits of a similar amount to the profit shown by the last balance-sheet, with interest, but with nothing for compulsory purchase, the Corporation to take over the rolling-stock on a valuation fixed by arbitration. The subject was discussed, but was adjourned, no decision being come to.

Sedgley.—At the last meeting of the District Council the Tramways Committee reported the receipt of the following letter from the Board of Trade: "With reference to your letter stating the nature of the objections of your Council to the use of whinstone setts in the paving of the tramways, I am directed by the Board of Trade to state that the views of the Council have received careful consideration, but on the information at present before them, the Board did not feel able to put an absolute prohibition on the use of whinstone setts. They appreciate, however, the force of the Council's objections based on the tendency to wear smooth, thus giving rise to the slipping of horses on sharp gradients, and the Board proposed to require the use of granite setts on the inclines of a certain gradient. Before deciding what the gradient should be the Board would be glad to be favoured with any suggestion the District Council may have to offer on the subject." The clerk was instructed to inform the Board that the Council objected to whinstone setts being used where a gradient was more than 1 in 50.

Lee.—At last week's meeting of the District Board of Works, the General Purposes Committee reported that they had considered the proposal of the London County Council to construct a light railway through portions of the Board's district, together with a report by the clerk and several memorials from residents objecting to the scheme. The committee recommended that such light railways are not desirable, and, if allowed, the roads should first be widened and underground electric traction alone authorised. They further recommended that the seal of the Board be affixed to the objections drawn up by the clerk and delivered to the Light Railway Commissioners, and that copies be sent to the County Council, the Lewisham and Greenwich Boards of Works, and other persons interested, and urging the Lewisham and Greenwich Boards to join in opposition to the light railways; and that the clerk be authorised to oppose the granting of both of the light railway orders relating to this district, and to instruct counsel and secure evidence for any enquiry to be held by the Commissioners. The committee's recommendations were agreed to.

Warwick.—As already reported, the Council have adopted a resolution to the effect that the present undertaking of the tramway company should, on the expiration of the present lease in the course of the present year, be purchased in pursuance of powers given by the Acts in conjunction with the Leamington Corporation; and a further resolution was adopted by the Council that, under certain conditions, negotiations should be opened with the company for a new lease. Subsequently the company applied for the sanction of the Council to the provisional order which they are promoting. This consent will be given provided that power is received to deal hereafter with special clauses therein, and that such acquiescence should be considered as in no way derogating from any powers of purchase given by existing Acts. In case the order is obtained, this shall not be taken into account in any way in the valuation which would be made on purchase of the existing undertaking, and the Corporation is to have the right to call upon the company to transfer the order, if obtained, to them or their nominees on payment of the costs of obtaining the same. The members of the Tramway Sub-Committee (the Mayor, Aldermen Stanton and Kemp, Councillors Mellor, Brown, and Carter) have been reappointed.

Darlington.—The *Darlington and Stockton Times*, in a leader on the Darlington tramways, says: "Extraordinary rumours have had currency since the last meeting of the sub-committee of the Tramways Committee of the Darlington Town Council. One is to the effect that certain members of the committee are anxious to arrange a compromise with the Imperial Tramways Company; another is that the tramways company were in negotiation and practically came to some arrangement with the North-Eastern Railway Company for modifications of their original plans, about which the Town Council were never informed. The first rumour is probably quite true, for it is a singular circumstance that there are members of the Town Council who still imagine that the Imperial Tramways Company are wishful to undertake a desperate enterprise in the interests of the public, and one which they would not dare themselves ask the ratepayers to undertake. As for the second rumour, it was the subject of comment at the committee meeting. A prompt contradiction by the Imperial Tramway Company would give an assurance of that candour which should subsist between all contracting parties. It is enough that the Council have known changes in the scheme to deal with without having to apprehend fresh surprises."

Glasgow.—Electric trams are now running in Glasgow over a double track of rails about five miles in length. The first section was opened in October, 1897, and in December of the same year the City Council decided to prepare the whole of the tramways for overhead electric traction. The work of relaying the track is at present being carried out under contract, and, according to the *Leeds Mercury*, about 15 miles of double track have been completed, the laying of the cable ducts being in the hands of the National Conduit and Cable Company. The foundation of the permanent generating station are now in progress, and the contracts for the engines are about to be entered into. There will be four 4,000 h.p. engines, two to be supplied by the E. P. Allis Company, and two by Messrs. Musgrave and Sons, Bolton It is the intention of the Corporation to have a considerable portion of the system ready by the spring of 1901, so that they may be able to cope with the increased traffic during the time of the Glasgow International Exhibition, which opens in May of that year. Practically all the work has been contracted for. The Corporation, however, are building cars in their own works, and can turn out an average of three a week, but as this would not give them sufficient by the beginning of next year they have arranged to have 80 others made by contractors.

Kingston.—The Town Council have adopted the following report of the Tramways Special Committee showing exactly the position in which they stand with regard to the various tramway

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schemes, and for which we are indebted to the *Surrey Advertiser*: "Deposits of the Bill had been duly made in accordance with the standing orders of Parliament and the other necessary deposits. The Hampton Wick Urban District Council had intimated, without prejudice, that they would be prepared to withdraw their dissent in regard to the Corporation's proposal to construct a short length of tramway from the bridge to High-street, Hampton Wick, provided the Corporation would agree that the lines at the foot of the Hampton Wick side of the bridge should not be used as terminal points, but would be joined both in the direction of the Hampton Court-road and of the High-street with the lines to be laid either by the Middlesex County Council or by any company who might obtain power for that purpose. The committee had intimated, as suggested, that they saw no objection to a suitable arrangement. As authorised by the Council, a communication had been addressed to the Light Railway Commissioners dissenting from the light railway scheme of Messrs. Greenwood and Batley, and in reply thereto Messrs. Greenwood and Batley's solicitors had replied that no steps were taken by the Corporation prior to the announcement of their clients' application, and they ventured to submit that their action was an afterthought merely intended to block out their clients' application and not brought forward *bonâ fide* in the interest of the borough. The committee had pointed out to the Light Railway Commissioners that it was not until after the Council had in March last decided to prepare a tramway scheme that the Corporation received an intimation of the proposals of Messrs. Greenwood and Batley; further, that the action of the Corporation in promoting their own tramway scheme and opposing that of Messrs. Greenwood and Batley was, in their opinion, in the best interests of the borough, and would be persevered with."

Burnley.—A memorandum on the negotiations of the Town Council with the outside local authorities for the reconstruction and working of the tramways in their districts, which appeared in the *Burnley Express*, states: "The Corporation, as the promoters of the Bill, entered into negotiations with the outside local authorities before the deposit of the Bill. A conference was held on Sept. 14, 1899, at which general approval was expressed of the intention of the Corporation to seek the requisite powers for a reconstruction of the whole line, after purchase from the Burnley and District Tramways Company, Limited, subject to agreements being entered into with the local authorities for the future working of the lines in their districts. An agreement was accordingly prepared and submitted to each local authority, in which it was proposed that the Corporation should obtain the requisite powers and reconstruct the lines throughout at the expense of the local authorities so far as their lengths were concerned, and that the Corporation should in respect of the first five years pay a rental equal to the annual charges for interest and sinking fund with the requisite payments for repairs and maintenance, and that at the end of that period in the absence of agreement the Board of Trade should be asked to determine the future rental to be paid. The form of agreement was returned by the local authorities on Dec. 28 last altered in such a way as to give the local authorities a share in the receipts of the whole undertaking both in Burnley and outside. The Corporation were put under an obligation by the Act of 1898 to work the portions of the tramway outside the borough, but there is nothing in that Act or elsewhere to give to the local authorities a partnership interest in the whole concern, nor is there any responsibility upon them in relation to the working thereof. Seeing that there was such an important principle at issue between the Corporation and their neighbours, a conference was held at the Town Hall on Monday week." The memorandum details what transpired at the conference. Since the conference, which resulted in an agreement being arrived at, Mr. Eastham, on behalf of the local authorities, has sent the terms of their modified proposal to the Corporation, and the Corporation have, on the other hand, forwarded their alternative proposal to each of the local authorities. The half-yearly meeting of the Burnley and District Tramways Company, Limited, was held at the Mechanics' Institution last week. With regard to the purchase of the company's undertaking by the Municipality, it was stated that notice was due on Aug. 11 next, and all transactions must be completed within six months of that date, so that the company shall practically cease to exist at the end of the year.

LIGHTING AND GENERAL.

Redditch.—The Council are applying for an additional £8,000 for extensions.

Govan.—The official opening of the electric lighting works has been fixed for the 20th inst.

Paisley.—An additional loan of £20,000 is required for electricity supply extensions.

Edinburgh.—It is proposed to raise the salary of the resident electrical engineer by £150 per annum.

Bradford.—The applications for the post of electrical engineer to the City Council have now been reduced to 10.

Stockport.—The Mayor (Mr. Thomas Webb) formally opened the Corporation's electricity works on the 18th inst.

Barnsley.—It is expected that the committee will be able to give an intermittent supply of electricity in about a week.

Walkden.—The trustees of the Duke of Bridgewater are having a large turret clock erected, which is to be illuminated at night by electricity.

Shannon Water and Electric Power.—A memorial has been lodged alleging non-compliance with Standing Orders in the case of this Bill.

Bury St. Edmunds.—In our last issue we referred to the appointment of Mr. Roe under the heading of Bury instead of Bury St. Edmunds.

Prism Globes.—We learn that Prism globes and fittings are being installed on the streets of Beckenham for the street-lighting by incandescent lamps.

Gravesend.—The request of Messrs. Crompton and Co., Limited, of an extension of the period for carrying out the electric lighting order has been refused.

Globe Telegraph and Trust.—Quarterly interim dividends have been declared of 3s. per share on the preference shares and of 1s. 9d. per share on the ordinary shares.

Hebburn.—The capital expenditure required for the electric lighting undertaking amounts to £18,695, and this amount has been increased to £20,000 to cover any possible incidentals.

China and Great Britain.—The Chinese Minister has paid a visit to the electric cable works of Messrs. W. T. Glover and Co. and those of the Chloride Electrical Storage Syndicate at Clifton.

Kingston.—The Electric Lighting Committee did not present a report at the last meeting of the Town Council, but it was stated that negotiations were pending, which would be discussed *in camera*.

Merton.—Signatures are being collected to a petition to the Postmaster-General from residents of Merton and South Wimbledon, asking that better telegraphic facilities should be provided in that locality.

Blaydon.—The District Council have received a letter from the Tyneside Electric Power Company (Newcastle), but they at present decline to consider the lighting of the district by electricity.

Mountain Ash.—The Urban District Council have deferred taking action at present against the South Wales Electrical Power Distribution Bill, but the matter has been placed on the agenda for their next meeting.

Inverness.—The expenses in connection with the electric lighting deputation which recently visited southern towns with a view to preparing a report for the consideration of the Town Council amounted to £126.

Partnership.—Mr. E. R Dolby has taken into partnership Mr. Percy M. Williamson. The style of the firm will be Dolby and Williamson, and they will act solely as consulting engineers at 8, Princes-street, Westminster.

Arlesey.—A committee has been formed to ascertain the cost of lighting the village with electric lights for the next lighting season. Mr. A Gibbs estimates that £750 would cover the total cost of an installation for 60 lamps.

Chester-le-Street.—The Rural District Council have decided to oppose the application of a private electric lighting company for powers to put down plant for supplying the whole of the Chester-le-Street union with the electric light.

Wellingborough.—The Urban District Council have given their sanction to the provisional order which is being sought by the Electrical Power Distribution Company for supplying electricity for lighting and power purposes in the district.

Tynemouth.—As the Board of Trade have stated that the loan for electricity purposes (£34,850) could not be advanced in one sum, the Town Council on Wednesday agreed that the Board be asked to advance £14,850 at once, £10,000 on May 1, and £10,000 on July 1.

Berwick.—The Sanitary Authority are consulting with Mr. Campbell-Swinton as to effecting an agreement with Edmundsons' Corporation, Limited, for the lighting of the district, subject to the approval of the authority, on the footing of several proposed alterations.

Radcliffe.—At last week's meeting of the District Council it was mentioned that Mr. F. F. Bennett threatened the Council with legal proceedings on account of their alleged action in appointing another consulting engineer without first discontinuing his appointment.

Removal.—The Private Wire and Telephone Installation Company announce that the increase of their business has necessitated its transference from 110, Cannon street, where it has been carried on since 1894, to larger premises at 5, Palmer-street, Westminster, S.W.

Accrington.—In December, 1898, the Town Council were considering tenders for cables, and they thought the price was high and resolved to wait until copper came down. Copper rose instead, and the cables being wanted a much higher price has now to be paid for them.

Pickering.—The question of lighting the workhouse premises with gas has been under consideration, but at the last meeting of the Guardians it was suggested that the matter should stand over, seeing that there was some talk about introducing the electric light into the town.

Rhondda.—A special meeting of the District Council to consider a Bill for incorporating and conferring powers on the South Wales Electrical Power Distribution Company was to have been held recently at Pentre, but the question was deferred owing to there being on insufficient attendance of members.

Thirsk.—The Parish Council are making representations to the Board of Trade with a view to securing the insertion in the Thirsk electric lighting draft provisional order of certain clauses which are deemed desirable in the public interest. Similar representations are being made by the Sowerby Parish Council.

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Electric Construction Co.—The transfer books for the ordinary shares will be closed until Jan. 31 inclusive for the payment of the second half of the dividend of 6 per cent. per annum declared on July 13 last.

Direct United States Cable Co.—An interim dividend has been declared of 3s. per share, free of income tax, being at the rate of 3 per cent. per annum for the quarter ended Dec. 31 last, such dividend to be payable on and after the 31st inst., setting aside £15,000 to reserve fund account and carrying forward a balance of about £6,347.

Twickenham.—A letter from the Richmond (Surrey) Electric Light and Power Company, Limited, informing the Council of their intention to apply for a provisional order authorising them to supply electricity, and asking the Council to consent to the scheme, is being considered by the Lighting Committee of the District Council.

Dunblane (Perth).—At a meeting of the Western District Committee of the Perth County Council, it was remitted to the Emergency Road Committee to deal with a notice of application for a provisional order for power to supply electric current to Dunblane and Bridge of Allan by the Urban Electric Supply Company, Limited.

St. Saviour's.—The National Telephone Company wish to acquire the premises in Southwark-street until lately Causton's printing factory. The Paving Committee have brought up a report recommending that certain rents be charged for wayleaves, etc. These rents will total about £158 per annum; besides that the wires, etc., will be assessed.

Saltburn.—Notice of motion has been given to the effect that the Council would not consent to further concessions to the Cleveland and South Durham Assets Company without an equivalent, and suggesting that the company should enter into an agreement that when they were prepared to sell their electric lighting property the Council should have the first offer.

Middlesbrough.—It has been decided by the Electric Lighting Committee of the Town Council to supply electricity outside the compulsory area to consumers willing to take it for three years and pay 10 per cent. on the cost of laying the mains to their premises. The company laying down cables at Middlesbrough have guaranteed their cables for 30 years.

Wooden Pulleys.—We have received from the Revolution Wooden Pulley Company, of Coronet-street, Hoxton, N., a copy of their price-list for wooden split pulleys. The advantages claimed for these pulleys are that they offer a better grip to a belt, there is less vibration, and they are cheaper, lighter, and stronger than the ordinary type of pulley.

Leeds.—The City Council will be asked at their next meeting to make extensive additions to the electric lighting station and plant in Whitehall-road. It is proposed to demolish the Britannia Mills, adjoining the present generating station, and to erect new buildings. The new plant will be of a different type to that now in use, and the two-phase system will be adopted.

Appointments Vacant.—A chief electrical assistant is required for Glasgow Corporation tramways.—The Corporation of Bedford invite applications for the appointment of assistant electrical engineer.—Particulars of the above appointments and also of vacancies for several draughtsmen, an engine-driver, and a motor inspector will be found in our advertisement columns.

London Gazette.—An order of adjudication has been made out *re* W. Dalzell, trading as W. Dalzell and Co., Newcastle-on-Tyne, Dec. 29, 1899; and *re* F. B. Paynter, Middlesex, Jan. 12. In the estate of C. H. Kitching, Kingston-upon-Hull, a first and final dividend of 2s. 9d. in the pound will be paid on Jan. 25 at the office of the Official Receiver, Trinity House-lane, Hull.

St. James, Westminster.—The arbitrator appointed by the president of the Surveyors' Institute has fixed Monday, Feb. 5, as the day for determining the value of the land on the north side of Ganton-street, payable to the Vestry by the St. James's and Pall Mall Electric Light Company, and the Vestry's solicitors have been instructed to take the necessary steps in the matter.

Greenock.—The question of lighting the harbour by electricity has been reopened, and the Electricity Committee are preparing a report for the consideration of the Harbour Trust. The engineer of the electrical station reports that for the four weeks ending Jan. 5, 1900, 15,217 units of electricity had been generated, at a total works cost of £55. 10s., and the estimated income on this is £116. 10s.

Dewsbury.—At a meeting of the council of the Dewsbury Chamber of Commerce on Wednesday the question of revision of telephone charges was discussed, and it was said that the National Telephone Company's alternative system was not available at Dewsbury, though granted to some other towns, because the Corporation refused to let the company lay wires beneath certain streets. The President remarked that, in his opinion, the action of the Corporation was in the interests of the community.

Wireless Telegraphy.—Laffan's Agency wires from New York as follows: "Mr. Nikola Tesla, having completed his experiments with wireless telegraphy in Colorado, has returned to New York. He says: 'My experiments have been most successful, and I am now convinced that I shall be able to communicate by means of wireless telegraphy, not only with Paris during the exhibition, but in a very short time with every city in the world. My terminal instruments will be absolutely immune from extraneous disturbances, and I hope to obtain a speed of from 1,500 to 2,000 words a minute. I have returned to New York to pursue a series of experiments with a view to solving the greater problem of transmitting power without using wires.'"

Reason Manufacturing Co.—A company has been formed at Brighton, with offices at 111, Gloucester-road, the object being to purchase or otherwise, as a going concern, the business of the Reason Manufacturing Company, Limited (registered 1891), and also to carry into effect a second agreement with the Mutual Electrical Trust, Limited, for the acquisition of certain patents relating to the distribution, measurement, and utilisation of electrical energy; to establish and maintain telegraph and telephone systems; to manufacture all kinds of automatic machines, working models, tools, and scientific goods; and to construct and maintain rail and tram roads. The capital is £50,000 in £1 shares.

Accidents.—A gentleman whose horse shied at the approach of a tramcar at Bradford was unsuccessful last week in his suit to recover £50 damages from the Corporation. In places where trams and motors abound owners of horses ought to make their horses motorproof, which is comparatively an easy matter. On Wednesday, through miscalculation on the part of the driver, or failure of a brake, an electric tramcar overran its distance on a crossing and collided with a car approaching from the opposite direction. The passengers escaped with a severe shaking. Owing to a failure in the cable in the trolley pole of one of the cars at Aberdeen on Wednesday the automatic switch at the generating station was set in motion, and in consequence a section of the line became isolated.

Ayr.—The electrical engineer, Mr. Arthur J. Fuller, in his last report, attributes recent troubles with the arc lamps to a bad batch of carbons. He also states that the load continues satisfactory. The accounts show that for the first half-year they are £400 better in private light alone than for the same period last year. This is an increase of about 40 per cent. Mr. Hammond recommends that notice should be given to Messrs. Siemens that delivery of the plant ordered from them will be required about Feb. 1. He also suggests the advisability of substituting a plant for giving direct supply to the area adjoining the generating station, and the Electricity Committee are to consider this proposal and advise him before the new plant is ordered.

British Thomson-Houston Co.—This Company have forwarded us their catalogue of transformers of sizes extending from 1 h.p. up to 10 kw. We notice that these are oil cooled, and that the cases are fluted on the outside to increase the cooling surface. On the second page of the list a curve is given as to the ageing test with respect to iron losses. The company claim to have found a brand of iron which does not deteriorate magnetically by continued heating. The curve shows the constant loss extending over 1,200 hours, the iron being maintained during that time at 80deg. C. No information is given in the curves as to the size of the transformer, so that the hysteresis loss in percentage could not be seen. Farther on in the list details of small transformers for synchronising and for use in connection with voltmeters are described.

Newcastle-on-Tyne.—The Bill to confer further powers upon the Newcastle-upon-Tyne Electric Supply Company, Limited, has been duly deposited for introduction into Parliament next session. Power is sought by the company to supply "energy in bulk" to the Walker and Wallsend Union Gas Company, the Walker Urban District Council, "or any other local authority, company, or person authorised by Parliament" to supply electricity. Provision is also made to enable the company to enter into agreement with Walker Urban District Council for the acquisition by the company of the undertaking, powers, and privileges of the District Council conferred upon them by the Walker Electric Lighting Order, 1899. The Bill, however, provides that the company shall not supply electricity "in bulk or in detail" within the urban district of Walker without the consent of the District Council, or within the area of supply of the Walker and Wallsend Union District Gas Company without the consent of that company. The Bill also extends the company's area of supply to Long Benton. The Town Council on Wednesday decided to oppose the Bill.

British Westinghouse Electric Co.—We have received from this Company their circular No. 1,010, which deals with transformers generally, and particularly with those which do not require any artificial means of cooling. In this pamphlet transformers designed for transmission work at very high voltages are described and illustrated. These run up to large sizes. For instance, on the face of the list we notice an illustration of a 375-kw. transformer for 15 000 volts on the high-tension side. In order to keep down the difference in potential between adjacent parts of the high-tension windings, the primary and secondary coils are divided up each into four sections. In this way the maximum voltage in any one section is reduced to some 3,750 volts, and the strain with an individual coil is greatly reduced. Apart from this the subdivision of the coils exposes a larger surface to the oil with which the cases containing these transformers are filled. The Company claim that the advantages of using oil in these machines as an aid in insulating them are great, and apart from this the oil also keeps down the temperature rise on the transformer. The oil used by the company is of a grade specially selected after extended research. As regards the efficiencies of the transformers, curves are given showing generally what may be expected. For instance, with the 375 kw. machine referred to above, the full load efficiency is 98·4 per cent., the half-load efficiency is 98 18 per cent., while at one-tenth load 93·38 per cent. of the power put into the primary is delivered from the secondary. On non-inductive loads its drop is only ·9 per cent, which increases with a load having a power factor of ·9 to 2·5 per cent. These figures were obtained with a frequency of 60 cycles per second. In the tables in the end of the catalogue full details of the various types are given, with the weights of the transformers, the cases, oil and floor space occupied, but for the cost of the same one has to apply to the company direct.

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King's Lynn.—Owing to the increasing demand for current, the Town Council have been forced to consider the question of permanent extensions of plant at their generating station. The consulting engineer (Prof. Robinson) has been asked to devise means whereby any excessive vibration caused in connection with the working of the gas-engines at the station may be prevented.

Personal.—Mr. Edward Lomer has been appointed agent in the United Kingdom for the Accumulator Works (Accumulatoren Fabrik A.G., of Berlin and Hagen, Westphalia) for the sale of their stationary and portable accumulators and accessories.—We are informed that Mr. J. Hardie McLean has severed his connection with the firm of W. Lucy and Co., Limited, ironfounders, Oxford.

Andover.—An agreement has been entered into by the Town Council with the National Telephone Company. It is reported that since the application was made by the Council to the Post Office for a trunk connection, the Post Office has asked the company for a guarantee before doing so, and that having now been given by the company, the work would be put in hand with the least possible delay.

Private Fire Brigade.—We are informed that, owing to the continued extension of their works at Hammersmith, the "Robertson" Lamp Company have found it advisable to institute a trained fire brigade for the purpose of fire protection in the factory. In view of this the company have engaged the services of Ex-Chief Superintendent Hewell, of the Metropolitan Fire Brigade, as instructor.

"Mechanical World" Diary.—The thirteenth issue of the "*Mechanical World* Pocket Diary and Year Book," for 1900, contains, as usual, a large collection of useful engineering notes, rules, tables, and data. It is published by Messrs. Emmott and Co., Limited, *Mechanical World* Offices, New Bridge-street, E.C., bound in cloth, at the low price of 6d., and makes a useful pocket companion for engineers.

Cleansing Superintendents' Association.—With reference to a note which we published in our last week's issue on "Steam-Boilers and Refuse Destructors," those wishing to obtain copies of this valuable report can do so by applying to Mr. F. W. Brookman, hon. secretary to the Association of Cleansing Superintendents of Great Britain, at the Sanitary Works, Rochdale. The price of the volume is 1s.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Brush Electrical Engineering Company's 4½ per cent. perpetual second debenture stock, and to allow the London Electric Supply Company's further issue of £150,000 4 per cent. first mortgage debenture stock (redeemable) to be quoted in the official list.

Newport (Mon.).—At the monthly meeting of the Town Council Mr. Llewellyn brought up the report of the Electricity Committee, and in reply to Mr. Wilkinson stated that the sub-committee had resolved, acting upon the advice of counsel, to accept the offer made by Mr. S. Taylor, baker, to sell his property near the electrical station for £4,500. The action of the sub-committee was agreed to after a heated discussion.

New Firm.—Messrs. Rouch, Lambert, and Penny, who have for many years been in the employ of King, Mendham, and Co., and Mendham and Co., of Bristol, have acquired premises at 6, St. Stephen's-street for the purpose of carrying on business as electrical engineers, contractors, and manufacturers. We learn that they have secured, amongst other contracts, that of lighting the Turkish baths and hydro, Bristol (some 200 lights).

Northallerton Electric Light and Power Co.—At an extraordinary general meeting of the members of this Company on Tuesday, Mr. C. E. L. Ringrose presiding, it was unanimously decided that as the Company had gained the public lighting, and the present power of the two engines was used up by the demands, the capital of the Company (£2,000) be increased by £8,000 in £1 shares. It was stated that the further demands for the light required extra plant.

Malton.—The Urban District Council's agreement with the Northern Counties' Electricity Supply Association for a provisional order of the Board of Trade to supply the electric light in Malton, referred to in a note on Jan. 5, has been altered to practically embrace the present lighting area except Greengate; also to reduce the price from 8d. to 6d. per unit after 20 units have been taken, and a corresponding reduction in the other maximum prices mentioned in the schedule.

Bangor (Wales).—Application is to be made to the Public Works Loan Commissioners to borrow the sum of £15,900 at 3 per cent. interest, for electric lighting purposes, repayable as regards the sum of £2 000 in 20 years, and as regards the sum of £19,000 in 25 years, by equal half-yearly instalments of principal and interest. Application is also to be made to the Local Government Board for power to borrow £2,500 for the purposes of extra mains, services, etc., in connection with the electric light works.

Walsall.—The total number of consumers supplied on Dec. 31 last was 153. The total units generated at the station during the month of December was 44,799. The question of how much additional land at Wolverhampton-street gasworks shall be appropriated for an extension of the site for the electric generating station and the rent to be paid therefor has been left to the chairman, as representing the Gas and Electric Lighting Committees, and the chairman of the Streets Committee.

Leeds.—Within a very short time the whole of the public thoroughfares in the centre of Leeds will be lighted by electricity. At the present time schemes are being carried out for extending the system of electric illumination from New Briggate to Sheepscar Police Station, and from the Great Northern Railway Station to Kirkstall-road, near the junction with West-street. The lamps are of 2,000 c.p. each. The Street Lighting Committee have also been authorised to prepare plans for the lighting by electricity of Duncan-street and Lower Briggate.

A New Electrical Handbook.—We are informed that Mr. Ulric Hoepli publisher, of Milan, Italy, is about to publish an Italian edition of the "Handbook of Electrotechnics," by Messrs. Grawinkel and Strecker. The handbook will deal with raw material, greasing substances, transmission and generation of electric power, distribution and various applications of electricity, measuring instruments and industrial electric companies, etc. Those wishing to obtain this manual may obtain it from Mr. Flavio Dessy, Via Alfani 49, Firenze, Italy.

Burton-on-Trent.—At the monthly meeting of the Town Council it transpired with respect to the electric lighting undertaking that the quantity of current in Board of Trade units sold during the past month amounted to 25,199, showing an increase of 4,470 units as compared with the corresponding month of last year. A letter was read from the National Electric Wiring Company, Limited, to Mr. Ramsden, as to the establishment of a wiring system in the borough, and it was resolved that Mr. Ramsden confer with the company's representative and report the result at the next meeting of the committee.

Barry.—The Barry District Council have given notice of a statutory meeting for the purpose of being empowered to spend money in opposing both the Cardiff Corporation Bill and also that of the new electric supply company in the next session of Parliament. The opposition to the Cardiff Bill will be chiefly on the ground that the proposed western sewer outlet at Lavernock would be in close contiguity to the proposed extension of the Council's district. The present gasworks supply by the town are already in the Council's possession, and it is contended would be adversely affected by the establishment of the electric supply company.

Keighley.—Plans for electricity offices and battery-room at a cost of £5,000, and of boilers, engines and dynamos, etc., at a cost of £7 510—total, £12 510—have been approved and tenders are now to be advertised for. At the meeting of the Town Council on Tuesday the following, among other proposals, were brought forward: That the final plans of offices and battery-room for the electricity works submitted by the electrical engineer be approved; that the electrical engineer be instructed to advertise for tenders for two boilers, three engines and dynamos, and the various plant required for the complete equipment of the works.

Salford.—Thirteen additional miles of electric cable have been laid in various main streets of the borough, making a total length of 28½ miles. The number of 8-c.p. lamps connected with the mains has increased from 31,800 to 48,381, and the output of current from the Wallness-road station has amounted to about 861,590 units, or an average of 16,569 units per week, compared with an average of 11,100 units per week in the previous year. Numerous applications for current have had to be declined lately, as the plant at the Wallness-road station is already overloaded. Among the applicants were the urban district councils of Prestwich and Whitefield.

Barrow.—The Town Council have resolved to inform the Municipal Corporations Association that the Council intended to establish a municipal telephone service. The chairman of the County Council and the borough electrical engineer have been authorised to take such steps as they may consider necessary in order to expedite the completion of the various contracts. A second generator and engine is to be purchased from Messrs. Bruce Peebles and Co., in accordance with the terms of their contract dated July 28, 1899. A sub-committee is discussing the question of utilising the steam which may be generated by the burning of house refuse.

Oldham.—Mr. H. P. Boulnois has held an enquiry into the application of the Corporation to borrow £36,000 for building an additional boiler-house, providing new dynamos and boilers, and extending the mains and other works connected with the electric lighting. Last year the Corporation obtained an Act of Parliament to lay down 26 miles of new lines to be worked by electricity, and there are already existing about 25 miles. The principle of spending the money before the enquiry had been held was objected to, and the Inspector said he would have to report the fact that work had been proceeded with, and he did not know what reply the Local Government Board would make.

Richmond (Surrey).—At the last meeting of the Town Council a letter was read from the Richmond Electric Light and Power Company giving notice of their intention to extend their works into the Kew-road and Kew Gardens district, and enclosing plan. The letter was referred by the Highway Committee to the Lighting Sub-Committee. Messrs. Price, Waterhouse, and Co. were appointed to audit the accounts of the Electric Light and Power Company for the year 1899, on behalf of the Corporation. The workhouse is to be connected with the National Telephone Company's system, and a private wire is also to be laid between the infirmary and the workhouse medical officer's residence.

Birstall.—A few weeks ago the Birstall Chamber of Commerce approached the District Council on the subject of electric lighting for the town. A letter was sent asking if the Council were going to lay down a plant, or, failing that, would it be in the power of any property-owner to supply electric light to his neighbours if desired. A letter has now been received from the District Council to the effect that there was no present intention on the part of that body to undertake any scheme of electric lighting for Birstall.

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The position of the Council in respect to any private undertaking would depend so much upon each particular case that it was not possible to give a definite answer applied to all cases generally.

Warminster.—At last week's meeting of the Urban District Council, the Clerk said he had received a further letter from Messrs. Rowcliffs and Co., with regard to the suggested lighting of the town by electricity, asking for particulars as to population and the requirements of the Council. These he had supplied, and it was very probable the firm would submit some terms to the Council after they had consulted their clients for whom they were acting. He added, in reply to Dr. Alcock, that Messrs. Rowcliffs and Co. had concluded that as Warminster had had the electric light the town had obtained a provisional order. He presumed if the firm proceeded with the matter they would obtain the required order.

Islington.—At last week's Vestry meeting the Vestry Clerk reported that Private J. Tierney, in the employ of the electric lighting department, was wounded on Dec. 15 at the battle of Colenso; Hobday, another employé, was at the front, but was not reported wounded. The electric light columns have been erected in Essex-road, and the light will probably be supplied next week. The Finance Committee reported that the Vestry on Dec. 16, 1898, passed the following as a standing resolution: "Resolved that in future no contract be entered into for works proposed to be paid for out of loans until the consent of the sanctioning authority has been obtained." The committee's resolution was confirmed.

Carlisle.—The Electric Lighting Committee propose to put up five additional public arc lamps (bringing the number on the streets up to 30), also two ornamental electric standards opposite the town hall in place of the gas lamps at present there. In each case they propose to charge no more than would just about cover the cost—namely, 2d. per unit for public lighting of offices, and £23 per lamp for the electric standards and arc lights—the sum including maintenance. A strong opinion having been expressed that it was hardly the duty of the Electric Lighting Committee to control these lights in the future, the Health Committee on Friday last passed a resolution recommending the Council to appoint a special lighting committee.

St. Marylebone.—A deputation of residents waited upon the President of the Board of Trade on Wednesday *re* the electric lighting complaints. A full report of the meeting will be found in another column. At a meeting of the Vestry last night a report from the Works Committee was submitted recommending that with regard to reference back from Vestry as to communication from the London County Council respecting notice by the Metropolitan Electric Supply Company to lay mains in Oxford-street from Rathbone-place eastward, and report from the surveyor as to notice from the company relative to the same work, the Council be informed that, in the opinion of the Vestry, the application is objectionable and should not be granted.

Cardiff.—The Parliamentary Committee of the Cardiff Corporation waited upon a committee of the Glamorgan County Council on Tuesday with reference to the redemption of the toll on Penarth-road. Reference was also made to the Bill promoted by the Electrical Power Company, in which it is sought to obtain the right to establish electric motive power in any part of the county where the company may deem advisable, and the committees discussed the feasibility of joint opposition, but no decision was arrived at. At a subsequent meeting of the Cardiff Lighting and Electrical Committee, the Chairman (Alderman P. W. Carey) stated that Mr. Appelbee (electrical engineer) had been instructed to bring up a full and elaborate report dealing with the whole question of the lighting of the town.

Glazine.—We have received from Messrs. A. Rote and Co., of 61, St. Mary-axe, E.C., some circulars relating to a compound called "Glazine," which they have introduced for lubricating commutators. They state that it gives entire satisfaction in preventing wear and reducing sparking with either metallic or carbon brushes. One paragraph in their working directions is, however, difficult to take in. They say that should, however, sparks appear at the brushes, owing to very great variation in the load, then the temporary wear is taken up by the coating of "Glazine," the commutator itself not being affected in the least. We fail to understand what is meant by temporary wear, or how the lubrication on the commutator can do more than decrease the eroding friction of the brushes on the commutator.

Employees' Dinner.—The employés of Messrs. Rosling and Appleby, electrical and mechanical engineers, Trafalgar Works, Bradford, held their eighth annual dinner at the County Restaurant on Friday last, when about 150 sat down. After dinner, Mr. Appleby presided at the concert, when the toasts "Queen," "Firm," "Mr. Fynn," "Soldiers in South Africa," etc., were proposed. Songs were rendered (accompanist, J. Sykes) by Messrs. Cork, Birk, Coates, Smith, Brown, Butterworth, Wren, Dale, and Cass. Mr. John Morgan sang "The Absent-Minded Beggar," and the tambourine was passed round, and the amount of £1. 9s. 6d. was collected for the Mayor's fund in aid of the reservists' wives and families. Praise is due to Mr. A. Haigh and Mr. W. Mullard, who acted as stewards.

Partnership.—We are informed by Mr. W. M. Mordey that he has taken into partnership Mr. R. A. Dawbarn, who until recently held the position of the superintendent engineer to the Brush Electrical Engineering Company. It will be remembered that we noted Mr. Dawbarn's resignation of this post in our last week's issue. The new firm of Messrs. Mordey and Dawbarn will carry on their consulting practice from 82, Victoria-street, Westminster. The practical experience of the incoming member of the firm is most extensive, going back to 1881, when he was connected with the manufacture of Gramme machines, with the old British Electric Company. Since then he has had unequalled experience in the planning, estimating, designing, and carrying out of all kinds of electrical engineering works, and we look upon Mr. Dawbarn as a decided acquisition to the list of our electrical consulting engineers.

Electric Printing.—We have received from the General Electric Company a copy of a brochure prepared by the Crocker-Wheeler Company, of New York, for whom they are the Lonodn agents. This brochure deals with the advantages possessed by electric motors for use in the printing trade. In the first place, the ease of control is pointed out, which enables the printer to obtain any speed required for various work. Again, the efficiency of the apparatus and small loss of power is shown, diagrams being given comparing the engine work with the motor work. The motors can be placed in positions where it would be impossible to drive from belts off line shafts, and one machine can be operated at a time, thus saving expense when only small orders have to be worked on. Another point touched on is the cleanliness of the motor 'as compared with driving shafts. As to the question of cost, it is stated that in many cases the initial outlay is not greater than for shafting, and the motor soon saves any slight extra cost by its economical working.

Woking.—The draft proposed provisional order of the Woking Electric Supply Company, Limited, is to be amended as follows: (1) a clause giving the Council power to purchase at the end of 15 years that portion of the undertaking then within their district, upon the terms of Section 2 of the Electric Lighting Act, 1888; (2) Section 15 of the order of 1899 to be so extended that no works be carried out in private streets without notice to and deposit of a plan with the local authority; (3) Section 32 of the general order to be so amended that a revision of prices may be applied for after each three years, instead of after each seven years; (4) the cost of public lighting, including maintenance and repairs (but not erection of standards), shall not exceed £3 per lamp per 25 c.p. for 2,000 hours, and an addition to that effect be made to Clause 34 of the Act of 1899; (5) the maximum for each unit over and above 20 units to be 7d. instead of 8d., and the fourth schedule to the special order to be amended accordingly. The clerk has been authorised to instruct counsel to settle clauses and amendments, and to advise.

Mile End.—The Vestry last week received a deputation from the Guardians with regard to the electric light installation provided by the latter. On behalf of the deputation, it was said the Guardians had their own electric light installation, but it had proved quite unequal to adequately lighting the various institutions belonging to the Guardians in Rancroft-road. It was costing the ratepayers from £500 to £1,000 a year more than a proper supply of gas, and was thus a continual expense to the district. The Guardians suggested that the Vestry might take over the dynamos and arrange to supply the current by building a dust destructor. In reply, attention was drawn to the fact that Mile End would shortly be connected with a district that already had its electric light installation in working order. The electric engineer for that district had stated that it would be quite possible to supply the whole area of the new borough, and consequently it would not be advisable to contemplate going to further expense. Eventually the matter was referred to the Finance and General Purposes Committee.

Transvaal Telegrams.—The *Globe's* St. Petersburg correspondent telegraphs that the Russian Government recently addressed the question to the Swiss Federal Government as to whether Great Britain can withhold and return private and official telegrams coming from or destined for the Transvaal, in view of the International Telegraphic Convention which was concluded at St. Petersburg in 1875. According to the reply made by the International Telegraph Bureau at Berne, the countries in the convention agreed to can certainly withhold such telegrams as are prejudicial to themselves; this suspension can be either complete or partial, and the other countries must be informed thereof. The *Herald* says: "The accent here lies on the word 'prejudicial.' However, all telegrams and telegraphic correspondence between merchants, as well as simple dispatches to newspapers, have not been forwarded. Are all these 'prejudicial?'" The action of the Russian Government in this matter is quite of a "Gilbertian" character. If there is one country in which every telegram, especially those destined for the outside world, is rigorously supervised, it is Russia. At any rate, the suspension of telegrams from or to the Transvaal cannot affect the trading community of Russia to any very serious extent.

Hours of Tramway Men.—The *Manchester Guardian* says the motormen and conductors in the employment of the Potteries Electric Traction Company have signed the following petition addressed to the manager of the company: "(1) That we ask for a 10 hours' day on weekdays and eight hours on Sundays; (2) that the motormen have 5s. per day; (3) that the conductors have 4s. 2d. per day; and (4) that all overtime be paid time and a quarter on weekdays and time and a half on Sundays. Sincerely hoping that after mature consideration this application will meet with your favourable consideration, and that you will be in a position to give us a reply at your earliest convenience," etc. At a midnight meeting of the motormen and conductors, at which it was decided to present a petition, complaints were made that the hours worked by the men were excessive. It was stated that some of the men, after working till midnight or later, had to be at the depôt at five o'clock the following morning to take out the cars. Sometimes they had to wait several hours before they got a car, and no account was taken of the time they were kept waiting.

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If, on the other hand, they were late, they ran the risk of being suspended for a week, because they were required to take out a car and were not ready. Some of the men also complained that they were not relieved frequently enough during the day. They had sometimes to work for five hours without a break.

Kensington.—At a meeting of the Vestry on Wednesday, a report was submitted by the Works and Sanitary Committee stating that the committee had considered the desirability or otherwise of steps being taken for the lighting of main roads in the parish with electricity, in view of the price for the supply of electrical energy for public purposes by the Kensington and Notting Hill Electric Lighting Companies having been provisionally fixed by Parliament last session at 2½d. per unit, and of the fact that the Brompton and Kensington Electricity Supply Company had also signified their willingness to supply energy at the same rate. The committee, however, were not prepared in the absence of a much more favourable offer on the part of the several electric lighting companies to submit a recommendation in favour of the adoption of electric light in the main roads, but considered that the Vestry should look for the improvement of the street-lighting in the parish to the increased adoption of incandescent gas lighting. The committee had also considered the question as to the lighting with electricity of the portion of Cromwell-road about to be paved with wood, but whilst they did not for the reasons given submit any recommendation for the present adoption of electric light in that thoroughfare, they were of opinion that advantage should be taken of the breaking up of the road for the wood-paving works to lay throughout that portion of the road an iron conduit which would be available for any mains for public electric lighting purposes in the road which might be hereafter decided on. The estimated cost of the work was £250. Notices and plans have been received from the undermentioned electric lighting companies relative to proposed extensions of their mains in the parish—viz., Notting Hill Electric Lighting Company—Campden-hill-road; Brompton and Kensington Electricity Supply Company—Drayton-gardens (two sections), Wetherby-road, and Earl's Court-road. Permission is to be given for the works to be proceeded with, subject to the usual conditions.

Whitechapel.—At the meeting of the Board of Works on Monday the Electrical Committee recommended: (1) That a sum of £20,000 be now borrowed from the London County Council, balance of the sum of £30,000 mentioned at the meeting of the Board held on Dec. 4 last, as required on account of such sum as may be necessary to carry out that portion of the work of erecting the electric lighting installation in the district, as contemplated by the report of Mr. Wright, the electrical engineer of the Board, and such further work as may have been since determined upon, such loan of £20,000 to be upon the instalment system, repayable in 42 years by equal annual instalments, with interest at the rate of £3. 5s. per cent. per annum, payable quarterly, such loan to be taken up at once, the Board paying the costs of such loan, and upon the understanding that if any works require to be renewed during the currency of any part of the loan, the cost of such renewal shall be provided for out of a sinking fund for the purpose, or shall constitute a maintenance charge and shall not be made the subject of a fresh loan, no part of the principal to be repaid until the expiration of three years from the date of the loan, and that the seal of the Board be now affixed to such mortgage, and that a cheque be drawn in favour of the London County Council for the sum of £32. 7s. for the fees in connection with such mortgage; (2) that 20 additional arc lamps be obtained from Messrs. Crompton and Co., Limited, under the terms of their present contract at the cost of £764. 6s.; (3) that the plans, which have been prepared for the construction of the first portion of the electrical power-house in Osborn-street, be approved by the Board, and that they be submitted to the London County Council for approval, and that such plans, when approved by the Council, be referred back to the Electrical Committee for the purpose of getting out specifications, quantities, and estimates, and with instructions to obtain and open tenders for the performance of the works, and to recommend to the Board the acceptance of such tender as the committee may think desirable.

PROVISIONAL PATENTS, 1900.

JAN. 8.

4981a. Improvements in and connected with telegraphy. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Albert Cushing Crehore and George Owen Squier, United States.) (Date claimed under Patents Rule 19, March 6, 1899.)

430. Improvements in electric arc lamps. Hugo Bremer, 42, Neuenweg, Barmen, Germany. (Complete specification.)

434. Improvements in and pertaining to phonographs, gramophones, telephones, and the like. Arthur Sidney Bowley, 168, Fleet-street, London.

435. Improvements in apparatus for electrically interlocking the doors or gates with the operative machinery of hydraulic or other lifts. Frederick Thomas Hollins and Henry Christian Thomas Amendt, Liverpool street Station, London.

462. Improvements in electrical switches. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Aktien Gesellschaft Elektricitätswerke, vorm. O. L. Kummer und Co., Germany.)

449. Improvements in electric light sockets. Leo Miller Chapman and James Madison Gelatt, 40, Chancery-lane, London.

466. Improvements in apparatus for facilitating the escape of gas from electric storage batteries or accumulators. Walter James Wells and Allen and Adamson, Limited, 65, Chancery-lane, London.

467. Improvements in or relating to electric light fittings. Bernard Morley Fletcher, 7, Victoria-street, Westminster, London.

JAN. 9.

489. Improvements in devices for locating earth contacts on electric circuits. Matthew Jervis Myers, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

507. Improvements in the construction and manufacture of electric bells. Adam Clarke, 36, Langley road, Small Heath, Birmingham.

516. Improved electric switch for electric trams and railways. Jaroslav Vesely, 8, Quality-court, Chancery-lane, London. (Complete specification.)

524. Improvements in and relating to variable electrical resistances. Edgar Alfred Goddin and James Tarbotton Armstrong, 40, Vartry-road, South Tottenham, London.

547. Improvements in process of and apparatus for magnetic separation. Clarence Quintard Payne, 1, Queen Victoria-street, London. (Complete specification.)

559. Improvements in transformers. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Aktien Gesellschaft Elektricitätswerke, vorm. O. L. Kummer und Co., Germany.) (Complete specification.)

565. Improvements in and/or connected with electric meters. James Grieve Lorrain, Norfolk House, Victoria-embankment, London. (Hector Alan Macdonald, France.)

JAN. 10.

591. Improved apparatus for regulating the current in an electrolytic interrupter. Llewelyn Newton Tyack and Frederick Benjamin Fawcett, University College, Bristol.

595. New process of total suppression of motive power as well as of electric energy in the industrial production of carbides. Josh de Burgue and Raphaël Sunyé, 41, Faubourg Montmartre, Paris.

610. Improvements in electric order telegraphs for use on shipboard and elsewhere. Charles Felix Kronheimer, 53, Chancery-lane, London.

623. Improved carriers for wires or electric conductors, such as the trolley wires or conductors of electric railways, tramways, and the like. Robert Frederick Black, 46, Lincoln's-inn-fields, London.

630. A method of and apparatus for connecting electric meters in three-wire circuits. John Reid Dick and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

JAN. 11.

636. Improvements in screens for incandescent electric lamps. Henry Simpson, 38, Margravine-gardens, West Kensington, London.

638. Improved electrode. Ernest Arthur le Sueur, Rideau Club, Ottawa, Canada.

655. Improvements in or connected with electrically-actuated mechanism applicable for various purposes, such as the steering of ships, the working of engine-room or like telegraphs, or the training of guns. George Edward Vaughan, 57, Chancery-lane, London. (John Alfred Vaughan, South Africa.)

659. Improvements in electric switches. Auguste Gardy, 21, Ely place, Holborn-circus, London.

661. Improvements in telephone apparatus. Walker Moseley, 32, Linden-grove, Peckham, London.

675. Improvements in or relating to electric batteries. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Robert Crosby McCartney, United States.) (Complete specification.)

683. Alternating-current meter for small non-inductive charges. Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

688. Improvements in sound transmitters or disseminators for phonographs. Frederick Myers, 111, Hatton-garden, London. (Complete specification.)

695. Improvements in magnetic cut-outs. Ernst Andreas, 46, Lincoln's-inn-fields, London.

709. Improvements in compounds for dielectrical purposes. Carl Jung, Adolf Brecher, and Adolf Kittel, Clun House, Surrey-street, London.

JAN. 12.

729. Improvements in electrical switches. Charles Mark Dorman, Reginald Arthur Smith, and Herbert George Bagge, Ordsal Electrical Works, Salford. (Complete specification.)

758. Improvements in controlling devices for the motor circuits of electrically-propelled vehicles. Jasper Wetter, 37, Essex-street, Strand, London. (Elektrizitäts Aktiengesellschaft, vormals Schuckert und Co., Germany.)

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759. Improvements in and relating to dynamometers. Frederick John Cox, 67A, Corporation-street, Birmingham.

768. Improvements in or connected with electric arc lamps. The Davy Electrical Construction Company, Limited, and John Leman Eckersley Daniel, 40, Chancery-lane, London.

776. Improvements in electric fittings. Arthur Edward Bennett, 24, Southampton-buildings, Chancery-lane, London.

JAN. 13.

813. Improvements in the manufacture of accumulator plates. Zdzislaw Stanecki, 322, High Holborn, London. (Complete specification.)

814. Improved method of and installation for operating two-phase electric motors. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 14, 1899, being date of application in United States.)

837. Improvements in or relating to incandescence electric lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Thomas Shearman, United States.) (Complete specification.)

838. Improvements in or relating to incandescence electric lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Thomas Shearman, United States.) (Complete specification.)

839. Improvements in or relating to incandescence electric lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Thomas Shearman, United States.) (Complete specification.)

840. Improvements in or relating to incandescence electric lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Thomas Shearman, United States.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1898.

19676. Electrolytic separation of zinc from zinc oxide. Steinhart, Vogel, and Fry.

26723. Device for indicating the frequency of an electric current or currents, the said device being applicable for signalling and indicating speeds and the like. Burnand.

26769. Electrically-operated clocks. Andersson.

1899.

214. Apparatus for electrically interlocking the block and mechanical signals on railways. Ferreira and Pryce.

218. Electric railways of the sectional conductor type. Lorrain. (Esmond.)

1188. Guards for overhead electric conductors, such as trolley wires and the like. Jones.

1493. Apparatus for heating by electricity. Jolin.

1673. Portable telephones, applicable also for testing purposes. Blackwell and Blackwell.

1809.* Switch or cut-out. Claremont. (Amended.)

1844. Manufacture of plates for secondary batteries. Champagne.

1866. Receiver for waves of light, heat, or electricity. Orling and Braunerhjelm. (Date applied for under International Convention, Oct. 27, 1898.)

1867. Apparatus for regulating the sensitivity of receivers for waves of light, heat, or electricity. Orling and Braunerhjelm. (Date applied for under International Convention, Oct. 27, 1898.)

1868. Device for regulating the distance between objects hermetically enclosed, applicable to receivers for waves of light, heat, or electricity. Orling and Braunerhjelm. (Date applied for under International Convention, Oct. 27, 1898.)

2906. Switchboards. Cox.

3648. Electrolysis of salts in solution and apparatus therefor. Chalandre, Colas, and Gérard.

4455. Electric railways. Esmond. (Amended.)

20862. Method and apparatus used in electrostatically measuring electric currents in a working circuit, and calibrating the measuring instruments so employed. Addenbrooke.

21663. Electric arc lamps. British-Thomson-Houston Company, Limited. (Fleming.)

21664. Electric arc lamps. British Thomson-Houston Company, Limited. (Harthan and Stevens.)

21668. Alternating electric current meters. British Thomson-Houston Company, Limited. (Pratt.)

23615. Safety device for starting-switches of electric motors. Atterberg.

23640. Apparatus for the electrolysis of alkali chloride solutions. Boult. (Störmer.)

23655. Current collecting apparatus for the underground conductors of electric railways and tramways. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Jan. 13	3,986	3,752	+ 234	7,914	7,607
Blackpool-Fleetwood	,, 15	142	113	+ 29	283	280
Bradford City Trams	,, 14	354	246	+ 108	689	—
Bristol Tramways Co.	,, 12	2,680	2 556	+ 123	—	—
City & South London	,, 14	1,124	1,107	+ 17	2,268	2 250
Dover Tramways ...	,, 13	146	151	- 5	305	306
Dublin U.T., elec. cars	,, 12	2,753	552	+2,201	—	—
Dublin S.D. Electric	,, 12	578	600	- 22	—	—
Halifax Corporation	,, 14	554	233	+ 321	24,419*a*	7,589*b*
Hull Corporat'n E.S.	,, 6	682	—	—	—	17,711*c*
Liverpool Corporat'n	,, 6*d*	6,774	6,068	+ 706	—	—
Liverpool Overhead	,, 14	1,529	1,337	+ 192	2,984	2,676
Sheffield Corporation	,, 14	1,819	—	—	—	—
South Staffordshire	,, 12	606	628	- 22	1,012	1,086

a Since April 1, 1899. *b* Since June 29, 1898.
d Partly electrical. *c* Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Tuesday.
Aron Electricity Meter, Ld., 6 p.c. Cum. Pref. Shs., 1-125,000	1	¾-⅞
Blackheath & Greenwch. District Elec. Lt., Ord. 1,201-101,200	1	⅝-¾
Blackpool and Fleetwood Tramroad	10	17-19
Bournemouth and Poole Electric Supply, Limited, Ord.	10	12-13
—— 4½ per cent. Cum. Pref.	10	10-11
British Electric Traction, Limited, Ordinary, Nos. 1-30,000	10	15½-16½
—— 6 per cent. Cm. Pf., 30,001-60,000	10	13-13½
—— 5 per cent. Perpetual Debenture Stock	100	125-128
British Insulated Wire, Ord., No. 1 to 40,000	5	11½-12½
—— 6 per cent. Cum. Pref., No. 1 to 27,500	5	6-6½ xd
Brompton and Kensington Electric Supply Co., Ordinary	5	7-8
—— 7 per cent. Preference	5	9-10
Brush Electrical Engineering, Limited, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2½-2⅝
—— 4½ per cent. Debenture Stock	100	110-115
—— 4½ per cent. 2nd Debenture Stock	100	102-105
Callender's Cable Company, Debentures	100	110-115
—— Ordinary	5	13-14
—— 5 per cent. Pref.	5	5½-6
Central London Railway, Ordinary	10	9½-10
—— Pref. Half-Shares	5	4½-5
—— ,, deferred	5	4½-5
Charing Cross and Strand	5	9½-10½
—— 4½ per cent. Cum. Pref.	5	5½-6
Chelsea Electricity Company	5	7½-8½
—— 4½ per cent. Debentures	100	109-111
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	12½-13½
—— 5 per cent. Debenture Stock	100	122-127
City and South London Railway, Consolidated Ordinary	100	59-62
—— ,,	5½	4½-5½
—— 4 per cent. Debenture Stock	100	125-130
—— 5 per cent. Pref. Stock '91	0	143-148
—— ,, ,, '96	100	135-140
County of London and Brush Prov. Elec. Light Co., Ord.	10	9½-10½
—— 6 per cent. Cum. Pref.	10	13-14
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	106-109
Crompton and Co.	3	3½ 4 xd
—— 5 per cent. Debentures	—	98-101
Edison and Swan United Ordinary	3	1¾-2½
—— 5 per cent. Debentures	5	3¾-4½
—— 4 per cent. Deb. Stock, Red.	100	91-93
Edmundsons' Electricity Corp., Ltd., Ord. Shares, 1-17,400	5	4¾-5½
Electric Construction, Limited	2	1¾-2½
—— 7 per cent. Cumulative Pref.	2	2⅝-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106 xd
W. T. Henley's Telegraph Works, Ordinary	5	12-13
—— 4½ per cent. Preference	5	5½-5¾
—— 4½ per cent. Debentures	100	111-114
India Rubber, Gutta Percha, and Telegraph Works	10	20½-21½
—— 4 per cent. Debentures	100	100-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	3	3-3½
London Electric Supply, Ordinary	3	2½-2¾
—— 6 per cent. Pref.	5	5½-5¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	102-104
Metropolitan Electric Supply, Limited, Ord.	10	14-15
—— 62,501-85,000	10	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	115-117
—— 3½ per cent. Mortgage Debenture, Red.	100	95-97
National Telephone, Ordinary	5	5½-5¾
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	98-100
New General Traction, Limited, Ordinary	5	3½-4
—— 6 per cent. Cum. Pref.	5	5-5½
Notting Hill Electric Lighting Company, Limited	10	15½-16½
Oldham, Ashton, and Hyde Electric Tramway, Ordinary	10	12-13
—— Preference	10	10¾-10⅞
Oriental, Limited, 1879	1	1½-1⅝
—— £5 Shares	5	7-7½
—— £4½ Shares, New	4½	6½-6⅝
Oriental Telephone and Electric Company	1	¾-1
Oxford Electric, Lim., Ord., Nos. 1 to 96 and 407 to 10,810	5	6¾-7¼
Potteries Electric Traction, Ld., Ord., Nos. 26,667-40,000	10	11-12½
—— 5 per cent. Cum. Pref., Nos. 1-20,000	10	10-11
Royal Electrical Company of Montreal	1½	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100	104-106
South London Electric Supply, Ordinary	3	4-4½
St. James's and Pall Mall, Limited, Ordinary	5	15-16
—— 7 per cent. Pref.	5	9-9½
Telegraph Construction and Maintenance	12	35-39
—— 5 per cent. Bonds	100	102-105
Telegraph Manufacturing, Ordinary	5	9-10
—— 5 per cent. Cum. Pref.	5	5½-6
Waterloo and City Railway, Ordinary	100	101-104
Westminster Electric Supply, Ordinary	5	14-15

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NOTES.

Earthing Wire Fences.—We are informed by Mr. F. L. Brodie, writing in the *Journal* of the Royal Agricultural Society, that in America wire fences are blamed for damage to live stock by lightning stroke. The director of the Iowa Weather and Crop Service calls them "death-traps," and recommends the use of "earth-wires" at intervals along the fences.

New Anglo-German Cable.—We are informed by Reuter's Berlin correspondent that various complaints having been made in the Press recently with regard to the slow transmission of telegrams between Germany and England, the Imperial Telegraph Administration recently proposed to the British Post Office that a new cable should be laid between Emden and the English coast, but that the assent of the British authorities has not yet been received.

Magnetic Disturbances.—In a paper recently read by Mr. Mariani before the Institute of the University of Rome the question of the magnetic disturbances caused by electric tramways was taken up. The author in his conclusions stated that the magnetic materials on a tramway directly affected the compass up to a distance of 150 yards from the line. The further disturbances, such as are felt by magnetic observatories, are due to the leakage currents from the earth return, and the range over which these are felt is stated to be some 2,000 yards. Experience in England has demonstrated that the above limit can easily be very much exceeded.

An Ice-Clearing Trolley.—We notice in the *Street Railway Journal* a new type of trolley pole, recently patented by Mr. P. G. Gilbert, of Scranton, U.S.A. In it, a clamp is fixed on to the ordinary pole, near the upper end. Fitted into this is a secondary short pole, which is pressed against the wire by a spiral spring. This secondary pole carries an ice-clearing wheel, so that in frosty weather a good contact may be secured to the ordinary trolley wheel, owing to the extra wheel having cleared the wire from ice. Each of the trolley wheels is divided in the centre of the groove, the two parts being sleeved on to the axle. They are held together by the flanges of the fork, which are pressed together by springs, and bear against the outer face of the trolley wheel hubs.

The Chamonix Electrical Railway.—The Paris, Lyons, and Mediterranean Railway Company, which is about to construct an electric railway from Foyet to Chamonix, has let the civil engineering works in connection with the water-power plant, which will cost roughly about £32,000. These works consist of the necessary dam, canals, and outlets on the River Arve. The intake canal will be about 1½ miles long, and the total fall at the power-house will be about 320ft. With the quantity of water available this will correspond to over 10,000 h.p., but at present only four turbines are to be laid down, which will be capable of developing some 2,140 h.p. It will be seen from the above that the scheme is actually under way, as under the contract the work in connection with the water-power plant is to be completed by next January.

A Large Street Sprinkler.—The *Street Railway Journal* publishes an illustration of a large sprinkling car supplied by the Taunton Locomotive and Manufacturing Company to the Philadelphia and Westchester Traction Company and to the New Jersey Street Railway Company. The sprinkler consists of a large cylindrical tank containing 4,000 gallons, supported on two bogie trucks, which are equipped with the usual electric gear for driving. In the front of the car is placed a 3-h.p. motor, which is used for forcing the water out of the sprinkling nozzles. The range of the sprinkler is said to be 35ft. to 40ft. on either side of the track. From a casual glance at the illustration in question, one is concerned with the great weight of the car and tank when full, and as to whether the street railway tracks will be able to stand the strain of such a heavy weight moving at a high speed.

The Newport Bridge.—In the Bill of the Newport Corporation, which is to come before Parliament next session, are the details of a new bridge which the Corporation propose to construct across the River Usk. The principle of the bridge is much the same as one we described for crossing the Mersey in a recent issue. It consists of a high-level bridge suspended by cables. On it are laid rails to carry a moving platform at a much lower level. The actual width of the river where the bridge is to be made is about 240 yards, and the upper portion of the bridge will be constructed at such a height as not to interfere with the shipping using the river. The moving platform, which is suspended from the bridge, will work at the ordinary street-levels, so that the expense of approaches will be saved. It is proposed to work the moving platform by means of electricity, which will be obtained from the Newport central station. The estimated cost of this bridge is put down at £65,000.

Electro-Harmonic Society Smoker.—At the smoking concert to be held at the Café Monico on Friday, Jan. 26, we notice that the following artists are to appear: Mr. H. Emlyn, Mr. I. Foster, Mr. A. Helmore, Mr. T. Clarke. Piano and violin solos will be given by Messrs. A. E. Izard and T. E. Gatehouse. The musical directors will also be these two latter gentlemen. This concert will partake somewhat of a patriotic nature. "The Absent-Minded Beggar" and a new sea song, "The Gallant English Tar," will be sung by Mr. Ivor Foster, and a string and wind orchestra will perform a nautical selection, "A Life on the Ocean," illustrating the commission of a man-of-war. We are informed that in this piece no less than 18 songs are "commandeered" to illustrate the incidents of commissioning, preparing for sea, leaving England, outward bound, gale, action, victory, rejoicing, homeward bound, and arrival in England, etc. There is also a good selection of violin and piano pieces and songs to make up the programme for this concert.

Electric Lighting Penalties.—What we believe to be the first penalties enforced on account of electric light undertakers failing to supply electric energy were granted against the Metropolitan Electric Supply Company on Friday last. Several summonses were taken out by the London County Council for failures to supply in October and November last with respect to premises in Wimpole-street and Harley-street. The counsel for the plaintiffs explained that by reason of the serious complaints received the London County Council had taken up the question, and evidence was brought as to the failures complained of. In giving judgment Mr. Curtis Bennett said that it was quite clear that the company had done its best under difficult circumstances, but that they had not complied with the conditions under which they obtained their very extensive powers from Parliament, and hence they were liable to penalties. The actual fine on each of the summonses was 10s. with 23s. costs. We trust that the reason for the infliction of these penalties will soon be removed.

The Electric Trade in 1899.—The *Western Electrician* of Chicago, in its first issue for the New Year, makes a careful computation as to the total value of the electrical machinery and apparatus manufactured

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in the United States during last year. This total value amounts to almost 25 million pounds, which, it is stated, shows an increase of 40 per cent. over the output for the previous year. In this value manufactured products only are listed, and not the amounts expended in working central stations and street railway plants. In a list given in connection with the article, the value of the goods imported for each particular section is also stated. It is curious to note that carbons for arc lamps, X-ray apparatus, and telephone parts, with the exception of small sums for electric lighting accessories, are practically the only electrical imports into the United States. Even with these the proportion is small, being rather more than 10 per cent. of the whole quantity used in the case of the arc light carbons and 3 per cent. in the case of telephone apparatus.

Electric Light and Gas.—We gather from the electrical Press of the United States that gas and electric light are no longer to be rivals in New York, as it is stated that the Consolidated Gas Company of that city have acquired the control of the public electric light supply undertaking. The amalgamation is said to have been arranged by the Consolidated Gas Company acquiring in some way the control of the major portion of the stock of the electrical undertaking, and, using this control, a closer alliance is to be made. The capital of the whole undertaking is said to be about £20,000,000. The reason for the deal is said to be due to the fierce war between the different gas interests in the city, so that the Consolidated Gas Company hope, by owning the electric light undertaking, to also obtain predominant command of the whole illuminating system of New York. How far the combination will affect the electric light undertaking we do not know, but at any rate the healthy stimulus of competition will be removed, and we should say that the consumers both of gas and electricity will suffer in consequence.

A Trade Journal.—We have received a copy of the second issue of the first volume of the *Victor Telephone Journal*, which is run by the Victor Telephone Manufacturing Company, of Chicago. The editorial pages of this journal number 24, and are filled with most readable matter. The general tone of the journal is of course "anti-Bell," as the company has everything to gain from the support of the independent movement. One of the articles in this issue is by Mr. Grant Newell on the law affecting the granting of telephone licenses in the United States. He gives at the commencement of this a model form of franchise, which it is interesting to compare with the licenses being issued by the Postmaster-General. Mr. Newell succeeds in compressing all the required provisions into less than two columns of the *Journal*, and we notice that no provision is made either for the lapsing or repurchase by the municipal authority of the license once granted. One great advantage which a manufacturing firm has in editing a journal of its own is that the advertising columns are freely at its disposal. In this respect the Victor Manufacturing Company has taken full advantage of its proprietary interests.

A Universal Measuring Instrument.—Mr. M. Aliamet describes in our French contemporary *L'Electricien* a neat combination of ammeter and voltmeter in one case for use on electric automobiles. The instrument in question is made on the Weston principle, but we are not told the maker's name. It consists of two sets of permanent magnets with iron cores, round which two movable fine wire coils with indicating pointers are pivoted. One of these is connected up as a voltmeter across the terminals of the accumulators, with a resistance in series with it. With this instrument the voltmeter is made to read up to 120 volts. The ammeter coil is connected to a low-resistance shunt in the main circuit. The ammeter is made to read in two directions, being graduated up to 40 amperes for the charging current and 100 amperes for the discharge. The scales on the face of the instrument are, of course, on two different levels, the voltmeter pointer moving on a plane slightly above that of the ammeter pointer. The graduated scale of the voltmeter in this way obscures the larger part of the ammeter pointer. The idea of combining the two instruments in one case is a good one, as the space available for such instruments on an electric carriage is limited.

Sheffield Tramways.—The chairman of the Sheffield Tramways Committee is about to introduce a resolution in favour of dividing up the cars on certain routes into first and second class compartments. He states his opinion that the traffic on the tramways is interfered with owing to the fact that workmen coming straight from the collieries and steelworks mix freely with the ordinary passengers, to their great discomfort. It is not yet settled what proportion of each car will be reserved for first class, but Alderman Clegg proposes that a substantial increase in fare will be made to first-class passengers. We think that the reason for the change is a good one, but that it could be also met by providing a large number of workmen's cars at those periods of the day at which the men are going to or leaving work. Otherwise, the conductors will find it exceedingly difficult to restrain the workmen on crowded cars from entering the first-class compartments. Alderman Clegg also states in an interview with the *Sheffield Daily Telegraph* that the success or otherwise of the ½d. fares on the electric tramways cannot be ascertained until the full equipment of cars has been obtained and run. The reason for this is that at the present time the long-distance passengers keep the cars full, so that the ½d. rides cannot easily be obtained.

Electric Lighting in St. Marylebone.—The members of the Vestry of St. Marylebone do not seem to agree on any one point with respect to the electric lighting in the parish. It was curious to note that at the deputation to Mr. Ritchie at the Board of Trade almost as much stress was laid on the differences between different sections of the Vestry as on the actual failures of the Metropolitan Company. At a Vestry meeting held the next day, one of the members moved that the vestry clerk should write to the Board of Trade stating that, while they objected to a second company, the parish itself was most anxious to have powers for generating electric lighting, and that it intended to apply for a provisional order. This motion was seconded, but was finally thrown out on the grounds that notice had not been given. The Chairman added that he did not think that any harm would have occurred from the delay, but we fail to see from the report any attention drawn to the fact that the Vestry own a provisional order. In the terms of this order the works of the Metropolitan Company have to be purchased before the new order becomes operative. In spite of this, we do not find the Vestry moving in the matter to effect the purchase in question. We know that the price asked by the company is exceedingly high, but we learn of no further negotiations with the company with a view to reducing the price.

Measuring Telephone Currents.—A number of experiments in the past have been made to determine the actual current used when telephone messages are being sent, and to show how sensitive telephone receivers are to exceedingly small currents. Mr. Eugene W. Caldwell describes in the New Year's number of the *Electrical Review* of New York some experiments he has made to determine

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how large these currents can be made without prejudicing the commercial value of a telephone. He points out that when telephoning over long lines high-resistance leaks improve the speaking, except when the received current is reduced by this leakage too much. He suggests, therefore, that there is every advantage to be gained from increasing the currents sent out to the line. It has been found, however, that increasing the size and mass of the vibrating parts of the transmitter impairs the accuracy of transmission, and the increasing of the battery current also has the same effect after a certain limit has been reached. The measurements described by the author were made with a hot-wire ammeter of ingenious construction, and the experiments consisted in increasing the currents used until the transmitter failed to give good results. The author found that the average current transmitted was about one watt, and he concludes from experiments made under conditions which more nearly approach those of everyday practice that the average energy in the ordinary telephone current is somewhere about $\frac{1}{4}$ watt. This is a much higher value than we should have expected from the figures which were given by Dr. Oliver Lodge and others at the Institution of Electrical Engineers.

Tramways Round Glasgow.—The competition for tramway concessions in the district surrounding Glasgow is exceedingly keen, and on account of the large number of competitors for the consent of the local authorities to their schemes the authorities should obtain exceedingly favourable terms. We have recently seen particulars of proposals which are being made for tramways in and around Paisley, and which are the subject of Bills shortly to come before Parliament. One of the companies in question (the Glasgow District Tramway Company) proposes to spend no less than £360,000 in the district. The company guarantee to run the service at a maximum rate of 1d. per mile, but they are understood to favour ½d. fares. Workmen's cars, morning and evening, are promised at fares not exceeding ½d. per mile, and the company express their intention to complete the whole work within 18 months or two years of the Bill passing. The lines are to be equipped on the overhead trolley system. The repurchase clauses provides that at the expiration of 42 years the local authorities could buy out the company on the usual terms of the 1897 Tramway Act. An option is also provided for the repurchase, at the expiration of 21 years from the opening, of the tramway at the fair market value of the undertaking as a going concern. Another scheme promoted by the British Electric Traction Company offers Paisley rather better terms in this respect, as it proposes to hand over the system to the Corporation at the end of 28 years. We trust that if either of these competitors receives the support of the municipal authorities, it will not be on such terms as will hamper the undertakings when they have been once started.

The Pacific Cable Board.—We gather from the *Financial News* that exceptionally valuable information has been obtained by the Pacific Cable Board during the work of revising the estimates for the cable. Some of the best-known experts have been asked to give their opinions as to the many items involved. These opinions and views having been collated and analysed, it has been found that in several directions considerable savings can be effected, these in the aggregate amounting to such a substantial figure as to almost, though not quite, equal the amount to be added to the original estimate, on account of the rise in materials, since it was made in 1896. As far as things go at present, it is certain that the Board's revised estimate will not largely exceed that of 1896. But over and above this, competent opinion has been expressed that further reductions can safely be made, in which case the figures of the revised estimate will come well within those of the original. To be on safe ground, however, further information is being sought as to whether it would be safe to accept this latter opinion, though favourable, as definite. In the face of the above it is curious to note, on the authority of the *Daily Mail*, that the Government of New South Wales has written to the Colonial Office for permission to grant to the Eastern Telegraph Company the right to construct land lines in their territory. Up to the present all the land telegraph lines in Australia belong to the Government, and no private company's lines have been allowed. Our contemporary goes further, and states that the Colonial Office has granted the permission asked. It would seem to us to be a great mistake to admit competition in this way, and also to enable a telegraph company to offer special terms to private individuals for direct connection with their cable system. If this permission is actually confirmed, it will in the future hamper the all-British cable in a way which should not be allowed.

The Henry Centennial Celebration.—We referred in a recent issue to the celebration at Albany in connection with the distinguished scientist Joseph Henry, and we now read in the *Electrical World* a *résumé* of the paper read on that occasion by Mr. J. F. McElroy, which was entitled "Joseph Henry's Contribution to Science." In this, the first notable work of Henry referred to is an investigation of the law covering the development of magnetism in soft iron by means of the electric current. By these investigations Henry discovered the fundamental rules connected with the winding of electromagnets, from which he developed the electromagnetic telegraph. In these investigations he proved that the power of a magnet depended on the number of turns multiplied by the current going through them. Prof. Henry's work in connection with telegraphy is then described in detail, a large amount of this work being done previous to 1831. Incidentally he also discovered about this date the phenomenon of magnetic induction, for which he would have received the credit as prior inventor had not he been somewhat slow to publish his results. In fact, it was pointed out that the work of this great scientist was prejudiced by the fact that he did not publish quickly the results of his experiments. In this way others working independently, and having the benefit of the criticisms of their fellows, were able to do more to develop electrical science. In the paper in question a great deal of other work done by Prof. Henry is referred to, such as his experiments on the oscillatory discharges of condensers, his experiments in connection with the return discharge after a stroke of lightning, his work on the inductance of circuits, and also the vast amount of original research he did in connection with magnetic induction. From another address given during the celebration, Prof. Henry's ancestors are traced to Kirkcudbright, from which town his grandfather emigrated to America in 1775.

Accumulator Plates.—Accumulators with mechanically supported active material in the form of paste—such as litharge, peroxide of lead, or pulverised lead with or without admixture—have given rise to the employment of divers forms of containing frame, each designed to give maximum support to the embedded material and to prevent the falling out of the same. For this purpose thin plates of non-conducting material have also been used to cover the surfaces of the positive electrodes. The problem of securing perforated plates to the surfaces of the electrodes has been solved in several ways. It has hitherto been accomplished either by wrapping the protecting plates around the electrodes and securing them in

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position by means of the insulating rods placed between the electrodes of positive and negative elements, or when composed of metal, by soldering or cementing them together, riveting them to the electrode grids, etc. A new practice recently introduced by the Berlin Accumulator Works, says the *Elektrotechnische Rundschau*, which possesses the merits of strength and cheapness compared with the methods hitherto in vogue, consists as follows: The metal plate or shield to be attached to the electrode is cut out to corresponding size, and so laid in the mould in which the electrode grid is to be formed that during the casting process the molten lead can run through the perforation provided in the shield, so riveting the latter to the grid. The method, however, allows one side only of each electrode to be so protected at one operation. When the electrode constructed according to this method becomes an end plate, it may be employed as a so-called half-plate or end plate, with its unprotected side facing the wall of the cell without further modification. But in the case of the remaining positive electrodes two such shields are provided for each so riveted, soldered, or otherwise fastened together, with the active element enclosed between them, as to form an efficient support to either side of the electrode.

Annealing Armour Plates.—At a recent meeting of the Engineers' Club of Philadelphia, Mr. C. J. Dougherty read a paper on the "Electrical Process of Annealing Armour Plates in the Construction of Warships." This paper is abstracted in the *Electrical World*, from which we take the following details. The armour plates in question were all Harveyised steel hardened to a depth of $\frac{7}{8}$in. The hardness is so great that they cannot be drilled unless they are annealed locally. The apparatus used for this is like the well-known Thomson electric welder, the ends of the secondary coils being held on the surface of the plate at the spot which is to be annealed; the secondary current therefore passes through the surface of that portion of the iron and raises it to a red heat, which draws the temper of the hardened shell. As the chilling action produced by the surrounding iron is great enough to restore the temper if the current is stopped suddenly, the current is reduced very gradually, from 10 to 20 minutes being allowed for this gradual diminution. The apparatus consists of a transformer, the secondary of which is made of a very large copper casting closely surrounding the primary, and both are surrounded by iron; the secondary is slit in one spot, and the two ends terminate in the contact points. The transformer is surrounded with oil, and the terminals are kept cool by a flow of water through them. The ratio of transformation is 100 to 1, the primary current about 100 amperes at 300 volts, and the secondary about 10,000 amperes at 2·5 to 2·8 volts. The contact surfaces are only about half a square inch, and the current density at those spots is therefore about 40,000 amperes per square inch. The total weight of the transformer is about 1,000lb., which, when resting on the plate, is sufficient to make good contact. Directly under these contacts the metal remains hard and cannot be drilled; the space to be drilled lies midway between the two contacts. The author proceeded to describe the plant used in connection with the annealing apparatus and the regulating rheostats for controlling it. It seems that there are two sets of these annealers in use in Cramps's yard, and that these have been proved to be quite capable of dealing with Krupp plates, which are hardened to a depth of 2in. instead of the $\frac{7}{8}$in. as mentioned for the Harveyised plates.

Ventilating without Draughts.—Last week at the Society of Arts Mr. A. Rigg delivered a lecture on the above subject, in which he reviewed the numerous systems of ventilation which have been tried with more or less success, and pointed out that in nearly every case it had not been found possible in practice to properly ventilate public buildings without creating objectionable draughts in certain parts. The author reviewed the causes of these failures, and arrived at the following conclusions as most likely to lead to the desired end: ventilation should as far as possible be carried out by the plenum, and not by the vacuum system; fresh air should be introduced as an upward current from openings above the heads of an audience, but not so high as the ceiling—it should be driven in divided streams into the upper part of the room, so as to mix with warm air already travelling there; exits for carbonic acid, dust, and watery vapour should be provided at or near to the floor level if required; the roof or ceiling of a properly-ventilated chamber should be hermetically closed; open windows should only be used during warm weather, never in winter; as natural draughts cannot always be relied upon, fans or a furnace or other means of producing artificial draughts should be resorted to when necessary. As was to be expected, certain of his conclusions were strongly controverted in the discussion which followed, particularly that with respect to open windows. It was also pointed out in the discussion by Mr. Graham Harris that the introduction of electricity in the place of gas made the question of ventilation considerably easier. This was because gas both heated and vitiated the air in a room. We also think that with gas lighting the heat given off would considerably interfere with Mr. Rigg's suggestion for having the outlet for vitiated air near the floor. It was also pointed out in the course of the discussion that a room like the Society of Arts lecture theatre was comparatively easy to ventilate, compared with one which had many windows and other openings. The cost of efficiently ventilating rooms was stated to be high, as the desired quantity of fresh air could not be obtained in the majority of cases without mechanical means. In this way electricity, in driving fans, lends as great aid to the ventilating engineer as it does to the consumer when used for electric lighting in reducing the quantity of fresh air actually required in a given space.

The Tyneside Electrical Power Company.—We have received a circular dealing with the objects and position of this company, which is promoting a Bill in Parliament to enable it to supply electrical energy throughout the whole of the Tyneside manufacturing district. The following gentlemen have taken a prominent part in the formation of the company, and their names being connected with large industrial undertakings in the district should have great weight in getting the Bill through Parliament. These gentlemen are Messrs. N. C. Cookson, H. C. Harvey, C. J. Leyland, J. D. Milburn, Saxton W. A. Noble, the Hon. C. A. Parsons, F.R.S., Messrs. J. B. Simpson, E. Smith, and A. A. Campbell Swinton, M.I.C.E. The object of the company is to distribute electrical power at cheap rates throughout the district, and in the Bill careful provision is made that the legal authorities who have already electric lighting schemes at work should not be interfered with. The company will undertake to supply electricity in bulk to any local authority who wishes to maintain an independent distribution system, and in other cases the company will lay down the necessary distributing mains themselves. Under the Bill the following maximum rates for electrical energy are given, together with a sliding scale for reduction in proportion to the profits earned: 4d. per unit for the first 200 hours' supply per quarter at the maximum demanded power. Any further supply up to an average of 400 hours per

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quarter, 2d. per unit; while if this amount is exceeded, 1d. per unit will be charged for the excess. It will be seen from the above that unless a consumer uses his maximum power for more than two hours per day he will pay 4d. per unit. While this price is quite reasonable for lighting consumers, we think that the sliding scale will have to be modified if the electric motors connected with the company's mains are to compete with steam-engines in the Tyne district. It will be remembered that in Newcastle the electric lighting companies only receive on the average about 4·11d. per unit for electrical energy actually sold. The supply of power will have to be given at a lower rate than this, and we do not doubt but that the company will find a good demand for electricity if it will supply the same at competition rates. There is no doubt that in a large number of the works on the Tyne great savings could be effected if only the present isolated steam-engines scattered over the district could be replaced by electric motors.

Lord Rayleigh on Flight.—The first Friday evening meeting of the Royal Institution took place last week, when Lord Rayleigh delivered a most interesting discourse on the above subject. He pointed out that the main problem of the flying machine was the problem of the aeroplane. The action of the wind on the plane could be experimented with up to a certain extent by means of kites, but these kites were always anchored to the ground, and as soon as this anchoring was taken away the problem become much more difficult. Lord Rayleigh proceeded to analyse the action of birds in flying and sailing without flapping their wings, and pointed out several popular misunderstandings in connection with such named operations. Proceeding to discuss the general question of the action of the wind on an aeroplane, Lord Rayleigh showed one or two experiments. In one of these it was seen that a light piece of sheet brass, evenly pivoted in, and nearly filling up, an aperture through which air was issuing under pressure, tended to set itself square to the aperture so as to block it as much as possible, but, if started, it continued to rotate in either direction, emitting a roaring sound. This phenomenon had never been properly explained, nor had the somewhat analogous action of a piece of card, which, when dropped, reached the ground with a rotatory motion. As to the pressure of the wind on a plane surface, if the latter was falling vertically at the rate, say, of four miles an hour, and also moving horizontally at, say, 20 miles an hour, did the horizontal motion make a difference to the pressure that existed at its under surface? It might be argued that it did not; but the argument was fallacious, and the truth was that the horizontal motion much increased the pressure under a vertically falling plane, a fact on which depended the possibility of flight, natural and artificial. Lord Rayleigh showed how this point might be illustrated, and even investigated, by means of a simple variation of the ordinary windmill. This was a light wheel having six vanes, each of which could be set at any desired angle, and it was used by setting four at a particular angle and finding at what angle the other two must be placed so as to compensate the rotation of the wheel produced by the former when it was moved quickly through the air. He next observed that not only was their pressure underneath a bird's wing or an aeroplane, but that the suction above was not an unimportant matter, and he performed an experiment to show the reality of this suction, about which he said there had been some scepticism. Turning to flight on a large scale, he remarked that it was a natural question to ask, Was it possible for a man to raise himself from the ground by working a screw with his own muscular power only? The investigation was not difficult, and the answer was that it was quite impracticable for him to do so. Artificial flight was a question of the speed of the horizontal motion. A bird did not use a revolving mechanism like a screw to propel itself, but he had no doubt that a revolving mechanism was the most suitable for artificial flying machines. Whether the difficulties of these would be surmounted he did not know, but he was disposed to agree with Mr. Maxim that it was mainly a question of some time and much money. Still, he did not think flight would ever be a safe mode of conveyance for those who were desirous of going out for a day's shopping, for it was hard to see how alighting on the ground could ever be rendered quite free from danger. But, as Mr. Maxim once remarked, the first use of flying-machines would be for military purposes, and they had not yet succeeded in making war quite safe. We are indebted to the *Times* for the above *résumé* of Lord Rayleigh's lecture.

Wireless Telegraphy. — On the 18th inst. Prof. Oliver Lodge delivered a lecture in the Queen's Rooms, Glasgow, before the Glasgow Association. A number of distinguished gentlemen were on the platform, and the lecture was well received by all present. Prof. Lodge's address on the same subject to the Institution of Electrical Engineers will be fresh in the minds of many of our readers. In his discourse last week the general rise of electricity and the knowledge of electric oscillations were traced from the predictions of Clerk Maxwell in 1853 to the discovery by Hertz, and subsequently of the work of Branly, Righi, Bose, Popoff, and others. Prof. Lodge also referred to the work of Signor Marconi and Prof. Slaby in connection with the practical development of the wireless telegraph. To make the action of this more clear to his audience, Prof. Lodge likened the electrical discharge from the vertical wire to an impulse along the thong of a whip, whereby a great disturbance or whipcrack is communicated to the air in the one case, to the ether in the other; this is the sending of the signal. At a distant station a small fraction of the effect of this sudden disturbance is collected by a similar elevated wire connected at its lower end with a small tube of filings called a "coherer," introduced into an electric circuit with a battery and relay, so that when the electric stimulus arrives the filings cohere and convey the current, thus throwing over the tongue of the relay until they are tapped back and restored mechanically to their previously disconnected state. The operation of signalling was described, it being shown how the Morse signals could be transmitted and recorded. Farther on in his lecture Prof. Lodge explained that at the present time no attempt is made in practice to discriminate one receiving station from another. All within range, if sufficiently sensitive, can pick up the signal. There are methods, which the lecturer partly explained, whereby syntony can be obtained—that is to say, where the sending and receiving stations can be tuned so as to respond to each other, but not to another station differently tuned. The attainment of tuning, however, at present restricts the range over which such telegraphy is possible—the radiating power of an attuned or syntonic instrument being less than the radiating power of an elevated wire, just as it is more easy to obtain a loud sound out of a piece of string by using it as a whip-lash and cracking it, than by stretching it on a sound-board and plucking it. He reminded his audience, in conclusion, that the sound analogy was simply used for the sake of explanation, as the disturbances utilised in wireless telegraphy are etherial and not aerial. In this respect optical analogies were more correct, and there was a wonderful similarity between signalling by flashlights and wireless telegraphy.

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AN AMERICAN PACIFIC CABLE.*

BY GEORGE OWEN SQUIER.

(Concluded from page 81.)

CONCLUSION.

After several years of comparatively little advance, the technical and scientific side of telegraphy has received much attention during the past two or three years, until at this moment there is no other special branch of electrical engineering which is more in evidence or promises more for the future. By whatever method the first Pacific cable is ultimately laid, and provided that it shall appear that all of the projected cable cannot be manufactured and laid in the United States within a reasonable time, it seems plain that the encouragement of American manufacturers in the building up in the United States of a deep-sea cable industry of the first class is a wise policy for this Government.

The successful completion of the submarine cable across the Pacific will mark an epoch in the telegraph history of the world. After 30 years of consideration—technical, commercial, and political—the end of this century sees this great enterprise at last seriously undertaken. The full influence which it will exert upon the Western Hemisphere and the world in general is not easily appreciated. Strategically, the importance of this intercolonial communication and its preservation are very great. However, the Philippine question should not overshadow the larger question—the Eastern question—in the consideration of this project. Important as the cable will be as a means of joining the Philippine Archipelago to the United States, its larger importance will ultimately be in the future of the commercial development between the United States and the East. In the broad extension of the Pacific trade consequent upon the completion of the Isthmian Canal and the development of steamship lines plying the Pacific, the telegraph cable will naturally become an important factor. The trans-Pacific steamship lines are heavily handicapped by the absence of a direct means of telegraphy between the ports embraced in their routes. Situated on the main trade routes leading from the Isthmian Canal to Asiatic ports, the Pacific cable will serve as a powerful adjunct and support to this enterprise. The two go hand-in-hand and are mutually closely related. It can be stated that there is scarcely any point in the world where there is greater need for a central cable station than in the Hawaiian Islands. Geographically situated at the military and commercial strategic position of the North Pacific Ocean, it will ultimately serve as the distributing centre of ocean communication between the two hemispheres, as well as to various island groups of the Pacific.

As to the probable traffic to be immediately expected there is little direct evidence at hand, since the waters spanned have never before been crossed by a submarine cable. Taking 150·00dol. as the average earning power per nautical mile of the long cables of the world as a basis, this project should prove a paying investment from the very first, but it is believed that this estimate, based upon the average of cables, will prove under rather than above experience, particularly as this route will immediately enter as a competitor for European traffic *vid* the Atlantic cables and United States land lines. The immediate effect of the trans-Pacific cables will be to lower the rates to the East, since European traffic will be open to competition, east and west, and the new Western route, due to the long spans and comparatively few repetitions, will have an advantage. A short span of cable of about 200 miles between Luzon and Formosa, connecting with the Great Northern Telegraph Company's route through Siberia, and also between Luzon and a Chinese port, will bring Japan and China into direct connection not only with the North American Continent, but also by two competitive routes east and west with Europe. In fact, the laying of the Pacific cable should operate to readjust the present cable through-tariff rates throughout the world upon a lower basis.

* Paper read at the one hundred and thirty-eighth meeting of the American Institute of Electrical Engineers, New York and Chicago, Dec. 27, 1899.

Appendix No. 1.

PROJECTED PACIFIC CABLE. Distances in Nautical Miles. (United States Coast and Geodetic Survey.)

Provincial routes.	Great circle.	Rhumb line.	Great circle distances + 10 per cent. slack.	Great circle distances + 15 per cent. slack.
San Francisco to Honolulu	2,078·43	2,086 86	2,286·27	2,390·19
Honolulu to Midway Island	1,139·98	1,140 95	1,253·97	1 310·97
Midway Island to Guam ...	2,293·64	2,299 25	2,523·00	2,637·68
Guam to Dingala Bay, P. I.	1,359 95	1,360·50	1,495 94	1,563·94
Totals	6,872·00	6,887·56	7,559·18	7,902·80
San Francisco to Honolulu	2,078·43	2,086 86	2,286·27	2,390·19
Honolulu to Wake Island..	2,004 27	2,008·23	2 204·69	2,304·91
Wake to Guam	1,304·43	1,305·08	1,434·87	1,500·09
Guam to Dingala Bay, P. I.	1,359 95	1,360·50	1,495·94	1,563 94
Totals	6,747·08	6·760·67	7,421·77	7,759·14
Guam to Yokohama	1,348·05	1,348·12	1,482·85	1,550·25

1 mile = 1,853·25m. or 6,080·2ft.

Geographical Positions Adopted.—San Francisco, California, Fort Point, Golden Gate; Honolulu, Hawaiian Islands, Harbour Light; Midway Island, or Brooks Island, Welles Harbour; Wake Island, centre; Guam, Fort Sta. Cruz, San Luis de Apra; Dingala Bay, Luzon Island; Yokohama, Japan, English Naval Storehouse.

The nearest point of the main land from Honolulu is Point Arena, next Point Reyes, next Point Sur, California. Taking the positions of the lighthouses the distances to Honolulu are as follows:

From Point Arena.....	2,045·7	nautical miles.
,, Point Reyes..	2 057·5	,, ,,
,, Point Sur.....	2,078·4	,, ,,

As evidence of the importance of particular secret manipulation during manufacture, independent of the weights of materials employed, and the measured K. R. of the finished cable, Messrs. Siemens Bros. and Co. have lately issued a table of Transatlantic cable speeds, from which the following data are taken:

TRANSATLANTIC CABLES.—Tabular Statement of Actual and Calculated Speeds.

Designation of cable.	Length in nautical miles.	Type of core of deep-sea cable. Pounds per nautical mile.	K. R. ohm × microfarads ÷ 10^6.	Speeds actually obtained in regular working. Five-letter words.	Calculated speed if lengths 1,860 nautical miles.	Calculated speed if lengths 1,850 nautical miles and core 650/400.
		Cop. G.P.				
Anglo-American	1,876	400/400	3·919	—	—	—
Anglo-American	1,837	400/400	3·512	20·2(*a*)	19·9	28·2
Direct United States ...	2.423	400/360	7·558	22·6(*b*)	38·6	70·2
Pouyer-Quertier	2,242	350/300	6·600	22 (*c*)	32·2	59·8
Anglo-American	1.852	—	4·632	—	—	—
Jay Gould	2.518	350/300	7 834	21·5(*d*)	39 8	69·4
Jay Gould	2 563	350/300	8·030	21·5(*d*)	41·2	71·2
Mackay-Bennett (S) ...	2.353	350/300	6·740	26	42 0	72·3
Mackay-Bennett (N.)..	2,346	350/300	6 630	26	41·8	71·2
Mackay-Bennett (3rd)..	2.161	500/320	4 671	40 (*g*)	54·6	77·2
Anglo-American	1,850	650/400	2·420	47·4(*e*)	47·4	47·4

(*a*) Report of engineers, Messrs. Clark, Forde, and Co., to the manager of the Anglo-American Telegraph Company, dated June 25, 1877. (*b*) Report of engineers, Messrs. Clark, Forde, and Co., to the manager of the Direct United States Cable Company, dated June 25, 1877. (*c*) Report of the engineer-in-chief, Mr. von Chauvin, to the Pouyer-Quertier Cable Company, dated June 15, 1880. (*d*) Report of Dr. Muirhead to Mr. von Chanvin, representative in London of the Western Union Telegraph Company, dated July 10, 1883.

{(i.) Special trial of code words, 18 words per minute } mean
(ii.) Press messages, usual rate, 25 ,, ,, ,, } 21·5
(iii.) As many as 135 letters per minute have been observed to pass at times without requiring repetition.

(*e*) *Electrician*, dated Oct. 12, 1894. (*g*) From a letter from Mr. G. G. Ward, vice-president and general manager of the Commercial Cable Company, dated May 10, 1895.

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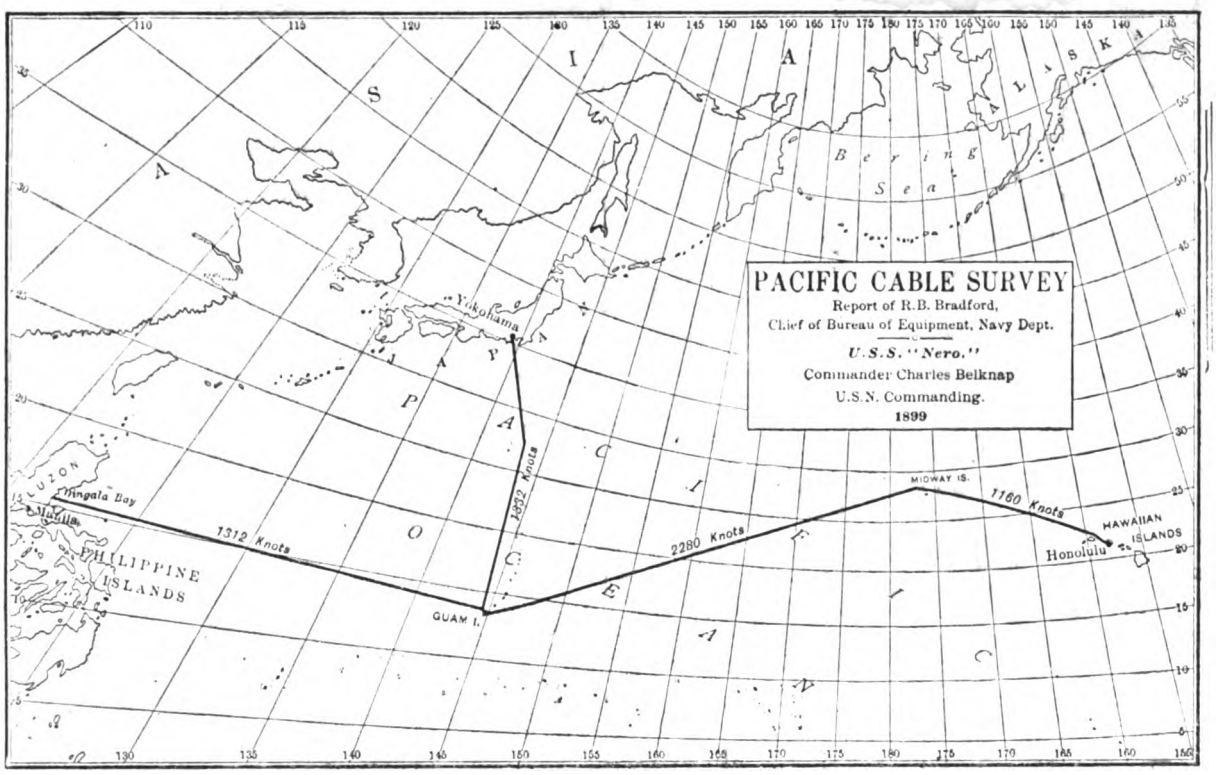
Appendix No. 2.

Trans-Pacific Telegraph Cable Survey.

(From Annual Report of Chief of the Bureau of Equipment, Navy Department, November, 1899.)

A practical route for a submarine telegraph cable was established between San Francisco and Honolulu some years ago. In order to continue the survey of the route from Honolulu to the Philippines, the U.S.S. "Nero," under command of Commander Charles Belknap, U.S.N., was very thoroughly fitted out and equipped for deep-sea exploration at the navy yard, Mare Island, during the early part of the present year. The "Nero" is a large steam collier purchased for use during the late war, and on account of great steaming radius was admirably adapted to make the survey. After a careful consideration of the subject, it was decided that the best route westward from Honolulu to the Philippine Islands was by way of the Midway Islands and Guam, landing the cable at a convenient point on the east coast of Luzon as near as possible to the latitude of Manila. It was also decided as desirable to survey a route from Guam to Yokohama. Elaborate instructions for the survey were prepared. The plan of the survey, which is represented on the accompanying chart, consists in carrying direct lines of soundings, taken at alternate intervals of ten and two knots, from Honolulu to the Midway Islands, thence to Guam, and thence to Luzon, and also from Guam to Japan. The return course to be pursued is a zigzag line passing back and forth to equal distances on each side of the route followed in going to the westward, with soundings at intervals of 20 knots at the turning points. The "Nero" sailed from San Francisco for Honolulu on April 22. She sailed from Honolulu to commence her work on May 6. On May 22 she had completed a single line of soundings to the Midway Islands, by July 4 to Guam, and by Aug. 1 to Luzon. Along this route, which is 4,812 knots in length, 853 soundings were taken. The characteristics of the bottom soil and the temperature of the surface water were observed at each sounding station, and these, together with the meteorological record and the frequent observations of specific gravity, bottom temperature, and the currents of the ocean, besides their value in laying a submarine cable, will form an important contribution to the physics of the Pacific Ocean. Two offsets from the projected great circle route between the Midway Islands and Guam were found to be necessary in order to avoid obstacles to a successful laying and operation of a telegraph cable. The first of these obstacles encountered is a submarine mountain situated a short distance westward of the Midway Islands, and rising from the floor of the ocean, which here sinks to a depth of 2,200 fathoms to within 32 fathoms of the surface. The second obstacle is one of the deepest submarine abysses yet found in the world, situated about 500 miles eastward of Guam, and sinking to a depth of more than 4,900 fathoms.

Reports have been received of the preliminary line of soundings from Honolulu to Luzon, and they indicate that the route which is being surveyed will prove entirely practicable. No reports of the soundings taken on the return trip, or of any soundings from Guam to Yokohama have been received. Owing to illness, Commander Charles Belknap, U.S.N., was relieved from the command of the "Nero" at Manila by Lieutenant Commander H. M. Hodges, U.S.N. The expenses of this survey, so far as this bureau is concerned, has been entirely defrayed from its current appropriations.



THE HEAT OF FORMATION OF IONS.*

BY A. HOLLARD.

(Concluded from page 62.)

In the determination of Ostwald, the electric charge which the elements receive in order to pass into the ionic state and to enter into solution, is taken from the ions which are already found in the solution. This charge can be taken from an exterior source, and we have then electrolysis taking place. Let us consider a metallic anode placed in a solution of one of its salts—for example, an anode of copper placed in a solution of copper sulphate. The calorific energy which results from the passage of a given quantity of electricity, Q, across the separating surface of the two conductors (Peltier effect), is equal to $EQ \times \frac{1}{4{\cdot}17}$ calorie-gramme-degrees; 4·17 is the calorific equivalent to the electrical energy, and E is the electrical pressure which exists between these two conductors. This is true for metallic conductors, but not for the case stated above, in which the metallic conductor is in contact by a conductor which is the electrolyte. The calorific energy resulting from the passage of Q coulombs from the metallic anode in the solution to the salt of the same metal is equal to $\frac{EQ}{4{\cdot}17}$, less the heat of ionisation, j, absorbed for

* Translated from the *Revue générale des Sciences.*

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the formation of ions, which are carried into solution. For this calorific energy we then have the value

$$W_a = \frac{E\,Q}{4{\cdot}17} - j \text{ calorie-gramme-degrees} \quad . \quad (1)$$

But this calorific energy is only the secondary heat of Helmholtz relative to reversible electrolysis.

$$W_a = \frac{T}{4{\cdot}17}\frac{dE}{dT}Q \quad . \quad . \quad . \quad . \quad . \quad (2)$$

T being the absolute temperature. Thus this secondary heat can only be developed at the surfaces of contact between the electrode and the electrolyte. While Joule's law is applicable to electrolysis, he excluded the hypothesis under which more heat changes will be produced in the mass of the same liquid by secondary reactions. If e is the pressure at the terminals of the cell or reversible battery, the total secondary heat calculated by Helmholtz is

$$W = \frac{T}{4{\cdot}17}\frac{de}{dT}Q,$$

which gives the sum of the secondary heat which is developed at the anode and at the cathode, and which may be expressed as follows:

$$W_a = \frac{T}{4{\cdot}17}\frac{dE}{dT} \text{ and } W_c = \frac{T}{4{\cdot}17}\frac{dE'}{dT}.$$

In the first formula W_a may be replaced by its value $\frac{T}{4{\cdot}17}\frac{dE}{dT}$, which gives for j the value $j = \frac{Q}{4{\cdot}17}\left(E - T\frac{dE}{dT}\right)$, and for a molecular gramme of ions, of valency n, passed into solution

$$j = \frac{n \times 96{,}537}{4{\cdot}17}\left(E - T\frac{dE}{dT}\right)$$

or

$$j = 23{,}067\,n\left(E - T\frac{dE}{dT}\right).$$

By this means Ostwald found directly for copper the value $j = -17{,}500$ at 17deg. C. The values expressed in Table III. have been calculated by Jahn from the preceding formulæ, and they correspond to a temperature of 20deg. and to an equal concentration per litre.

TABLE III.

—	Mass of metal separated (in grammes)	E	$\frac{dE}{dT}$	Heat of ionisation
Sulphate of copper ...	63·7	−0·585	−0·000750	−16,470
Sulphate of zinc	65·0	+0·524	−0·000763	+33,950
Sulphate of cadmium.	112·0	+0 162	−0·000658	+16,120
Nitrate of lead	207·0	−0·079	−0·000182	− 1,160
Nitrate of silver	108·0	−1·055	−0 000176	−22,873
Nitrate of copper.....	63·7	−0·585	−0·000756	−16,470

The heats of ionisation which are given in the last table correspond to the heat absorbed when they are prefaced by the negative sign, and to the heat set free when the positive sign is prefixed. The source of heat is in each case at the anode due to the passage of the metal in the solution into the ionic state. At the cathode the ion is recondensed as metal, and the heat which results from this transformation is of the opposite sign to the first. Thus, one molecular gramme of zinc (65 grm.) which passes from the metallic state into the ionic state in setting free 33,950 calories absorbs and deposits at the cathode the same quantity of heat. Let us consider, for instance, a reversible battery, like the Daniell, for example. The secondary heats at the anode and at the cathode are equal, as shown above, at

$$W_a = \frac{E\,Q}{4{\cdot}17} - j,$$

and,

$$W_c = \frac{E'Q}{4{\cdot}17} - j';$$

or,

$$E - E' = \frac{4{\cdot}17}{Q}\left[(W_a - W_c) + (j - j')\right] \quad . \quad . \quad . \quad (3)$$

but we have,

$$W_a = \frac{T}{4{\cdot}17}\frac{dE}{dT}Q \text{ and } W_c = \frac{T}{4{\cdot}17}\frac{dE'}{dT}Q.$$

In substituting these values in equation (3), we have, after making all simplifications,

$$E - E' = \frac{j - j'}{n} \times \frac{1}{23{,}067} + T\,\frac{dE - dE'}{dT},$$

or $E - E' = e$, the electrical pressure at the terminals of the battery;

then,

$$e = \frac{j - j'}{n} \times \frac{1}{23{,}067} + T\,\frac{de}{dT};$$

but $j - j'$, the difference of the heats of ionisation of zinc and copper, represents the heat of the decomposition of copper sulphate by zinc. $j - j'$ therefore represents only the heat, W, of the chemical reactions of the Daniell battery. Substituting this value in the preceding expression, it becomes

$$e = \frac{W}{n} \times \frac{1}{23{,}067} + T\,\frac{de}{dT}.$$

In this way we again obtain the formula of Thomson and Helmholtz.

The formula for ionisation in the case of reversible phenomena, $j = 23{,}067\ n\left(E - T\frac{dE}{dT}\right)$, can also be obtained from thermodynamics. We know that the Nernst formula which is applicable to a soluble anode has the form

$$E = \frac{9{\cdot}81}{Q}RT\log_e\frac{P}{p} \text{ volts} \quad . \quad . \quad . \quad (a)$$

R is the constant for gas and is equal to 0·847, P is the pressure of dissolution, and p the osmotic pressure of the metallic ions of the electrolyte, this metal being the same as that of the anode. This formula, as is well known, has been obtained from thermodynamical principles. Differentiating this expression with respect to T, we get

$$\frac{dE}{dT} = \frac{9{\cdot}81\,R}{Q}\left[T\,\frac{d\log_e\frac{P}{p}}{dT} + \log_e\frac{P}{p}\right] \quad . \quad . \quad (b)$$

but

$$\frac{d\log_e\frac{P}{p}}{dT} = \frac{1}{P}\frac{dP}{dT} \quad . \quad . \quad . \quad . \quad (c)$$

or, on the other hand, the formula of Clapeyron in thermodynamics permits us to determine the value of $\frac{dP}{dT}$. This formula is applicable to all reversible transformations in which the pressure is a function only of the temperature. It can be shown by thermodynamics as applied to vaporisation that the formula of Clapeyron takes the form of

$$\lambda = \frac{T}{J}\frac{dP}{dT}(u' - u),$$

λ being the latent heat of vaporisation. This is the quantity of heat necessary to make the united mass of the body pass from the liquid state into the state of saturated vapour without a change of temperature. In the above formula J represents the mechanical value of heat, while u' and u represent the volumes of a unit mass of the liquid and of the saturated vapour. Thus $u' - u$ represents the variations of volume during the vaporisation of the united mass of the body. When applied to the change of the metallic state to the ionic state, these ions having a mass of a molecular gramme, the above formula of Clapeyron has the following significance: λ is the heat necessary to make one molecule-gramme of the body pass from the molecular state into the ionic state. In this way the heat of ionisation, P, is the pressure at which the metal passes into solution, while $u' - u$ represents the variation of volume during the ionisation of the molecule-gramme. This variation of volume is given, as we know, by the formula $PV = RT$, from which

$$u' - u = V = \frac{RT}{P}.$$

In substituting this value of $u' - u$ in Clapeyron's formula, as applicable to ions, we have, for $\frac{DP}{DT}$ the following value: $\frac{dP}{dT} = \frac{j\,J\,P}{R_d T^2}$.

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Substituting this value in the equation (*c*) we get

$$\frac{d \log_e \frac{P}{p}}{d T} = \frac{j J}{R T^2}.$$

Substituting this equation in the equation (*b*), we have

$$\frac{d E}{d T} = \frac{9{\cdot}81 R}{Q}\left[\frac{j J}{R T} + \log_e \frac{P}{p}\right]$$

or, on replacing J by its value 0·425, we get

$$\frac{d E}{d T} = \frac{9{\cdot}81 \times 0{\cdot}425}{Q} \frac{j}{T} + \frac{9{\cdot}81 \times R}{Q} \log_e \frac{P}{p}.$$

But the second part of the second expression in this equation is from equation (*a*)—namely, $\frac{E}{T}$. We have, then, after making all simplifications, the formula

$$\frac{d E}{d T} = \frac{1}{Q} \frac{j}{T} + \frac{E}{T},$$

or $$j = \frac{Q}{4{\cdot}17}\left(E - T \frac{d E}{d T}\right) \text{ calorie-gramme-degrees;}$$

and for a molecule-gramme of ions the valency

$$j = \frac{n \times 96{,}357}{4{\cdot}17}\left(E - T \frac{d E}{d T}\right),$$

or $$j = 23{,}067\, n \left(E - T \frac{d E}{d T}\right) \text{ calorie-gramme-degrees.}$$

In this way the considerations relating to the Peltier effects in electrolysis and the application of the thermodynamical principles lead to the same expression for the absolute value of the heat of ionisation. In this way the formula is firmly established. The conception of calorific energy thus applied to ions gives to the ionic theory a definite direction. The electric charge of ions does not give them a specific character, because this charge is the same for ions of equal value whatever may be the nature of the ion. This value is about 96,540 coulombs per ion gramme at a valency of 1. On the other hand, the variation of calorific energy which accompanies the formation of the ion varies with the nature of it, and this is in consequence an important specific characteristic.

THE GLASGOW CENTRE OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

It was with feelings of considerable gratification that we wended our way to the hall of the Philosophical Society in Bath-street last Thursday. We felt that at last the second city of the Empire had made up its mind to follow the example of Newcastle, Dublin, and Cape Town. To the labours of Mr. Henry A. Mavor and Prof. Magnus Maclean the success of the first meeting was due, and in point of numbers and enthusiasm it rivalled many other meetings held in the same hall.

Prof. John Perry was called to the chair, and thereafter Prof. MAGNUS MACLEAN read several letters of apology, one from Mr. Alexander Siemens, who expressed great regret that he was unable to be present, a previous engagement making attendance impossible. Dr. Maclean expressed the feelings of the audience when he said that Glasgow's electrical engineers were exceedingly gratified to see Prof. Perry (senior vice-president) and Mr. W. G. McMillan (secretary) on the platform, and before proceeding further he hoped they would have the pleasure of listening to some remarks from Prof. Perry.

Prof. PERRY, in the course of his address, expressed great pleasure at seeing such a large audience. Coming to Glasgow that day brought back recollections of his first visit to the city. He was then 15 years of age, and was serving his apprenticeship with Messrs. Victor Coates and Co. at Lagan Foundry, Belfast. While there he heard much of the famous Sir William Thomson (as Lord Kelvin then was), and he resolved to go to Glasgow in order that he might pursue a course of study under the distinguished scientist. It was interesting to note that 25 years ago Glasgow was the only place where one could receive instruction in electrical science; since then the number of places had increased wonderfully. After briefly sketching the history and progress of the institution, Prof. Perry proceeded to indicate the enormous growth of the applications of electricity to modern life. Some of the younger members, he thought, did not quite grasp this wonderful development. They had grown up among these wonders, and had become so familiar with them that they did not understand what wonderful things they really were. After referring to the regrettable circumstance that their meeting clashed with the lecture of Prof. Oliver J. Lodge on "Wireless Telegraphy," the chairman proceeded to speak of the wonders of ætheric telegraphy, and pointed out that in 1899 he spoke of people being able to signal through walls, houses, and over long tracks of country by means of Hertzian waves; indeed, he actually took out a patent for such a method of signalling. Some people at that time imagined he had gone mad, and some of his intimate acquaintances pointed out to him how very silly he must be. Since that time they had gone through some very curious experiences, and he questioned if even yet they had even a remote idea of the wonders to come in the early future. They would surpass even the "Arabian Nights." Many of the things in the "Arabian Nights" had come true, and more had yet to come, only engineers did not read that book, and if they read it—well, they did not believe it. This led Prof. Perry to enlarge upon the value of fiction in stimulating the imagination. At South Kensington he had established a library of fiction, much to the disgust of his colleagues, but he ventured to say that much of our progress was due to fertility of imagination, yet there was nothing so much neglected—especially among engineers—than the imagination. This was particularly the case in electrical engineering, and he believed that in stimulating the imagination of his students he was materially improving their prospects. No one who did not cultivate his imagination would make much progress in the electrical industry; and one who could manage a central station now, but who did not apply himself to the study of his work, would not be much good 10 years hence. The changes would be great; hence the need for institutions such as they were inaugurating that evening, where one's ideas and experiences could be discussed. Speaking of the necessity of seeing what their neighbours were doing, Prof. Perry referred to the Institution's visit to Switzerland. They went from a country where coal was cheap and water power not much thought about, to a country where coal was dear and water power abundant and highly prized. That visit was a revelation to many of them—for instance, in the practical application of two and three phase currents they were years behind that country, and in the application of electricity to steam railways, who would have dreamed that they would have seen a railway where steam and electrically propelled trains ran on the same track? Yet there they were, sometimes standing at the station quite uncertain whether the next train would be propelled by steam or electricity. This year they were going to the Paris Exhibition, and he felt quite sure that they would see much that they had never seen before. Next year they hoped to come to Glasgow, when the local branch would probably get some work to do. Prof. Perry concluded by congratulating the members on the starting of the local section, for he felt sure that it had a long and prosperous career before it.

The election of office bearers was then proceeded with. On the motion of Prof. W. H. WATKINSON, seconded by Mr. ANDREW JAMIESON, Lord Kelvin was unanimously elected chairman. For the post of vice-chairman there were three nominations, Mr. Andrew Jamieson (late professor of electrical engineering at Glasgow Technical College), Mr. Henry A. Mavor, and Prof. Magnus Maclean. On a division Prof. Maclean was elected. For the honorary secretaryship, Prof. W. H. Watkinson was unanimously elected. The following gentlemen were afterwards elected members of committee: Henry A. Mavor, W. B. Sayers, Francis Teague, W. A. Chamen, Andrew Jamieson, W. Lackie, J. M. M. Munro, and Thomas Young.

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OUR POSITION AS ENGINEERS.

On Saturday last Mr. Henry Hodgson, the president of the Manchester Association of Engineers, delivered his presidential address on the above subject at the annual general meeting at the Grand Hotel. The annual report of the council, read by the secretary, Mr. F. Hazelton, showed that the number of members is now 453, as compared with 416 at this time last year, and that the association had a balance at its credit of £4,488, showing a surplus of £263 on the year's work. For the following abstract of Mr. Hodgson's address we are indebted to the *Manchester Guardian*:

The PRESIDENT commenced by stating that it is no longer true to describe England as the workshop of the world. It is true, he went on to say, that our export trade in manufactured mechanical articles is still on the increase, but is the increase commensurate with the increase of the population of the world? This is probably a question that is not within the province or knowledge of anyone here to answer, but, allowing that it is, it is certainly not advancing at the same rate as the increased requirements of civilisation, and the opening of new sources of trade, together with the increase of the population and the greater numbers brought within the reach of civilisation. We are forcibly reminded of this by the immense growth of the mechanical and industrial productions of foreign nations, notably America and Germany, and other countries in a lesser degree. America and Germany are not only large producers for home consumption (and in this manner reducing their requirements from us), but they are also large suppliers to other countries of which we at one time had the monopoly. This may not in itself be detrimental to us, and on the whole I do not think it has been, as it has undoubtedly been the means of stimulating healthy competition. We are all, of course, quite willing to admit it in a general way that that must be right and best which does the most good to the greatest number, and we can all appreciate the force of this truth until it comes home to us individually. The question which I draw your attention to is this. In the race for the world's mechanical requirements are we holding our own, and, if so, are we likely to continue to hold our own? We do not want all the trade, for if we had all we could not execute it. Taking a backward view of the last 25 years, and more especially of the last 10, does the prospect before us hold out a hope that we shall maintain the foremost position in the race for the world's trade if we continue on our present lines? We shall, no doubt, for some considerable time to come be the foremost, but we should not forget that, compared with any other country, we are large industrial producers, whilst they, on the other hand, are largely engaged in agricultural production. I am no pessimist, but I am of opinion that the conditions of production will have to undergo considerable modification if we are to continue to hold the foremost place in the rank of the mechanical producers of the world. The systems upon which we have been working, whilst they have served well in the past, have been, and are, too much stereotyped. The old and much of the present system will have to be largely modified if we are to maintain the leading position. One of the modifications, and a very important one, will have to be the relations between capital and labour; these ought under no circumstances to be antagonistic, and although at the present moment there is no open display, there is an undercurrent of antagonism which prevents workmen from doing all in their power to advance the interests of employers, which in the long run are also the interests of the workmen themselves. Piecework, if it could be put on an equitable basis, and so formulated as to meet all cases, seems to me to promise a good measure of success, and in such work as lends itself to a fixed basis of prices has proved fairly successful. But, unfortunately, there is a fly in the amber in this case. A rate or price is fixed for the production of a certain piece of work, the workman lays himself out to do his best, and in course of time becomes very expert, and earns a considerable sum weekly. Someone suddenly discovers this, and on the ground that he is earning too much the price is cut down, not because the price paid per article is too much, but because the man has (even though it may be a natural consequence of intelligence and practice, and the use of small appliances of his own designing) largely increased his power of production. The effect of this is to prevent the man using his best endeavours in the future, and this is eventually to the detriment both of himself and his employer. There is another aspect of piecework which, so far as I can judge, must somewhat militate against the system. This is a want of elasticity to meet the varying prices of the article manufactured. If a standard price exists for the construction of any article, there is not always a standard price for the sale of that article, and the price must necessarily ebb and flow according to the demand, the cost being a fixture, but the sale price a variable one. The employer is the one who has all the advantages and disadvantages of the varying prices. The piecework system, however worked, does not meet the whole case of the relations between employer and employé, between capital and labour. Some system more comprehensive will sooner or later have to be adopted by which the interest of the two shall be so bound together that the interest of one shall be equally the interest of the other. A system of industrial partnership appears to me to be the solution of the problem. In this partnership capital should have some fixed minimum rate of interest, and the workman a fixed minimum rate of wages, the profits resulting, after these having been met, being divided equally (or in some other proportion) between the two. The rudiments of such a scheme is in operation in the manufactured iron and steel trades. The Cleveland district is more particularly the one I have in mind, but I believe the system also prevails in the other iron and steel centres. It is well known that the makers' books are examined quarter by quarter to ascertain the selling price of each commodity, and from the prices so obtained an average is struck which regulates the prices to be paid to labour for the ensuing quarter. In this manner labour participates in the prosperity and shares in the adversity of this branch of industry. So far I have dealt with my subject on somewhat general lines. I now desire to draw your attention to what is taking place at the present time. As you are all aware, there have been orders placed in America within the past few months for a number of locomotives, some of which have been delivered and some are now in course of delivery. We are all aware that the reason ascribed for these orders being placed in America was that it was impossible to obtain deliveries within anything like reasonable time from home manufacturers. I suppose we must accept this as true; but, I ask, is it creditable to us as a wideawake business people that we have not sufficient energy, forethought, and adaptability to increase our facilities to keep pace with our requirements? The fact that America can supply her own wants, together with a large foreign trade, including our Colonies, and still have left a sufficient surplus of producing power to supply a portion of our wants, proves the case against us. I think no one will be bold enough to assert that there is not sufficient capital in England to extend and increase the number of works for the manufacture of this particular branch of engineering. If there is the capital, is there the energy and enterprise to use it? I know that this question may be met by the answer that it would be all very well if this present activity could be guaranteed to continue. What are we to do about the locked-up capital in the years of depression in trade? My answer to this argument is that exactly the same laws of fluctuation prevail in America, and yet it does not prevent the Americans from rising to the demands made upon them. It may be said that at home many of the railway companies manufacture their own engines, and therefore there is not sufficient scope to warrant private enterprise in fixing capital in this particular branch of business. I am by no means prepared to accept this as a sufficient answer. I believe that with greater energy on the part of private enterprise the market for supplying locomotives to our own railways would have been a much larger one than it is at the present time, and that the railway companies were in a large measure compelled to make themselves into producers in consequence of the lack of facilities for obtaining their locomotives, etc., from those whose legitimate business it is to supply them. Private enterprise should, and I feel sure can, produce and sell with a reasonable profit at a less price than railway companies can build their own engines. Sentiment may have had some influence, but I think railway companies are managed on lines with which sentiment has little consideration, and that given equal facilities and advantages they would quite as soon purchase engines as make them. Even should exception be taken to this latter proposition, I do not see that this materially alters the original proposition, as many of the American railway companies also build their own engines, and I have no doubt that they are also compelled to obtain engines from outside sources to meet their immediate and pressing requirements, but we never hear of them coming to England for engines at their time of special demand. There is another branch of engineering which has been and now is suffering from an invasion of the American. I refer to the building of stationary engines for electrical installations, both for lighting and traction. Is it because the Americans can build a better or more suitable engine for the purpose, or can they supply an equally good engine at a lower price? I am aware that some orders were placed there during the strike period, but there are cases where orders have been placed in America since that time, and which I am sure could and should have been executed in this country. We all remember what occurred very recently at Glasgow, when out of a requirement for four large engines for tramway traction purposes, the order for two of these engines was placed in this country and the order for two went to America. Could not the construction of the four engines have been undertaken by English firms, and, if not, why not? Each may answer this question in his own way, but to my mind this placing even part of the order in America points to a lack of energy and enterprise on our part, and clearly proves that we have not

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placed ourselves in a position to deal with this or any other work of a like character of whatever magnitude. I am afraid we have got into a much too easy-going, self-satisfied style that we have become too well off, and, like Jeshurun of old, we have waxed fat. It appears to me to be a very humiliating position for us as engineers that the foregoing orders for something like 100 locomotives and for at least 25 sets of large stationary engines (one firm alone having supplied this number in the last three years) should, from any cause whatever, be placed outside our own land, with all its boasted skill and constructive power. These orders will in the aggregate amount to about half a million of money, and I see no sufficient excuse for them being executed abroad, except our apathy and want of energy and adaptability. The foregoing does not exhaust our delinquencies on this head. Russia at one time was our best customer for steam-engines (stationary and locomotive), but now the orders for this class of work are few and far between, as far as we are concerned. What is the explanation? Do they manufacture these for themselves now? Yes, to some extent; but by far the largest number of orders for the stationary engines required in Russia go to one firm in Switzerland. I say all honour and credit are due to the firm to which these orders go for their enterprise or whatever other cause may have led to this result. From what I can learn, this firm not only secures the orders, but they secure them at better prices than English firms quote, when they have the opportunity of quoting. The specimens of engine work supplied by this firm which I have had the opportunity of examining leave nothing to be desired on the score of quality, but surely engineering firms in England can do as good work and obtain as good results as any engineering firms the world through. Then why have we let this market slip through our fingers? Our machine tool makers will have to be up and doing if they wish to hold the excellent position they have hitherto occupied. Within the last few years there has been a movement in the right direction by those who are responsible for this class of work, and the automatic labour-saving tools which are so much in evidence on the other side of the Atlantic are being manufactured here in constantly increasing numbers, and greater care and thought are being given to the production of tools, which will enable work to be produced cheaper and better than formerly. From what I have seen of American tools for doing heavy and medium-sized work I do think that our machine tool makers are far ahead of our competitors, and, providing they will only be content to keep awake, they have not much to fear. There is one branch of engineering in which up to the present competition has not invaded our shores. I allude to shipbuilding and marine engine building; but even in this particular branch of engineering our two competitors (America and Germany) are now in a position to supply almost without exception their own requirements, and are, especially the latter, supplying some other countries with a large portion of their needs in this line. I ascribe this more particularly to political influences than to those of an economical character. Our supremacy even in this, which we may term our national branch of engineering, is being successfully assailed, and we shall have to take greater heed to our steps than we have done lately if we are to maintain our supremacy. We have allowed Germany to make herself possessor of the blue ribbon in the races across the Atlantic; we also allowed her to hold for a time the honour of having built the largest steamer the world had yet seen, and I do not think it will be long before she again takes the position. In the manufacture of textile machinery I believe we are up to the present unassailable. In the attempts that other countries have made to dispense with our services in this particular branch of engineering their work comes immeasurably behind ours, and it is only through political jealousy and national prejudice that our competitors in this branch of business exist at all. There are other businesses of an engineering character which might be dealt with, but I have touched on sufficient to create some interest in your minds on a subject of such vital importance to the welfare of this country in general and of engineers in particular. The subject is one that demands the most careful consideration of everyone—not engineers alone, but everyone who may have the welfare of this country at heart, and unless we are prepared to take prompt, and I fear, drastic measures, we shall have to bewail a still further falling away from our position as a foremost producer. When the present abnormal demand is over and the world settles down to a scramble for work, then will come the testing time. The competition will not be confined amongst ourselves, and unless we take steps to place ourselves in a better position to meet the outsider I am afraid we shall in the end come off very badly. I have dealt with our position as engineers as I see it. Others may view it from different points, and may attach much less significance and weight to the position than I do, but I venture to think that the more consideration each gives to the matter, the more weight will they be inclined to attach to what I believe to be an extremely grave question. At any rate, in thinking over the subject in the course of preparing this address, it has impressed itself upon my mind as second only in gravity with the war upon which we are at present engaged, and will probably be even more far-reaching in its results unless vigorous steps are taken to amend our system of working.

On the motion of Mr. T. ASHBURY, seconded by Mr. J. NAISMITH, a vote of thanks was given to the President for his address.

ELECTRICITY ON THE COMMON ROADS.

After the Automobile Club's house dinner on Wednesday, 10th inst., a paper on the above subject was read by Mr. Thomas Parker, of Wolverhampton. The paper, which was illustrated by lantern slides, is abstracted in the *Automobile Club Notes* this week as follows:

Having been called upon by the committee to contribute a paper for the benefit of the members of this club this evening, and being a member having its interest and that of the movement at heart, I will endeavour to give a short sketch of the history of electricity on common roads in this country, together with some personal experience, and invite discussion and correction on the history of the past which, in the whirl of the present enthusiasm, has been overlooked and forgotten. In the year 1882 my father, Mr. Thomas Parker, exhibited on the lecture table at the Coalbrookdale Institute, Siemens and Edison incandescent lamps, supplied with current from accumulators of his own make and design, and in the same year he discovered that the action of nitric acid facilitated the formation of accumulator plates, and took out a patent in which the novelty of the chemical agent was claimed. A singular coincidence occurred with regard to this patent. Two specifications reached the Patent Office claiming this novelty about the same time, one from M. Gaston Planté, of Paris, the other from Mr. Parker. The Solicitor-General met the case by dividing the patent between them. It was about this time that a partnership was arranged between the late Mr. Paul Bedford Elwell, of Wolverhampton, and Mr. Parker, the latter going to Wolverhampton, and this partnership created the business known as Elwell-Parker, Limited. Arrangements were made with M. Planté, and the manufacture of accumulators and general electrical work was commenced on a large scale. Soon after, Faure and Sellon discovered the pasted battery, which soon superseded the Planté-Parker cell, Elwell-Parker, Limited, taking up the manufacture, and afterwards transferred it to the Electrical Power Storage Company, since which time very little alterations have been made in the material used in accumulators, although during the past three years many successful attempts have been made to reduce the weight and increase the output. In the year 1884, soon after the advent of these new batteries, Mr. Elwell designed and built an electric carriage, the general design of which was similar to the four-wheeled hansom cabs to be seen about the London streets, except that the driver's seat was inside the vehicle instead of behind. It had single bogie steering gear, manipulated from the driver's seat by means of a long lever connected to the bogie by links and rods, the springs were elliptic, the wheels of wood, with steel tyres, the brake of the ordinary carriage type applied by a foot lever, and there was an auxiliary band brake on the back axle. This axle was similar to those commonly used on tricycles, having a differential gear in the centre enclosed in a metal case, a small series-wound motor with diamond-shaped magnets, and, having a normal speed of 1,500 revolutions per minute, delivered its power direct to the periphery of the gear case by means of, at that time, a novel form of worm gear and flexible coupling. The worm was an ordinary coarse pitch thread, the wheel being formed of a number of studs screwed and riveted into the periphery of the gear case, and upon each stud was a small roller shaped to fit the groove and pitch of the worm. The flexible joint allowed for any movement between the motor, which was fixed to the body, and the gear on the axle. The batteries were of the pasted type, being 24 in number and weighing about 6cwt.; they were stowed neatly away in the back of the body of the car. The several speeds of the car were obtained by arranging the batteries in parallel and series and with resistances; the backward movement had a separate reversing switch. A trial was made under the Light Locomotives Act then in force, the maximum speed attained being five miles per hour. All went well until the steep grade of Queen-street was reached, when some of the threads in the worm-wheel sheared and the car came to a standstill, but this was removed and the car reached its destination—the coach painters—by gravitation. It was afterwards repaired, and taken to Mr. Elwell's private house at Albrighton, and from there it went to London. Later, it was shipped for Paris, but about half-way across the Channel the boat foundered. Some time after the boat was raised, and the motor and gear came back to Wolverhampton to be used for other purposes. Thus ended the career of what I believe to be the first British electric motorcar. Not long after this Mr. Ward commenced his work on omnibuses, and placed an order for a vehicle of his

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design with the Electric Construction Corporation (late Elwell-Parker, Limited) in 1890. This 'bus, the first built in Wolverhampton, had a very respectable appearance, but, like most of Mr. Ward's work, was very heavy; in fact, it was said to weigh when loaded over three tons. After a series of trials in London the London Electric Omnibus Company was formed in 1896 with Mr. Ward as chief engineer, and a great deal of money was spent in trying to gain success.

Although success was not achieved, Mr. Ward must be credited with having built the first and second electric omnibuses that were licensed by the police authorities for passenger traffic in London. The passing of the Locomotives on Highways Acts in 1896 brought a number of names to the front, chief amongst them being Mr. Bersey, who must be credited with the design of the first electric cab to obtain a license. Thus Pope, Headland, Riker, Elieson, Britannia, and Oppermann are familiar names. At this date I was occupied erecting electrical and general machinery in the Transvaal, where electric motors, with few exceptions shunt wound, were used for nearly all auxiliary purposes above and below ground. Many of our troubles with the electric plants were caused by the controllers sent out with these motors. After giving considerable thought to the problem, I succeeded in devising a means of preventing the main circuit being closed before the shunt, and of breaking it with all resistance in circuit before the shunt, each movement being locked, and only one handle required, as against two or three in other designs. I sent the designs to Wolverhampton for use in the factory. On hearing that the Bill to allow motorcars to run on the streets of England had been sanctioned by Parliament, and feeling sure that the controller could readily be adapted for controlling electric cars, I set sail for England to make a start in the new industry. Immediately after my arrival I began to work on the design of an electric car. The section of road over which it was obvious the car would have to run lay between my father's house at Tettenhall and the town of Wolverhampton, a distance of 3½ miles without a single yard of level ground in its length, the gradients varying from 1 in 120 to 1 in 15. To get some idea of the power required on a vehicle to carry nine persons was the first difficulty, but the family brougham with horse and a spring balance supplied this information. Having determined the approximate power required for speeds up to eight miles per hour, and the weight of batteries to supply such power for three hours, the next problem was the design of motors and gearing. Many suggestions were put on paper, the final one being two motors geared to the hind wheels through double-reduction gear, the second reduction being Renold's chains; wear on the chains was taken up by eccentrics. These first motors were series wound and designed to run at 950 revolutions per minute, and give a torque effort of 30lb. on the periphery of each armature with 25 amperes. Forty was the number of cells chosen, to permit of their being charged in series on the usual 110-volt circuits. The controlling of the car next, to obtain the necessary changes of speed without the use of resistances, was a difficult problem at one time, but now is simple enough to all of us. Three speeds forward and one backward were found to meet all requirements, and these variations were obtained by dividing the 40 cells into two groups of 20 each. The three forward movements were as follows: the first, putting batteries in parallel and motors in series, gave two miles per hour; the second, batteries series and motors series, four miles per hour; the third, batteries series, motors parallel, eight miles per hour. The one backward movement, batteries parallel, motor series, with current in the armature reversed, two miles per hour. The next problem, and perhaps the most difficult, was the steering. Sketches were made of the Ackerman double cycle head, single wheel, and single bogie systems, but none of these satisfied my desires. I wanted a steering gear that would admit of a car running round a small circle with as little resistance as going straight ahead, and after a great deal of scheming conceived the idea of moving the front and back axles in opposite directions at the same time and through the same angle, which both in model and practical form worked splendidly. It permits a car to be turned in its own length without turning the wheels under the body, and is naturally twice as sensitive as a single bogie or broken axle gear. Another great advantage is that it admits of either front or back or all four wheels being driven, also the weight being distributed equally on all wheels. It gives a good support to the bottom of the vehicle, which can be made quite flat. A brake can be used on each of the four wheels. About this time, early in 1897, the Blot accumulator came to the front, and so good were the results of the tests made on some sample cells, that it was decided to use them on the car. A small shop was rented, so small indeed that the car could not be moved in it. The doors had to be taken down, and the car lowered on planks 18in. into the street before a test could be made. The news of a trial had leaked out, consequently a large crowd awaited us in the square. The trial was very successful; with nine persons on board we ran a 10-mile trip without a hitch. In descending some of the steep grades, I found the powerful combined band of block brakes were not sufficient to check the car, and decided to dispense with series motors. Immediately after the trial I dismounted the motors, and had them shunt-wound. The amount of chaff and ridicule I had to stand was very considerable, for such a thing as running shunt motors in conjunction with storage batteries on tramways had years before been given up as impracticable. The motors, however, were rehung, the connections made, and the car run down into the street. The result was very marked, for instead of the sudden rush of current as at starting with the series winding—viz., 50 amperes—the car moved steadily away with less than 10 amperes, although the current was about the same when the rate of travelling accelerated, as with the series winding.

We then proceeded to take some tests on an incline by running the double journey to Tettenhall and back, and so much was the work of manipulation reduced by this means that it was only necessary to set the controller for the required speed and look out for obstacles. On descending the steepest grade the speed did not increase more than 5 per cent., and it was very gratifying to see the ampere-meter reading 20 amperes to the good, instead of one's knowing that the brake blocks were being worn away. It was also found that in case of need it was possible to bring the car to a stand on a 10 per cent. grade from full speed ahead in 3ft. without reversing the motors or using the brakes, which was an impossibility with the series motors, the difficulty of keeping a constant voltage across the field magnets of the motors, while varying the voltage across the armatures by grouping the batteries and armatures in series or parallel, was overcome in the following manner. The field magnets of each motor were wound to give saturation with 40 volts, the cells, 40 in number, were divided into two sections each giving 40 volts, and were separately connected across the field magnets, which arrangement left the batteries and armatures free to be grouped as desired. This original car ran daily for two years without a hitch or breakdown, and during that time carried some of the most eminent men in the country. Owing to recent illness and completion of engagements my connection with motor manufacture has been partially severed for the past three months, and this has to some extent prevented my making any valuable additions to the lantern slides, which I will now proceed to describe to you.

THE ECONOMICAL GENERATION OF STEAM POWER.

BY BENJN. A. TAPP.

(Continued from page 87.)

We will now consider another apparatus for promoting economy which receives too little attention from engineers in England, but which is making considerable strides on the Continent, and more especially in Germany—*i.e.*, the "superheater." The principle underlying the practice of superheating is briefly as follows: With saturated steam, as commonly used, the range of temperature is very limited, and the conversion of heat into work occasions great losses, which principally occur in the cylinder through steam condensation. Early cut-offs producing a considerable range of temperature between admission and exhaust steam account for this. One method of minimising these losses is to superheat the steam by adding so many units of heat above those contained in saturated steam, so that the ratio of sensible heat to total heat may be increased, and a considerable reduction of temperature may occur in the cylinder before reaching the condensation point. By so doing we maintain our cylinder walls hotter than the saturation point of the steam in contact with them. A certain quantity of heat is unavoidably lost during expansion in any cylinder, but this loss is small compared with the loss of the latent heat in the steam during initial condensation. Superheated steam has the additional advantage that its specific volume is greater than that of saturated steam of the same pressure, while the more you superheat the less steam is used per horse-power.

The results of superheating may best be shown by a comparison as follows: "A triple-expansion engine working with 180lb. steam pressure may, under favourable conditions, produce 1 h.p. with 12½lb. of steam. The same steam superheated 150deg. C. will, in a compound engine, produce 1 h.p. with 8¾lb. steam; the actual saving in heat units is 22½ per cent., and it would be possible to get the same efficiency in a compound engine working with 11 atmospheres pressure as in a quadruple-expansion engine working at 25 atmospheres pressure. A double advantage

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would be gained, as we could mostly do away with triple expansion and could reduce boiler pressures." (Extract from a paper on "Saturated Steam," read before the Northern Institute of Electrical Engineers.")

It is as to the quantity of superheat that English and Continental engineers differ, the former holding that a few degrees of superheat will give all the economy worth having, and the latter that in order to obtain any considerable economy you must use highly superheated steam, which requires specially-designed engines and superheaters, as in the Schmidt system, to overcome lubricating and other difficulties. The arrangement of superheaters shown in the accompanying drawing (Fig. 13) is made by Messrs. Hick, Hargreaves, and Co., Limited, of Bolton, who have erected a large number. It consists of a series of simple bent wrought-iron tubes placed in the downtake flue, as shown, steam travelling down one leg and up the other leg. The whole apparatus has been removed, examined, and replaced in 2½ hours. The valves are arranged to pass the whole or part of the steam through the superheater as may be desired. It has been found in practice with compound condensing engines at 100lb. boiler pressure a superheat of 100deg. F. will give 15 to 20 per cent. economy.

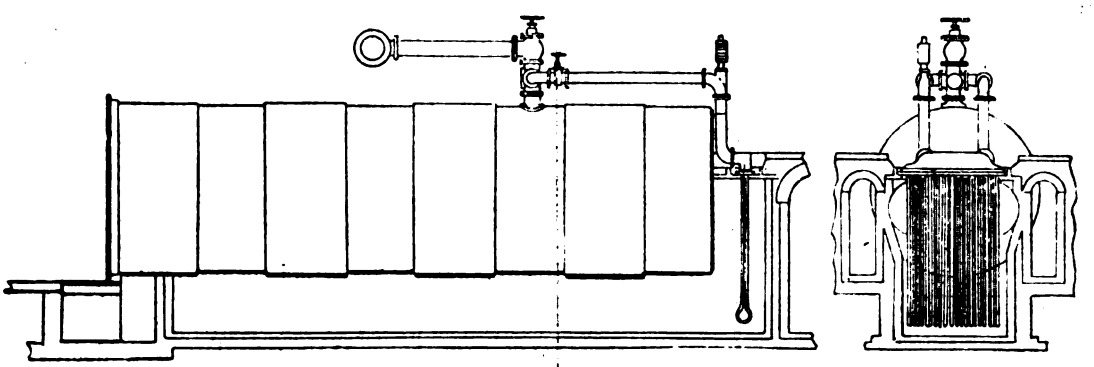

FIG. 13.—Details of the Hick-Hargreaves Superheater as applied to a Lancashire Boiler.

Another form of superheater, much used in Germany, is the Schwoerer, and the Diagram Fig. 14 shows one in combination with a water-tube boiler in use at a pumping station. This apparatus was tested on several occasions, and the following results were obtained:

Amount of superheat	0°	57°	109·5°	57°
Steam per pump horse-power hour ...	20·98	19·71	18·75	19·48
Saving effected per cent.....	—	6·0	10·5	6·75

Another test with a superheat of 121deg. showed 15 per cent. saving. The conditions for the tests were approximately the same, and the results, which, it will be noted, are progressive with the amount of superheat, show a substantial gain.

A third form of superheater, by Messrs. McPhail and Simpson, of Wakefield, introduces some special features. The apparatus as applied to a Lancashire boiler consists of four series of pipes: a set in the flues, a length of pipe in the water space, another set in the flues, and another set in the water space. It is difficult to understand any direct gain accruing to the steam from this arrangement, and in practice it appears that the steam is merely dried as a result of its passage through the apparatus, receiving about 10deg. F. of superheat, an amount which is inappreciable. If the final passage of the steam through the water space were omitted, a productive amount of superheat would be secured. The above apparatus appears, however, to be conducive to boiler efficiency, as from 30 to 50 per cent. in evaporation per pound of coal has been gained by its addition. These results appear to be due to the fact that steam-tubes are very efficient absorbers of heat from flue gases, and are very efficient in transmitting the heat so gained to the water in the boiler.

Many Continental plants are worked on a system devised by Mr. Schmidt, who employs highly superheated steam, and has succeeded in constructing a superheater capable of withstanding the high temperature of the gases, and also has designed a special form of engine to secure efficient lubrication when working at very high temperatures. A plant consisting of a 750-i.h.p. compound engine has been running for 3½ years, night and day, satisfactorily, and as the power given off by the engine varies from 400 i.h.p. to 750 i.h.p., the economy is certainly remarkable, only 8¾lb. steam per indicated horse-power per hour being used, and an equivalent consumption of 1lb. of coal per indicated horse-power hour. The economy of smaller plants on this system is also very high, a 70-i.h.p. tandem compound engine, driving an ice factory in Ireland, having a steam consumption of 10·2lb. per indicated horse-power per hour, and a coal consumption of 1·4lb. per indicated horse-power per hour. The Diagram Fig. 15 sets forth graphically the steam consumption guaranteed under penalty for different sizes and types of engines in connection with their superheater, by Messrs. the Schmidt Stationary Engine Company, Limited.

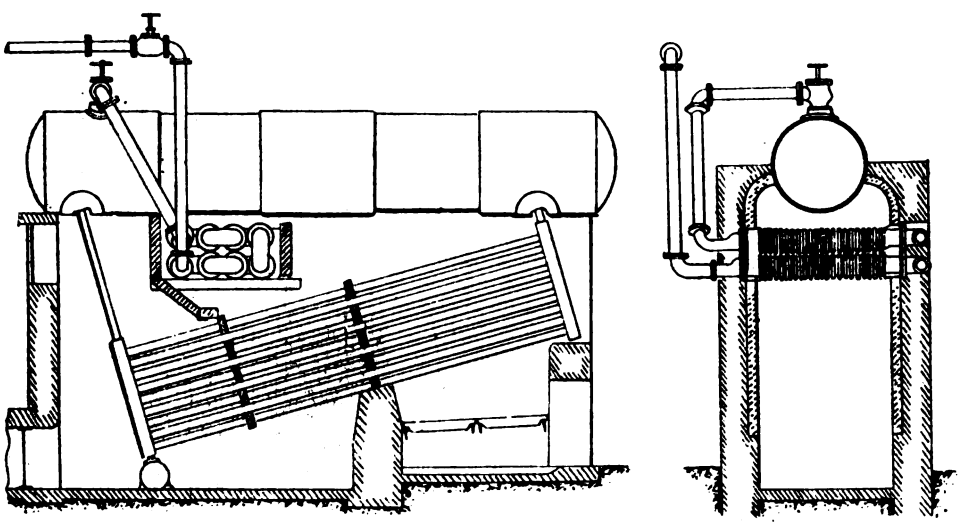

FIG. 14.—Side and End Elevation of Schwoerer Superheater as attached to a Babcock and Wilcox Boiler.

Yet another method of economically producing steam has been devised by Mr. Druitt-Halpin. This system consists in delivering the excess steam generated in the day into a large thermal storage vessel or cylinder, where it is mixed with a small quantity of cold water from the feed pumps, the proportion being gradually increased, so that by the evening the cylinder is full of water at nearly

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boiler temperature and pressure. The cylinder is then connected to the boilers, supplying the necessary feed water at such a temperature that the fuel being consumed has only to supply heat sufficient to overcome the latent heat of evaporation at the required pressure to the water in the boiler. The result of this arrangement is a gain of one-third more steam generated than if the boiler feed came direct from the water-mains.

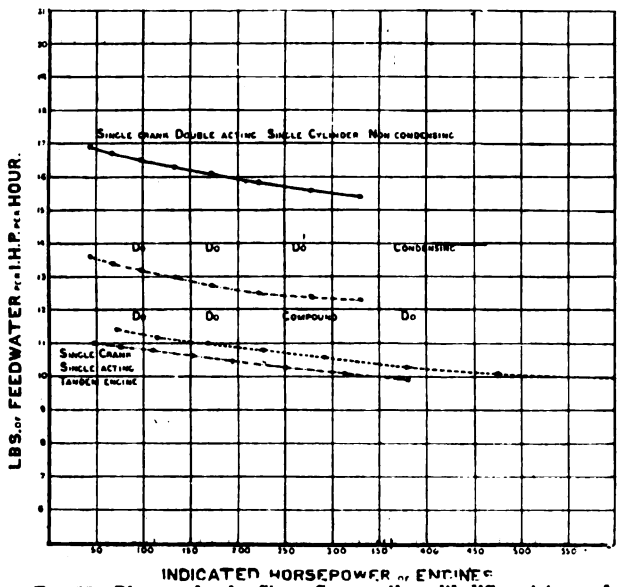
LBS. OF FEEDWATER PER I.H.P. PER HOUR.
INDICATED HORSEPOWER OF ENGINE.
SINGLE CRANK DOUBLE ACTING SINGLE CYLINDER NON CONDENSING
DO DO DO CONDENSING
DO DO COMPOUND DO
SINGLE CRANK SINGLE ACTING TANDEM ENGINE

FIG. 15.—Diagram showing Steam Consumption with different types of Engines supplied with Superheated Steam.

No account of economical steam-raising apparatus would be complete without some reference to the modern refuse furnace. It has been frequently demonstrated that large quantities of heat are available from the combustion of refuse, and when consumed in suitable apparatus it has been shown that eight tons of refuse will raise as much steam as one ton of good coal, and it will raise the steam to the highest ordinary working pressure. One of the leading scientists of the day, Lord Kelvin, has, in reporting on a certain well-known furnace, given decisive evidence in favour of their adoption. His lordship says: "We would recommend to local authorities the careful consideration of the economic aspect of the problem. With such town refuse as is treated at Oldham we consider it should be easy to obtain a steam production equivalent to the evaporation of 1⅓lb. of water from and at 212deg. F. per pound of unscreened refuse treated, and we believe that in a plant designed to utilise the heat to the fullest extent an evaporation of 1½lb. of water per pound, or even more, could be reached, and that without in any way affecting the perfection of the process from a sanitary point of view." These figures show that the Oldham refuse has a fuel value of about one-seventh that of good steam coal.

Numerous furnaces have been designed for efficiently burning refuse, and prominent among them we find the Fryer type, Beaman and Deas, Horsfall, Meldrum's, Simplex destructor, etc. The first-mentioned was the pioneer of successful furnaces, but it has, on comparison with more recent designs, been found wanting in an important feature—*i.e.*, the ability to consume all fumes evolved by drying refuse. A refuse destructor to be satisfactory must be so arranged that these fumes pass through or over the hottest part of the fire, and are subjected to a high temperature for a sufficient length of time to ensure that all obnoxious fumes are consumed.

The construction of the Beaman and Deas furnace and its application to a water-tube boiler will be seen from Fig. 16. With this destructor two cells are placed side by side, connected at the back by a single chamber leading to the underground flue. Charging is effected from an elevated platform into the hopper at the left hand of the elevation, the refuse sliding down the inclined fire-brick hearth, and being gradually dried as it moves forward to the burning mass over the firebars, which is gradually consumed and removed by clinkering. It will be noticed that the fumes from the drying rubbish must pass over the hottest part of the fire, and are consequently consumed before reaching the chimney. The furnace has a closed ashpit, and a current of air is forced into it by means of a fan through the pipe shown. Under the grate is the ashpit door, and above it is the clinkering door. Beyond the firebrick bridge at the back of the furnace is a narrow combustion furnace, where the burning gases intermix with a secondary air supply to more effectually complete their combustion. The gases follow the usual course through the boiler, passing over the ordinary firegrate (for use with coal if necessary), and are finally discharged up the chimney. A destructor of this type during a test which lasted 24 hours burnt 23 tons 18cwt. of refuse; the resulting clinker equalled 27·9 per cent. In a subsequent test over seven tons were burnt in 6 hours 43 minutes, or at the rate of over 25½ tons per day, the clinker being only 17 per cent. of the original refuse. The Corporation of Warrington use the steam generated from their destructors for driving 13 engines for various purposes, and the steam power obtained per ton of refuse burnt is valued at 9¼d.

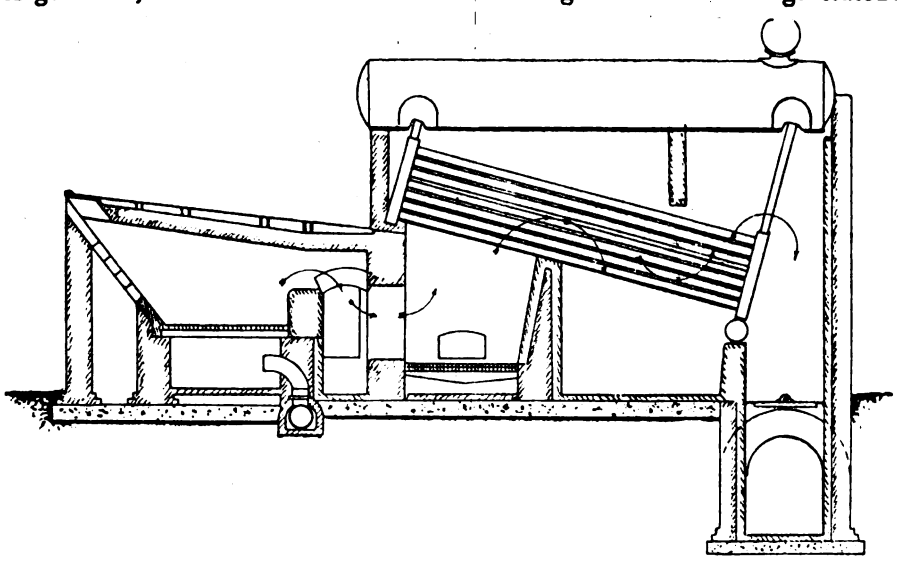

FIG. 16.—Longitudinal Section of the Beaman and Deas Refuse Destructor.

(To be continued.)

STOCKPORT ELECTRICITY SUPPLY WORKS.

The long-delayed formal opening of the above works took place on the 18th inst. in the presence of a large gathering, including the Mayor of Stockport (Councillor T. Webb), who conducted the ceremony, Robert Hyde (town clerk), R. Lievesley Carter (resident electrical engineer and manager), J. N. Shoolbred (consulting engineer), and the members of the Town Council. Mr. Wm. Lister, the vice-chairman of the Gas Committee, received the visitors in the engine-room of the electrical works in Millgate, and

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detailed the history of the scheme at some length, afterwards calling upon the mayor to start one of the engines. Councillor T. Webb, in the dual capacity of mayor and chairman of the Gas and Electricity Committee, duly performed this ceremony. In the course of a long speech subsequently addressed to the gathering the Mayor referred to the cost of various electrical stations built in neighbouring towns. Oldham, which was the cheapest laid down, cost £51 per kilowatt capacity; Bolton cost £64; Huddersfield, £79; Manchester, £101; Bury, £108; Liverpool, £123; Burnley, £133; and Salford, £223. The cost of the Stockport station, all completed, was £56. 10s. per kilowatt, so that the installation was the cheapest but one in the district. The works having been inspected, luncheon was indulged in, during which the usual toasts were honoured.

A brochure, a copy of which was presented to each of the visitors on the occasion of the opening, gives the following particulars with regard to the undertaking: "In the year 1891 the Corporation obtained a provisional order for the supply of electricity, and in November, 1896, the Council authorised the Gas Committee to be the Electricity Committee for the purpose of carrying out its provisions. On Dec. 31, 1896, the first meeting of the committee was held and steps taken to investigate the systems in general use. On Jan. 14, 1897, a report was made by the chairman, Mr. Councillor Thomas Webb, as to those adopted by several important undertakings; at this meeting it was decided to request Mr. Ernest Mountain, of Huddersfield, and Mr. James N. Shoolbred, of London, to prepare reports and estimates for establishing an electricity supply station. The full committee afterwards visited Liverpool, Birkenhead, and Huddersfield, and also interviewed the two engineers upon various points contained in their reports. The chairman and engineer of the department were then deputed to visit other towns with a view to a further elucidation of these points, and to note the results of the most modern practical experience. A report was submitted by them, and after full and careful consideration it was decided that the scheme of Mr. James N. Shoolbred for a supply upon the three-wire continuous-current system at a pressure of 460 volts between the outer wires, equivalent to 230 volts upon the consumers' lamps, be accepted, that the site of the central station be upon land at Millgate then occupied by the gasworks, and that application be made for a sum of £25,000 to cover the cost. Tenders for buildings, machinery, and plant were advertised for in December, 1897, and various contracts let on Feb. 10, 1898. Consequent on various delays, no doubt due to the heavy demand for all electrical work, the committee were unable to commence the supply until Dec. 9, 1898, instead of Oct. 1, 1898, as originally intended. Since the current was turned on a full and regular supply has been maintained without, up to the present, the slightest interruption. The constant and rapid growth of the business has given the committee much satisfaction. The number of consumers has increased from 30 on the opening day, with an equivalent of 1,596 8-c.p. lamps, to 120 consumers, with 7,700 8-c.p. lamps, on Jan. 1, 1900, and the committee trusts at the close of the financial year to be able to present a report showing that the undertaking has at least paid its way (a most unusual thing for the first year of electrical undertakings) and justified the enterprise of the Council in having undertaken an electrical supply in the old borough of Stockport. The following is the plant installed up to Dec. 31, 1899: two Lancashire boilers, 8ft. 3in. diameter by 28ft. long, supplied by Tetlow Bros., Hollinwood; three 56-kw. dynamos driven by 90-h.p. Willans and Robinson's engines; two 140-kw. dynamos driven by 240-h.p. Willans and Robinson's engines (the dynamos were made by Messrs. McClure and Whitfield, electrical engineers, Stockport); two sets of accumulators, capacity equal to 750 ampere-hours, supplied by the Chloride Electric Storage Battery Company, Limited, Clifton Junction; two battery switchboards and one main switchboard by Crompton and Co., Limited, London; and one six-ton crane, 33ft. span, by Heginbotham and Mannock, Manchester. The buildings have been carried out by Messrs. T. and W. Meadows, of Stockport, and the roof, water-tank, and ironwork by Messrs. Nowton, Chambers, and Co., of Sheffield. The first section of the distributing and feeder cable was supplied by Messrs. Glover and Co., of Salford, and an additional feeder cable is now on order from W. T. Henley's Telegraph Works Company. The lamps installed are equivalent to 7,700 of 8-c.p. each and 36 arc lamps for public lighting, and the total plant capacity now fixed is equivalent to 13,000 8-c.p. lamps, not including the accumulators or spare engine.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

239. A fracture having developed in the journal of a crankshaft, state how you would proceed to determine if it is sufficiently serious to necessitate the immediate replacement of the shaft.—E. G. T.

240. What do you consider the largest area of copper which can well be insulated and laid as a low-tension feeder? How does the cost of several such feeders laid on the solid system compare with the cost of the equivalent conductors of bare copper laid on insulators in a conduit?—P. T.

ANSWERS.

Question No. 233.—Which do you consider best, over or underground sub-stations for transformer distribution, or single transformers in street boxes?

[N.B.—The first two answers to this question are considered of equal value. In no case has the question of relative danger of the various systems been discussed, and in this respect the street-box transformer is to be preferred to a sub-station.—ED. *E. E.*]

Answer to No. 233 (*awarded* 7*s.* 6*d.*).—This question will be best considered under two headings: (1) the advisability of using transformer sub-stations or single transformers in pits; (2) the advisability of underground or overground sub-stations.

1. Transformer sub-stations are undoubtedly more satisfactory than single transformers in pits, but in a scattered district, where the load on the distributors to be fed from one point does not seem likely to amount to more than 20 kw. or 30 kw., the extra cost of building a sub-station instead of a pit would prohibit its use. The advantages of a sub-station over a pit are greater accessibility and better arrangement of both primary and secondary switches and fuses. In the case of a pit where the primary feeder is in duplicate (as it should be), and there are, say, four secondary distributors, the switching and fusing arrangements are necessarily cramped for want of space. In a sub-station, a current-recording instrument to indicate the highest load on the transformers can be fixed, whereas this would be very difficult to arrange in a pit. If there are three or more transformers in a sub-station, the fact of one breaking down ought not to interrupt the supply, but if a single transformer in a pit breaks down, the supply is off until the transformer can be replaced. Of course, if three or more pit transformers are connected in parallel, the failure of one ought not to interrupt the supply. Another advantage of the sub-station is that it can be used as a distributing point for small primary mains.

2. Overground sub-stations are better than underground ones, but unless the ground rent for the overground one is very low, it will be found to be much more expensive. As a rule, no rent is paid for underground sub-stations, as they are built under the public footpath or roadway. As the overground sub station would have to be built fireproof, and

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to have a presentable appearance outside, the cost of constructing the two types would be about the same, therefore the overground sub-station would cost the amount of its ground rent more than the underground one per annum. The advantages of the overground sub-station are that it would be drier, easier to ventilate, and slightly more accessible. An underground sub-station, unless it contains transformers of fairly large output, is liable to sweat in damp weather, and in some towns it is impossible to drain them, so that there is some danger of flooding.

In conclusion, taking cost and efficiency into consideration, an overground sub-station is best where the ground rent is small and the probable output is more than 30 kw. An underground sub-station is best where the ground rent is high and the probable output is more than 30 kw. A single transformer in a pit is best where the probable output is less than 20 kw., and where it is not required to use the position as a primary distributing centre.—J. R. P. L.

Answer to No. 233 (*awarded* 7*s.* 6*d.*).—The most advantageous position of a sub-station for transformer distribution depends upon the size and number of transformers it has to accommodate, and upon the district in which it is situated, as these conditions are very varied. It would be impossible to say offhand which would be the better to construct—the sub-station overhead or underground. However, it may at once be said that providing a suitable site can be obtained at a reasonable price the better way is to erect the sub-station overground, especially if situated in a thickly-populated district, where a large number of transformers can conveniently be placed in one station. The chief advantages to be claimed for an underground sub-station are that it is out of the way when once erected, and that is very convenient for the entering and leaving of the distributing mains. These advantages are counterbalanced to a considerable extent by the expense of excavating and carting; a great difficulty is further experienced in preventing them from becoming damp. The expense entailed in securing freedom from damp, especially in wet districts, is considerable, and efficient ventilation is another problem which has to be solved, so that the cost of an underground station will generally be greater than one of similar dimensions constructed overhead. The difficulties of constructing underground stations increase as their size increases, and a limit is reached when it becomes almost impracticable, or, at any rate, the cost would be prohibitive to construct one. When only two or three transformers are in question it will perhaps be advantageous to place them underground, as the excavation necessary would be a small item and additional cost of building an absolutely watertight vault would be slight as compared with the expense of securing a suitable site above ground. Regarding a comparison between sub-station distribution and street transformers, this has already been partially discussed in these columns in a question as to the relative advantages and disadvantages of house transformers and the banking of transformers in sub-stations. The district to be served governs to a certain extent the system to be adopted, but it is only in very scattered districts that street transformers can be employed with much success. This is owing principally to the fact that, while a transformer will give a very good efficiency when at full load, its efficiency at light loads is far from satisfactory, and as in all probability it would only be working at maximum load for perhaps two out of the 24 hours, it is quite clear that its all-day efficiency will be very low. Another source of waste is due to the iron loss which goes on as long as the primary coils are in circuit, even though the secondary circuit may be open. When a number of transformers are placed together in a sub-station, which is the system most generally used, they can be switched in or out of circuit as the load demands. Those in use will thus always be working at or about their full capacity, and consequently at maximum efficiency.—F. A.

Answer to No. 233 (*awarded* 5*s.*).—This is an open question, and much depends upon the locality in which transformers are to be used. The amount of traffic, the space in streets, and the dryness or otherwise of the ground will decide the question as regards underground or erected sub-stations. The extent of the demand for current will indicate if banked transformers in sub-stations or single transformers in street boxes should be used. Take a busy place like the City of London, where the demand is huge and compact day and night, and varies tremendously according to the state of the weather—then banked transformer sub-stations are necessary. There will be no room on pavement or in roadway to build a transformer-house, and if there is no space underground for a decent-sized chamber a basement must be obtained. If a sub-station is wanted where the land is marshy, such as at Newport, the room should be built upon the ground; as it is very difficult to keep moisture from soaking through the walls of an underground chamber, no matter what lining is used. Single transformers in street boxes are used where the demand is scattered and small; but a great deal depends upon the design of such boxes. It is sometimes most important to be able to get at a transformer's fuses or switches in a very short space of time; but there are types in use whose fuses could not be got at under half-an-hour's hard work taking off nuts placed so as to require a contortionist to operate. Speaking generally, the writer is of opinion that transformers should be easily accessible for inspection and renewal of every part; and, to that end, it is better to have it in a covered chamber of some kind than to use that type of transformer whose parts are fastened down with nuts and bolts, and when opened are exposed to whatever weather is going.—J. H. C. B.

Question No. 234.—Make a list of the causes tending to produce excessive noise or vibration in a dynamo. Name the simplest remedies you know in the various cases.

Best Answer to No. 234 (*awarded* 10*s.*).—The cause of noise or vibration in a dynamo is not often very easy to determine, but in most cases it will be found to be one or other of the following: the foundation of the machine may be bad, or the bed-plate may not be securely bolted down to its place. This, especially if the machine is direct coupled, is almost bound to produce vibration in excess, with consequent noise and knocking. The remedy is obvious: look to the foundation and foundation bolts.

The armature may be badly balanced. The usual shop method of balancing is to weight the armature on the light side (which is found by placing it on a pair of level rails), until the whole is in equilibrium when at rest. But this does not necessarily imply equilibrium when running, and hence vibration may occur even in a carefully-balanced armature. The remedy for this is simply one of trial and error. The balance weight must be modified in some way, possibly spread out so as to give a more even distribution of weight over all while retaining the statical condition of neutral equilibrium. But it is difficult to say exactly, and off-hand, how this should in every case be remedied. In actual cases other circumstances will be present which will probably give an indication as to what should be done.

Another cause of vibration is bad fitting, especially in the armature. If the key which drives the armature core is badly fitted, either in the key-seat or in the notches in the armature plates, then the whole core is apt to move about and rattle very badly. This can in cases necessitate the entire rebuilding of the armature.

In some machines, especially small high-speed machines, the pressure of the brushes on the commutator rotating very fast may produce a very unpleasant noise, which almost amounts to a "shriek." This may happen, too, with multipolar machines with several sets of brushes, especially if the commutator surface velocity is high. The remedy is to set the brushes so as to press as lightly as possible on the copper, consistent with good contact and small contact resistance, and to have the brushes trimmed as well as possible and thoroughly ground in. Possibly a trace of oil on the commutator may help to reduce the trouble, though many makers say that oil must never be used. In excess it certainly is bad.

In self-oiling machines, with rings in the brackets, a small amount of noise may be caused by not having enough oil to keep the rings running steadily, in which case they rattle against the bracket sides.

Of course, too, any loose bolts about the machine itself are almost bound to lead to noise, if not to more serious trouble.

In alternators and machines which have frequent reversals

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of magnetism there is generally a "hum," which is probably caused by the molecular changes in the iron. That this is the cause seems to be supported by the case, of which the writer has heard, in which the hum was so excessive that the machine had to be replaced by another of different shape which made less noise. The machine in the first case was probably of such a shape that the reversals of magnetism corresponded with the natural period of vibration of the whole structure, and this was cured by having a different structure instead. Such a noise is difficult to put away entirely, as it is inherent in the machine. It is not likely to occur in direct-current machines, however.

If the armature is out of truth the "high" part may possibly catch on the iron of the field and produce a noise, occurring once per revolution. This periodic character will readily indicate the situation of the trouble, which should by all means be put right at once, else the whole armature may go to pieces.

If the word "dynamo" may be taken to include motors also, then we may have an additional source of noise in any gearing present if the wheels are not properly fitted. But this is hardly a case which comes under the scope of the question, and the difficulty is not so frequent as it used to be since the introduction of raw-hide pinions.

It remains to add that mechanical vibration is always present to some degree, and is not necessarily detrimental, because it to some extent diminishes the stability of the molecules of the magnetic circuit, and may thus diminish hysteresis losses.—T. C.

Answer to No. 234 (*awarded* 5*s.*).—The causes of vibration and noise in a dynamo are as follows: (1) bad foundations; (2) armature out of balance; (3) slack in bearings or too much end play; (4) poor belt joints; (5) armature rubbing against pole-pieces; (6) bad condition of commutator; (7) use of certain kinds of brushes; (8) excessive sparking; (9) high centre line of shaft; (10) harmony of speed of armature, or, in an alternator, the number of alternations, with the natural period of vibration of any part of the framework of the machine.

To take the above in order: (1) unsuitable or insufficient foundation will play havoc with the best dynamo ever made, and cause greatly increased wear and tear of the whole machine. If the case is not a bad one, or the dynamo cannot be stopped for any length of time, heavy buttressing will be the simplest way out of the difficulty, but, if possible, a new foundation of stonework or concrete should be carried deep enough to secure a good bottom. Foundation bolts must go low, and be fastened to iron plates built in the foundation, the holes being filled with a grouting of cement. The engine and dynamo of a direct-driven set must be placed on one foundation.

(2) Want of balance in the armature should have been rectified in course of construction, as in some armatures it is difficult, if not impossible, to remedy without partial unwinding. The armature is taken out, and the journals placed on parallel and level knife-edges or rails, and then given a turn or two either way; the heavier side will fall, and tend to remain at the lowest point. The proper course to pursue before winding would be to drill a few holes equally at each end of the core, in the thick end plates, until proper balance is obtained. In most cases, unless the fault is very pronounced, the winding had better be left alone. One authority has recommended that the pulley be drilled on the heavier side, or weighted on the lighter side, but it is possible that this will accentuate the evil, because the heavier sides of the armature and pulley respectively being on opposite sides of the shaft centre, and also on opposite sides of the pulley end bearing, a couple is formed tending to impart a twist to the armature. To weight the pulley on the heavy side would, of course, only throw the armature, as a whole, still more out of balance. A ring armature of fairly large diameter might be more satisfactorily dealt with by operating on the spider arms, care being taken not to unduly weaken them.

(3) Any slack in bearings must be taken up by filing if the brasses are in halves, and, if necessary, the lower brasses must be packed up. Bushes are relined with magnolia or other bearing metal. Too much end play may cause the shaft to knock against the bearings. This may be temporarily remedied by unscrewing holding-down bolts and slewing the dynamo a trifle either way on the slide rails. It is best to put a washer of suitable thickness between the shaft collar and bearing.

(4) On belt-driven dynamos, as a rule, the belt makes most noise. A link belt beats most belts for dynamo driving, but produces a considerable amount of noise, particularly on small pulleys. No belt should have lap joints, but either a butt-joint is used or a good splice made, the leather being carefully pared down at both ends, which should preferably be cemented, before being sewn and riveted. A little thought should be given to the arrangement of rivets, a point too often neglected. A cotton or similar belt in one length spliced by the makers and put on endless is better in this respect, but rope driving is almost noiseless.

(5) When the armature rubs against the pole-pieces, it is probably due to imperfect alignment of or wear in bearings. These should be examined, and, if necessary, packed up or relined. If part of the winding projects it must be beaten down, and additional binding applied, or failing this, the part of pole-piece against which it rubs must be chipped and filed away. If due to a bent shaft, the latter is taken out, sprung straight between lathe centres, and a light cut taken off both bearings *and commutator*.

(6) A commutator with a rough, uneven surface caused by sparking, or un-uniform material, causes a dull rattling sound as each bar pounds away at the brushes. The commutator should at once be turned (a slide rest to fix to the framework of the dynamo is very desirable) or carefully filed, and the greatest care taken to keep it in good condition.

(7) Certain kinds of plate and carbon brushes keep up a disagreeable hissing noise. Soft gauze, woven, or very fine wire brushes keep least noise, and next in order, perhaps, a brush of very thin leaf metal.

(8) Excessive sparking causes a nasty crackling noise, but with modern dynamos and care should be of rare occurrence. The load on the machine should not be too great and attention given to the adjustment of brushes.

(9) A dynamo with a high centre line of shaft will be liable to vibration, to avoid which the foundation must be good, and belt joints very carefully made.

(10) This is probably not of common occurrence. Prof. Silvanus Thompson, in his "Dynamo-Electric Machinery," relates a "case of an alternator which emitted a sustained howling sound of piercing loudness." The cause in this case was the accidental coincidence between the number of alternations and the natural vibration period of some of the solid iron parts. It was cured by refitting the iron parts so as to alter the fulcrum from which the parts could vibrate.

With reference to alternators, the same writer says: "Alternators do not usually run silently, for the coils of all disc armatures churn the air between the poles. If the iron cores of the armature part are subjected to too severe a cycle of magnetisation they will emit a loud humming sound, which cannot be cured except by using the machine at a lower degree of excitation, being a defect of design.—G. EVANS.

NEW COMPANIES, 1899.

From a list published in the *Investors' Guardian and Joint-Stock Companies' Review* we extract the following particulars as to the companies registered in 1899 as compared with previous year's:

	1898—4,653 companies.	1899—4,529 companies.
Trams	£3,185,500	£1,746,007
Railway	4,674,250	9,166,550
Electric	3,452,364	11,192,790
Telephone	854,000	350,500
Iron and steel	6,856,000	9,372,418
Engineers	12,846,580	9,037,160

The comparative figures for the first and second halves of 1899 are as follows:

	First six months, 1899, 2,679 companies.	Last six months, 1899, 1,850 companies.
Trams	£505,000	£1,241,007
Railways	8,476,550	690,000
Electric	6,234,130	4,958,660
Telephone	300,000	50,500
Iron and steel	4,738,604	4,633,814
Engineers	4,481,160	4,556,000

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

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THE LATE PROF. D. E. HUGHES, F.R.S.

It is with the deepest regret that we record the death of Prof. D. E. Hughes. Elsewhere we give a brief biographical account of the friend whose loss we all deplore. When the close of the century is reached, and an endeavour is made to compare the talents of the men of science who have lived and worked for the benefit of the human race, and died, few will be held to have been greater benefactors to the race than the late Prof. Hughes. If not only his position in science is considered, and we look upon the man, his consistent modesty, his real and unaffected friendship, his chivalry, as well as his charming disposition, these will combine to cause all those who knew him well to place him upon as high a pedestal of honour as any man of this or any other century. The closing year of the nineteenth century is claiming a holocaust of those great men who remained to witness its incoming—Ruskin, Blackmore, Martineau, Steevens: each shone in his particular sphere, and now the scientific world is so much the poorer by the loss of Hughes. Born in London in a year when Faraday made some of his most remarkable discoveries—discoveries which in their more recent applications have employed men and capital to an enormous extent and give even richer promise of more extended utility in the immediate future—Hughes saw the birth, and we might almost say the manhood, of every great application of electricity, and in some directions by his inventions and discoveries played no mean part in making development possible. Before his twenty-fourth year he had given the world his well-known printing instrument, never very largely used in this country but very widely adopted in other parts of the world, especially on the Continent of Europe and in the States. In our opinion, the scientific world has never sufficiently realised the greatness of this work. Very little was at that time known in either the theory or the practice of electricity, yet the more this apparatus is examined the more wonderful becomes our admiration for the talents of the man who in the then state of knowledge invented that beautiful mechanism. It is very certain, however, that while the world is ready to credit Hughes with this invention, it does not know how much and how valuable was his work in other directions. While giving the greatest meed of praise to Bell for his telephonic discoveries, it is certain that to Hughes, and to Hughes alone, the great practical development of telephony is primarily due. Bell gave us a beautifully simple and practical apparatus as a receiver, but when used both as sender and receiver it becomes painfully apparent that in its application the apparatus is limited. However, Hughes's discoveries gave to the world just what Bell's apparatus lacked, and rendered possible the general use of this particular development of applied electricity. Although to-day such an idea may be scouted by many people, yet to a very large number of thoughtful men the time seems to be very near when every dwelling-house, as well as every business office, will be equipped with its telephone, and historians will then realise how much humanity

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owes to the twin discoveries of Bell and Hughes in the nineteenth century. We have spoken of his discoveries and of his inventions, but it was not the thoughts of what he had achieved in these directions that endeared him to his friends. It was, if we may use the expression, the extreme loveability of the man himself that made him so popular, and will correspondingly increase the void in the hearts of all who called him friend. Our heartiest sympathies go out to her who has so long borne with him the burden and heat of life, who strengthened him in adversity and shared with him in prosperity; and if anything can console her in her hour of greatest grief, it will be to know that his loss will be deeply and sincerely mourned by all who knew him. Does not Tennyson well express with great truth what must be in the minds of all his friends :

That nothing walks with aimless feet :
  That not one life shall be destroy'd,
  Or cast as rubbish to the void,
When God hath made the pile complete.
  * * * *
I leave thy praises unexpress'd
  In verse that brings myself relief,
  And by the measure of my grief
I leave thy greatness to be guess'd.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

STEAM-TURBINES.

SIR,—Our attention has been called to the following paragraph inserted in your issue of the 19th inst. :

"*Steam-Turbines.*—We learn from the presidential address given by Rear-Admiral G. A. Melville to the Mechanical Society of American Engineers, that Mr. G. Westinghouse is working on the interesting subject of steam-turbines. It was stated in this address that Mr. Westinghouse had already attained success in connection with the design of steam-turbines for driving electrical generators, and that he is now working on a steam-turbine which is to develop some 2,000 h.p. We are not informed, however, on what principle these turbines are working, but everyone must admire the pluck of Mr. Westinghouse in experimenting on such a large scale."

In reference to the subject, we beg to say that Mr. Westinghouse purchased the patent rights for the Parsons steam-turbine for land purposes for the United States and Canada from Messrs. C. A. Parsons and Co. about three years ago, and that these large turbo-generators are of 2,500 h.p., and are constructed under the Parsons patents. We trust you will insert this letter to correct erroneous impressions conveyed by the above paragraph. The Parsons Company are manufacturing turbo-generators of equal size—that is, capable of generating 1,500 kw.—which on recent tests have surpassed the best records of steam consumptions obtained for piston engines for the production of electricity from steam.—Yours, etc.,

C. A. PARSONS AND CO.

Newcastle-on-Tyne, Jan. 24, 1900.

DOUBLE-ARC LAMPS.

SIR,—I notice with great interest an article you give in the current issue of your paper respecting Messrs. Koerting and Mathiesen's double-arc lamps, and it may possibly further interest your readers to know that my principals, Messrs. Koerting and Mathiesen, have three types of double-carbon lamp which they manufacture, particulars of which are as follows : pattern U, which is a shunt lamp in which both sets of carbons burn at the same time; pattern C J is a differential lamp, in which the mechanism is so arranged that when one pair of carbons burn out the other pair are automatically switched into the circuit; pattern C is of similar construction to the above-mentioned lamp, the only difference being that it is a shunt lamp. I may also point out that these lamps are used with the greatest success, amongst other places, both at Bradford and Bury.—Yours, etc., G. BRAULIK, A.I.E.E.

London, Jan. 22, 1900.

THE INSTITUTION WIRING RULES.

SIR,—Being somewhat interested in the above subject, which appeared in your paper of the 19th inst., I should be glad to be allowed the opportunity of endeavouring to answer, or rather suggest, some points referring thereto. I should certainly deem it advisable that some additional regulations should be enforced in order that safe and durable wiring would be installed. The rules issued by the Institution, in my opinion, cover sufficient ground in one sense, but I would strongly suggest that some slight addition should be made in one rule especially, and that is the one referring to the use of casing. There is a great deal of risk being run by using wooden casing in *damp* places. I think that the following or some similar addition would prove beneficial :

"That wooden casing must not be used in any place whatever under any circumstances where there is damp, unless it is protected by some suitable means (bitumen or some waterproof substance) from the wall or to whatever the casing is attached."

We have also noticed cases in which fires have originated owing to the unworkmanlike manner in which wiremen have done their work and by evading rules. It is the general rule in wiring private houses to avoid having any casing in sight. This is a great inducement for some wiremen to shuffle their work—for example, making dry joints, and not insulating them, and then covering the wires up. I think that strict attention should be paid to prevent this by adding a rule which provides, "That no wiring should be allowed to be done out of sight, unless run in iron or earthenware pipes."—Yours, etc.,

Morley, Jan. 24, 1900. RUPERT H. WAITE.

OBITUARY.

The Late Prof. D. E. Hughes, F.R.S., etc.

We regret to have to record the somewhat sudden death of Prof. David Edward Hughes on Monday, the 22nd inst.

Prof. Hughes was born in London in 1831. His parents came from Balla, at the foot of Snowdon, North Wales, and in 1838, when David was seven years old, his father, taking with him his family, emigrated to the United States, and became a planter in Virginia. The elder Mr. Hughes and his children seem to have inherited the Welsh musical gift, for they were all accomplished musicians. While a mere child, David could improvise tunes in a remarkable manner, and when he grew up this talent attracted the notice of Herr Hast, an eminent German pianist in America, who procured for him the professorship of music in the College of Bardstown, Kentucky. Mr. Hughes entered upon his academical career at Bardstown in 1850, when he was 19 years of age. Although very fond of music, and endowed by Nature with exceptional powers for its cultivation, Prof. Hughes had, in addition, an inborn liking and fitness for physical science and mechanical invention. This quality of taste and genius may seem, at first sight, strange, but experience shows that there are many men of science and inventors who are also votaries of music and art. The source of this apparent anomaly is to be found in the imagination, which is the fountain-head of all kinds of creation.

Prof. Hughes now taught music by day for his livelihood and studied science at night for his recreation, thus reversing the usual order of things. The college authorities, knowing his proficiency in the subject, also offered him the Chair of Natural Philosophy which became vacant, and he united the two seemingly incongruous professorships of music and physics in himself. He had long cherished the idea of inventing a new telegraph, and especially one which should print the message in Roman

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characters as it is received. So it happened that one evening, while he was in the glow and enthusiasm of musical improvisation, the solution of the problem flashed into his ken. His music and his science had met at this nodal point. All his spare time was thenceforth devoted to the development of his design and the construction of a practical type-printer. And as the work grew upon him he became more and more engrossed with it, until his nights were almost entirely given to experiment. He begrudged the time which had to be given to teaching his classes; and the fatigue was telling upon his health, so in 1853 he removed to Bowlingreen, in Warren County, Kentucky, and acquired more freedom by taking pupils.

The main principle of his type-printer was the printing of each letter by a single current. The Morse instrument, the only other rival then in the field in America, required, on the other hand, an average of three currents for each signal. In order to carry out this principle it was necessary that the sending and receiving apparatus should keep in strict time with each other, or be synchronous in action, and to effect this was the prime difficulty which Prof. Hughes had to overcome in his work. In estimating the Hughes type-printer as an invention, we should never forget the state of science in those days, nearly half a century ago. He had to find his own governors for the synchronous mechanism, and here his knowledge of acoustics helped him. Centrifugal governors and pendulums would not do, and he tried vibrators, such as piano strings and tuning-forks. He at last found what he wanted in two darning-needles, borrowed from an old lady in the house where he lived. The steel rods fixed at one end vibrated with equal periods, and could be utilised in such a way that the printing wheel could be corrected into absolute synchronism by each signal current.

In 1854 Prof. Hughes went to Louisville to superintend the making of his first instrument, but the first patent for it was not taken out in the United States until 1855. In that form straight vibrators were used as governors, and a separate train of wheelwork was employed in correcting; but in later forms the spiral governor was adopted, and the printing and correcting is now done by the same action. In 1855 the invention may be said to have become a practical success, and no sooner was this the case than Prof. Hughes received a telegram from the editors of the American Associated Press summoning him to New York. The American Telegraph Company, then the leading one, was in possession of the Morse instrument, and levied rates for transmission of news which the editors could no longer stand. They therefore took up the Hughes instrument in opposition to the Morse. A company was formed and the lines of the smaller fry of companies—among which was the Western Union Company, then doing business on a poor scale out West—were leased. After a time they united in 1857 with these smaller companies to form one large corporation, the Western Union Telegraph Company of to-day. They bought over the Morse instrument, too, and when the monopoly was all in their hands the editors were again left in the lurch.

In 1857 Prof. Hughes, leaving his instrument in the hands of the Western Union Telegraph Company, came to England to effect its introduction here. He endeavoured to get the then Electric Telegraph Company to adopt it, but after two years of indecision on their part he went over to France in 1860, where he met with a more encouraging reception. The French Government Telegraph Administration became at once interested in the new receiver, and a commission of eminent electricians, consisting of Du Moncel, Blavier, Froment, Gaugain, and other practical and theoretical specialists, was appointed to decide on its merits. The first trial of the type-printer took place on the Paris-to-Lyons circuit, and there is a little anecdote connected with it which is worthy of being told: The instrument was started, and for a while worked as well as could be desired; but suddenly it came to a stop, and to the utter discomfiture of the inventor he could neither find out what was wrong nor get the printer to go again. In the midst of his confusion it seemed liked satire to him to hear the commissioners say, as they smiled all round and bowed themselves gracefully off, "*Tres-bien, Monsieur Hughes—tres-bien. Je vous felicite.*" But the matter was explained next morning, when Prof. Hughes learned that the transmitting clerk at Lyons had been purposely instructed to earth the line at the time in question to test whether there was no deception in the trial, a proceeding which would have been strange had not the occurrence of a sham trial some months previous rendered it a prudent course. The result of this trial was that the French Government agreed to give the printer a year of practical work on the French lines, and if found satisfactory, it was to be finally adopted. Daily reports were furnished of its behaviour during that time, and at the expiration of the term it was adopted, and Prof. Hughes was constituted by Napoleon III. a Chevalier of the Legion of Honour.

The patronage of France paved the type-printer's progress into almost all other European countries, and the French agreement with Prof. Hughes respecting it became the model of those of other nations. On settling with France in 1862, Prof. Hughes went to Italy. Here a commission was likewise appointed, and a period of probation—only six months—was settled before the instrument was taken over. From Italy Prof. Hughes received the Order of St. Maurice and St. Lazare. In 1863 the United Kingdom Telegraph Company, England, introduced the type-printer in their system. In 1865 Prof. Hughes proceeded to Russia, and in that country his invention was adopted after six months' trial on the St. Petersburg-to-Moscow circuit. At St. Petersburg he had the honour of being a guest of the Emperor's in the Summer Palace, Czrarskoizelo, the Versailles of Russia, where he was requested to explain his invention and also to give a lecture on electricity to the Czar and his Court. He was there created a Commander of the Order of St. Anne.

In 1865 Prof. Hughes also went to Berlin, and introduced his apparatus on the Prussian lines. In 1867 he went on a similar mission to Austria, where he received the Order of the Iron Crown, and to Turkey, where the then Sultan bestowed on him the Grand Cross of the Medjidie. In this year, too, he was awarded at the Paris Exhibition of 1867 a grand hors ligne gold medal, one out of ten supreme honours designed to mark the very highest achievements. On this occasion, also, another of these special medals was bestowed on Cyrus Field and the Atlantic Telegraph Company. In 1868 he introduced it into Holland, and in 1869 into Bavaria and Wurtemburg, where he obtained the Noble Order of St. Michael. In 1870 he also installed it in Switzerland and Belgium, returning to England in 1872.

In 1878 Prof. Hughes communicated to the Royal Society his researches on the microphone, which may be said to form the foundation of modern telephony, for, although telephones had already been invented, it was Hughes's microphonic work that enabled them to be constructed of their present power and sensitiveness. His discovery consisted in the introduction into an electrical circuit of an electrical resistance in such a manner that it should vary in exact accord with sonorous vibrations, whereby an undulatory current of electricity from a constant source was produced, the waves being in length, height, and form an exact representation of the sonorous waves. At the same time he found that when an electric conductor in a divided state, such as a metallic powder or two wires in loose contact, is subjected to a varying pressure, less than would produce cohesion but more than would allow of separation by sonorous vibrations, the molecules so arrange themselves as to increase or decrease the electrical resistance of the circuit in a most remarkable fashion. This much Prof. Hughes made public, together with elaborate theoretical considerations respecting the nature of the phenomena. But it is now known that he carried his investigations of the phenomena afforded by imperfect electrical contacts very much further, and it is not too much to say that if he had published his results at the time he would probably now be regarded as the real inventor of wireless telegraphy. More than 20 years ago he observed what have since been termed the phenomena of "cohesion," whereby a poor electrical conductor, such as is referred to above, becomes a good conductor under the influence of electric waves. Further, he used this property for the

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detection of electric waves, and thereby anticipated to a certain extent the methods and achievements pertaining to present-day wireless telegraphy. In other words, he actually succeeded in transmitting electric signals without connecting wires to a distance of over 500 yards, and deducted the conclusion—now recognised as the correct one—that his results were due to real electric waves. However, as the opinion of experts was very much divided as to the correctness of this theory, some advancing the opinion that sufficient explanation of the phenomena was afforded by known electromagnetic effects, Prof. Hughes resolved to wait until he had found a complete scientific proof of the existence of these waves before publishing his work to the world, whereby the progress of scientific knowledge unfortunately suffered some delay.

Another beautiful electrical contrivance invented by Prof. Hughes was the induction balance—an instrument which has found several interesting practical applications, such as the testing of sensitiveness of hearing, the discovery of the position of a bullet in a wounded man, and the location of ores in the ground. Neither must it be forgotten to mention that Prof. Hughes was also the author of many valuable investigations in electricity and magnetism, which, together with his practical achievements, procured him admission to the ranks of the Royal Society in 1880. That body five years later awarded him a Royal gold medal, and in 1897 he received the Albert medal of the Society of Arts, and in 1886 he served as president of the Institution of Electrical Engineers.

The funeral is to take place on Saturday next at the Highgate Cemetery at 12 o'clock.

ELECTRICAL ENGINEER VOLUNTEERS.

SEND-OFF DINNER.

As is now well known, the War Office has accepted the services of a detachment of the Electrical Engineer (R.E.) Volunteers for active service in South Africa. This detachment will be under the command of Major R. E. Crompton, who will have five officers with him. A certain number of electrical engineers meeting at the Whitehall Club have decided to organise a send-off dinner, to which all the members of the corps going to Africa will be invited as guests. This dinner will be held a day or two before the detachment embarks, and invitation cards will be issued as soon as this date is settled by the War Office. The committee elected to make the necessary arrangements includes the following gentlemen: Messrs. H. Alabaster, W. W. Beaumont, C. H. W. Biggs, H. Edmunds, and R. Wallis-Jones. Mr. H. Edmunds will act as treasurer, and cheques should be sent to him at 2, Queen Anne's-gate, Westminster. The tickets will cost £2 each in order to provide for the large number of guests, and any surplus left over will go to the equipment fund or some similar fund connected with the corps. The subject of the dinner was brought before the Council of the Institution last night, so that it might receive official approval. We trust that a large and representative gathering of electrical engineers will take tickets to show our fighting members how proud we are that they have been allowed to uphold the honour of the profession at the front.

Taipo Accumulator Co.—We have received a copy of the prospectus of this Company, which is to have a capital of £25,000, of which £5,000 is to be issued as 6 per cent. preference shares. At the present time only £7,000 worth of shares are to be issued to the public, but we gather that the balance goes to the vendor and inventor (Mr. Hathaway). The prospectus is a very badly-prepared one, as all useful technical information is withheld. We are told that the accumulator has been tested by the consulting engineers of the company, and that a report on the same has been received, but there are no quotations from this report to support the statement that the accumulators are practically indestructible, or that the cost of maintenance is low. For small portable cells great advantages are claimed both as regards space occupied and weight, but without some technical evidence as to durability we are inclined to doubt the few figures quoted. The offices of the Company are at 101, Clifton-street. Finsbury, and applications for shares will be received at the Law Courts branch of Lloyd's Bank up to Monday next, 29th inst.

FORTHCOMING EVENTS.

FRIDAY, JAN. 26.

Royal Institution.—At 9 p.m., lecture on "Motive Power—High-Speed Navigation—Steam-Turbines," by the Hon. C. H. Parsons.

Physical Society.—At 5 p.m., papers on "Some Developments in the use of Price's Guard Wire in Insulation Tests," by Prof. Ayrton and Mr. Mather; "Reflection and Transmission of Electric Waves along Wires," by Dr. E. Barton and Mr. L. Lownds; and "The Frequency of the Transverse Vibrations of a Stretched Indiarubber Cord," by Mr. T. J. Barker.

Electro-Harmonic Society.—At the Café Monico, Smoking Concert.

SATURDAY, JAN. 27.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., at Glasgow, paper on "Dynamo Testing and the Care of Dynamos," by Mr. N. C. Woodfin.

MONDAY, JAN. 29.

Institution of Junior Engineers.—From 2 to 4 p.m., visit to the Operative Department of the Royal Mint.

Society of Arts.—At 8 p.m., Cantor lecture, "The Nature and Yield of Metalliferous Deposits," by Mr. Bennett H. Brough.

TUESDAY, JAN. 30.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper on "Steamers for Winter Navigation and Icebreaking," by Mr. R. Runeberg.

Society of Arts.—At 8 p.m., paper on "Niello Work," by Mr. C. Davenport.

WEDNESDAY, JAN. 31.

Institution of Electrical Engineers.—At 7.30 p.m., students' meeting. Discussion on "A Comparison between Continuous-Current and Alternate-Current Motors."

THURSDAY, FEB. 1.

Civil and Mechanical Engineers' Society.—At 8 p.m., at Hotel Victoria, paper on "Graphical Solutions of Certain Problems in Engineering," by Mr. F. H. Hummel.

Rontgen Society.—At 8 p.m., at 20, Hanover-square, paper on "Röntgen Rays in Diseases of the Chest," by Dr. Hugh Walsham.

Chemical Society.—At 8 p.m., ordinary meeting.

FRIDAY, FEB 2.

Royal Institution.—At 9 p.m., discourse on "Wireless Telegraphy," by Signor G. Marconi.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel, paper on "Arc Lamps and Arc Lighting," by Mr. H. G. Cotsworth.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the electrical works of the London United Tramways, Limited. Assemble at works, 88, High-road, Chiswick; train from Westminster Bridge to Turnham Green at 1.52 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., at Newcastle, discussion on paper on "Receiver Drop in Multiple-Expansion Engines," by Prof. R. L. Weighton, and paper on "The Distribution of Materials in the Upper Works of Large Steamers," by Mr. S. J. P. Thearle.

THE PITY OF IT!

The hate of the French for the trident-wench; the hate of the Greeks for the Turks;
The hate of the Jew for the porcine-stew; the hate of the good by the bad;
The hate of the works for the office staff, and the office's hate of the works:
Are based on the fact that we're all part cracked, and the most of us raving mad.

Where hate can roam in a business home; where scorn can live beside;
Where rank distrust and thoughts unjust can be where aims are one;
Where men before their duty place their departmental pride:
That firm's defeat in Stubbs's sheet is surely half begun.

Not here, not there, but everywhere; where men should work combined.
Where muscle, brain, and hand, and eye should strive as if in one;
The heads of the departments and the foremen you will find
In this agree: to disagree in everything that's done.

* * * * *

These words will fail. Of no avail is it to point the blame;
To show the wrong by pen or tongue of internecine strife.
While there are works and offices—so shall it be the same;
So shall these petty jealousies envenom business life.

J. H. C. B.

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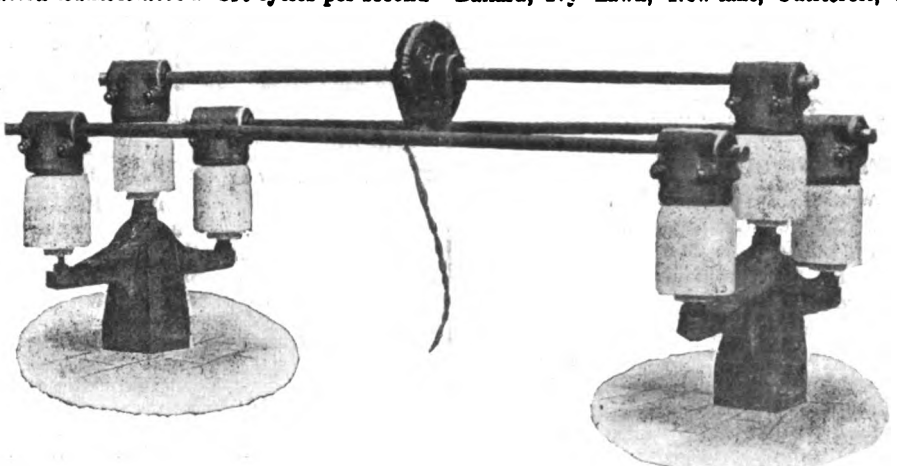
BRITISH THOMSON-HOUSTON TRANSFORMERS.

The standard types of transformer now being manufactured and supplied by the above-mentioned company are interesting in several of the details used, both in the construction of the transformers and of the containing boxes. These latter are made with corrugated exteriors so as to present a large cooling surface to the atmosphere and also to the oil which is used inside the case. The iron core is of rectangular shape, the coils being wound upon the two long sides of the rectangle. As each side is wound with both primary and secondary coils, magnetic leakage or reactance in the windings is reduced to a low value. There is but one surface of separation between primary and secondary coils, and this surface is a smooth curve to which insulating material can be uniformly and thoroughly applied without danger of defects in the workmanship or injury in assembling. It is easy with this construction to allow ample insulation space between the primary and secondary coils, as well as to secure complete circulation for the oil which is generally used in these transformers, in and about the coils, core, and connections. The core is built up of laminated iron punchings, each punching being separately insulated with a coating of a special insulating material. The joints at the corners of the rectangular core are lap-joints, ensuring a low value for the magnetic reluctance of the circuit. Between iron and copper, in the larger sizes of transformers, a duct is left to allow the oil to circulate. This, besides assisting in the cooling of the transformer, and rendering the heating of iron and copper more independent of each other, also adds greatly to the strength of the insulation between the secondary coils and earth. It also enables a severe test pressure to be applied without injury. The core losses of British Thomson-Houston transformers at 100 cycles per second vary from 2 per cent. in the smallest sizes up to ¾ per cent. in the largest sizes, and the full-load efficiencies from 93 per cent. up to 98 per cent. The impedances of the windings are so proportioned that when the transformers run in parallel between the same 'bus bars, the division of current is approximately proportional to their capacities. Also the coils are so arranged that an unbalanced load on a three-wire system does not unbalance the voltages on the two sides of the secondary. The company are also making a neat form of current transformer for use on omnibus bars of alternating-current stations. This transformer is illustrated in the accompanying figure, and consists of a ring-shaped magnetic circuit which is threaded over the 'bus bar and which is wound with a secondary coil. The secondary coil is connected to the measuring instrument, which in this way can be made to take only a very small fraction of the heavy current in the 'bus bar. Also the same recording instrument with a different scale can be made to read widely different currents by varying the transforming ratio of this transformer, which has a single-turn primary. In the illustration one of these transformers is shown connected to the conductor of a three-phase system. These transformers can also be used in connection with integrating wattmeters.



INSTITUTION OF ELECTRICAL ENGINEERS.

The following is a list of the candidates balloted for at the meeting of the Institution on the 11th inst.:

Member.—T. Howard, Post and Telegraph Department, Melbourne, Australia.

Associate Members.—M. A. Adam, 12A, Hyde Park-mansions, W.; F. Black, British Electric Traction Company, Donington House, Norfolk-street, W.C.; J. C. Calastremé, care of Argentine Contract Company, 35, King William-street, and of Buenos Ayres; J. E. Donoghue, 37, Westfield-terrace, Sheffield; S. G. L. Eustace, 4, Fairlie-place, Calcutta; H. D. Evans, Electric Light Department, General Post Office, Melbourne, Australia; H. H. E. Heath, Poste Restante, Kimberley; W. J. A. E. Horne, South African College, Cape Town. S.A.; H. R. Low, Molteno-road-gardens, Cape Town. S.A.; F. Pickering, Electric Light Works, Cape Government Railways, Cape Town, S.A.; P. W. Sankey, Messrs. Johnson and Phillip's Cable Works, Old Charlton; H. Snowdon, 77, Tyrwhitt-road, St. John's, S.E.; G. S. Wallace, 6, Third-avenue, Manor-drive, Halifax; J. W. F. Warren, Lower Commercial-street, Middlesbrough; H. B. Whitmee, Rose mount, Muswell Hill, N.; J. A. Windham, Hotel Cecil, Gibraltar; W. R. Wynne, 42, Palace-mansions, Addison Bridge, W.

Foreign Members.—F. B. Crocker, 44, West Forty-fourth-street, New York; A. de la Mora, Electricista Castellana, Valladolid, Spain.

Associates—H. G. Alder, Rockhampton, Queensland; W. R. Barclay, Richmond View, Kimberworth, Rotherham; J. Beattie, Lower Commercial-street, Middlesbrough-on-Tees; D. C. Behrends, Telephone Exchange, Rockhampton, Queensland; A. S. Blundell, 381, Halley-road, Forest Gate, E.; J. Brown, 170, Harmony-row, Govan, Glasgow; S Dale, 21, Henry-street, Cavendish-street, Keighley; D. Gill, C.B., F.R.S., Royal Observatory, Cape Town, S.A; H. Griffiths. Thornbury, Woodbourne-road, Edgbaston, Birmingham; A. R. Hakoumoff, 43, Ormistou-road, Uxbridge-road, W.; E O. Henrici, 34, Clarendon-road, Kensington, W.; H. H. Hodd, Lowood, Crystal Palace Park-road, Sydenham; J. F. W. Hooper, Deepdene, Coventry-park, Streatham; W. G. Hull, Pangbourne, Reading, Berks; G. G. Jobbins, Wrexham-road, Windsor, Victoria, Australia; J. T. Mertens, Electricity Works, Goldsmid-road, Hove, Sussex; T. F. Santonna, 34, Sidbury, Worcester; C. J. E. Walker, 195, Severn-road, Cardiff; L. W. Wild, The Grange, New Eltham; J. M. Williams, Electricity Works, Chatham; N. C. Woodfin, 1, Buchanan-terrace, Paisley, N.B.

Students.—C. F. Anderson, 51, West High-street, Salford, Manchester; R. P. Avens 31, Elm-grove, Southsea, Hants; J. A. Ballard, Ivy Lawn, New-lane, Patricroft, Manchester; A. W. Bartlett, 141, Graham-road, Dalston, N.E.; F. C. Baumann, 11, Milner-square, N.; J. D. Billington, Albion-place, Crescent, Salford, Manchester; G. J. Bish, 40, Lammas Park-road, Ealing, W.; R. P. Blennerhassett, 52, Hans-place. S.W.; B. E. Briggs, Holmefield House, Clarendon-crescent, Eccles; G. B. Davies, 45, St. Quintin's-avenue, North Kensington; L. H. Davies, Oakington, The Ridgeway, Enfield; H. C. Dear, 40, Wiltshire-road, Brixton, S.W.; W. A. Dutton, 24, Shaftesbury-street, Eccles; C. L. Faunthorpe, Elmfield, Bromley Common, Kent; R. Fisher, Albion-place, Crescent, Salford, Manchester; W. A. Fitzgerald, Lynwood, Hampton Wick, Middlesex; H. Frodsham, 16, Kingdon-road, West Hampstead, N.W.; T. Garnett, 41, Mayfield-road, Whalley Range, Manchester; J. A. Gilfillan, 26, Woodberry-down, Finsbury Park, N.; H. A. Green, Kirkella, Sanderstead-hill, South Croydon; H. H. B. Grundy, Greenhill-view, Ratcliffe, Manchester; E. C. Handcock, 59, Addison-road, Wanstead, Essex; L. J. B. Hannan, 89, Camden-road, N.W.; F. J. Hiss, jun., 107, Crouch-hill, N.; G. H. Hunt, 26, Garfield-road, Clapham, S.W.; W. J. Jeffery, 13, Station-road, New Southgate, N.; B. C. Johnson, 165 Osmaston-road, Derby; C. R. Kemp, 16, Great Percy-street, W.C.; E. McK. Kerr, Nantwich-road, Crewe; A. A. Kift, 201, Sutherland-avenue, Maida-vale, W.; T. H. Langford, 20, Lambourn-road, Clapham, S.W.; P. A. Laubach, 26, West End lane, Kilburn, N.W.; A. H. Laurence, 45, Caledonian-road, Leeds; E. Lea, 179, Swinton Hall-road, Manchester; E S. Luyks, 9, Muswell-rise, Muswell Hill, N.; B. H. Morphy, 29, Deodar-road, Putney, S.W.; H. F. Moulton, King's College, Cambridge; L. Murphy, 25, Wrottesley-road, Plumstead, S.E.; M. Parker, 25, Bracklyn-street, London; R L. Pearson, 87, Queen's-road, Battersea; F. Pritchard, 7, Osney-crescent, Camden-road, N.W.; F. R. C. Rouse, 204, Kentish Town-road, N.W.; G. B. D. C. Saw, 58, Brownswood-road. N.; H. Seward, 47, Rathcoole avenue, Hornsey, N.; J. E. Starkie, 2, Colonnade, Preston, Lancashire; C. P. H. Tamm, 116, Brondesbury-villas, Kilburn, N.W.; F. Tidman, Fairlight, Eastbourne, Sussex; T. H. Vigor. 14, Ainger-road, Primrose Hill, N.W.; P. Webberley, Ludwall House, Highfields, Longton, Staffordshire; P. A. E. Warburton, 41, Edith road, West Kensington, W.; W. S. Wright, 28, Belle Vue-road, Wandsworth Common, S.W.

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(*Concluded from page 98.*)

18. The local authority shall at all times keep all such books of account as the Postmaster-General may from time to time reasonably require of and relating to their telephonic business and their aforesaid telegraphs (including all private telegraphs worked or used by persons respectively entitled or permitted to use any other telegraphs of the local authority, and also all telegraphs sold by the local authority which the local authority after the sale thereof do not work or use as aforesaid), and all moneys and other valuable considerations received by them in respect thereof as aforesaid, and such books of account shall contain all such particulars as the Postmaster-General shall from time to time reasonably require; and the local authority shall preserve all vouchers of the said accounts and all contracts and agreements between them and all or any such persons as aforesaid respectively, and the local authority shall from time to time and at all reasonable times produce for the inspection of the Postmaster-General and his officers, at the chief office for the time being of the local authority, all or any such books, accounts, vouchers, contracts, agreements, and other documents as aforesaid, and all other books, accounts, vouchers, contracts, agreements, and other documents in any way relating to any telephonic business carried on by them, and the Postmaster-General and his officers may make copies of and extracts from all or any of such books, accounts, vouchers, contracts, agreements, and other documents.

19. (1) Subject to the provisions of this indenture respecting sums received by the local authority for the Postmaster-General and commission allowed by the Postmaster-General to the local authority and by the local authority to the Postmaster-General, the local authority shall within 28 days after March 31, June 30, Sept. 30, and Dec. 31 in every year render to the Postmaster-General a statement or statements of account in writing, in such form or forms as the Postmaster-General may from time to time require, showing the amounts of all sums of money and the nature of all other considerations and benefits which from the date hereof, or from the date up to which the last statement or statements of account (if any) shall have been rendered, have been paid or become payable or been given or conferred by all such persons as aforesaid in respect of all the matters aforesaid or any of them respectively, or which have either before or since the execution of these presents been paid or become payable or been given or conferred in respect of any telephones, telegraphs (including such private telegraphs as lastly hereinbefore mentioned), or other telegraphic apparatus or appliances which from the date hereof, or from the date up to which the last statement or statements of account (if any) shall have been rendered have been placed at any office, or between any two offices, together with all such particulars in each case as the Postmaster-General shall or may from time to time require, and the local authority shall pay to the Postmaster-General within six weeks after each of such days of account the amount due to the Postmaster-General in respect of the preceding quarter of a year. (2) The local authority shall also, on or before the ..... day of ..... in every year, prepare and render to the Postmaster-General an annual statement of accounts of the telephonic business transacted by them made up to the ..... day of ..... then next preceding, and such statement shall be in such form and shall contain such particulars as may be from time to time prescribed by the Postmaster-General.

20. The Postmaster-General, and his engineers and agents, may from time to time, and at all reasonable times, enter upon all or any office or offices in the possession or occupation of the local authority, either solely or jointly with any other person or persons respectively, for the purpose of inspecting, and may inspect the telephones and other telegraphic instruments and appliances fixed or being in such places respectively, and the working and user of such telegraphs respectively, and the local authority shall from time to time, upon the request of the Postmaster-General, procure from any person permitted by the local authority to use the said telegraphs at any other office or offices which may be occupied by them either solely or jointly with any other person his consent to such entry and inspection so far as regards such office or offices of such person, and the telephones and other telegraphic instruments and appliances fixed or being in such office or offices.

21. (1) The local authority shall at the request of any person within the licensed area supply the means of telephonic communication to such person on the same terms on which they supply the like means of communication to any other person in such area under similar circumstances—it being the intention of these presents that no preference or special advantage of any kind be shown to any person by the local authority in the transaction of telephonic business of any kind. (2) The local authority shall not as a condition of supplying the means of telephonic communication to any person require from such person the grant of any facility except for the purpose of supplying telephonic communication to such person.

22. The Postmaster-General will from time to time, at the request of the local authority, authorise the local authority to exercise within such parts of the licensed area as are within or adjoining to any urban district all such powers of executing works (other than works under, in, upon, over, along, or across any railway or canal) as are conferred upon the Postmaster-General by the Telegraph Acts, 1863 and 1878, and by Section 2 (but not by any other section) of the Telegraph Act, 1892. Provided nevertheless as follows: (1) any authority given by the Postmaster-General under this article shall have effect only so long as the licenses, powers, and authorities granted by this indenture are in force, and within such area only as is specified in the instrument giving or evidencing the grant of such authority; (2) in exercising such powers and executing such works the local authority shall be subject to the several restrictions and provisions in the said Acts or any of them contained, and particularly and without prejudice to the generality of this provision the local authority shall be subject to the provisions of the following sections of the said Acts—that is to say, Sections 42 and 48 to 52, inclusive of the Telegraph Act, 1863, and Sections 5 and 7 of the Telegraph Act, 1892; (3) the local authority shall not be entitled under the authority hereby conferred to exercise any power or enjoy any right, benefit, or advantage conferred upon the Postmaster-General by the Telegraph Act, 1863, the Telegraph Act, 1878, or the Telegraph Act, 1892, otherwise than in relation to the execution of works; (4) Section 4 of the Telegraph Act, 1892, shall not apply to the local authority; (5) nothing in this indenture shall be construed to give the local authority any wayleave or right-of-way under, in, upon, over, along, or across any railway or canal, or any right to execute any work under, in, upon, over, along, or across any railway or canal, or to call upon the proprietors or lessees of any railway or canal or the directors or person having the control thereof to execute any such work.

23. All telegraph posts, wires, and telegraphic appliances used or intended to be used as part of or in connection with the telegraphs of the local authority shall be so erected, fixed, placed, and used as not either directly or by reason of the working or user thereof to interfere with the efficient or convenient maintenance, working, or user of any telegraph posts, wires, or telegraphic appliances of the Postmaster-General which may from time to time exist, or which it is probable that the Postmaster-General may have occasion to erect, place, fix, or use, or to expose any such posts, wires, or appliances to risk of damage or to risk of interference with the efficient or convenient working or user thereof.

24. In case any telegraph post, wire, or telegraphic appliance used or intended to be used as part of or in connection with the telegraphs of the local authority, or the working or user of any such post, wire, or appliance shall in the opinion of the engineer-in-chief for the time being of the Post Office, certified by writing under his hand, directly or indirectly damage or interfere with the efficient or convenient maintenance, working, or user of any telegraph post, wire, or telegraphic appliance of the Postmaster-General for the time being existing, or expose any such post, wire, or appliance to risk of damage or to risk of interference with the efficient or convenient working or user thereof. (*a*) The local authority shall within 24 hours after service on them of notice in writing by the Postmaster-General complaining of such damage or interference, or apprehended damage or interference, either remove the post or posts, wire or wires, or telegraphic appliance or appliances complained of in such notice or refix, alter, or repair the same to the satisfaction of the engineer-in-chief for the time being of the Post Office, and (*b*) if the local authority shall make default in so doing within the time aforesaid it shall be lawful for the Postmaster-General to remove, alter, or repair the post or posts, wire or wires, or telegraphic appliance or appliances complained of in such notice, and the local authority shall on demand pay to the Postmaster-General the cost of any removal, alteration, or repair by the Postmaster-General of the posts, wires, and telegraphic appliances complained of in such notice or any of them.

25. In case any telegraph post, wire, or telegraphic appliance of the Postmaster-General shall be damaged, or the efficient working or user thereof shall be wholly or partially interrupted or otherwise interfered with, and the engineer-in-chief for the time being of the Post Office shall certify by writing under his hand that such damage, interruption, or interference has been caused directly or indirectly by any telegraph post, wire, or telegraphic appliance used or intended to be used as part of or in connection with the telegraphs of the local authority, or by anything done by or on behalf of the local authority in relation thereto, the local authority shall, on demand, pay to the Postmaster-General all costs that shall be reasonably incurred by him in repairing such damage and in removing or altering such post, wire, or telegraphic appliance so as to restore the same to efficient working order, and in adding thereto or substituting therefor, either temporarily or permanently, any other posts, wires, or telegraphic appliances if the said engineer shall

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certify that such addition or substitution is reasonably required.

26. Except with the consent in writing of the Postmaster-General the local authority shall not (1) assign, underlet, or otherwise dispose of the benefits of the covenants herein contained, or of any of such covenants, or the licenses, powers, or authorities hereby granted, or any of such licenses, powers, or authorities; or (2) sell, assign, transfer or deliver, or underlet to any other licensee of the Postmaster-General any plant used by the local authority in supplying the means of telephonic communication under these presents, or allow such licensee in any manner to have the use, benefit, or enjoyment of any such plant in connection with his undertaking; or (3) purchase, lease, or acquire any interest in the business or plant of any other licensee of the Postmaster-General, or any part of such business or plant, or enter into any working or other agreement with such other licensee.

27. The local authority and the Postmaster-General shall from time to time do and execute, or cause to be done and executed, all such acts, deeds, and things whatsoever as may be required by the Postmaster-General or the local authority (as the case may be) to give effect to the covenants and agreements in this indenture contained.

28. In any of the following cases—that is to say: (*a*) in case the local authority do not within two years from the date of this indenture establish an exchange system, and so long as the licenses, powers, and authorities hereby granted shall continue maintain such system in effective working to the satisfaction of the Postmaster-General; or (*b*) in case any sum of money which ought to be paid by the local authority to the Postmaster-General under or by virtue of these presents shall be in arrear and unpaid for one calendar month after the time at which the same ought to be paid under or by virtue of the covenants herein contained; or (*c*) in case of any breach, non-observance, or non-performance by or on the part of the local authority of any of the covenants (other than a covenant for the payment of money) or conditions herein contained and on the part of the local authority to be observed and performed, then and in any such case the Postmaster-General may by writing under his seal revoke and determine these presents and the licenses, powers, and authorities hereinbefore granted, and each and every of them, and thereupon these presents and the said licenses, powers, and authorities, and each and every of them, shall absolutely cease, determine, and become void. Provided always that no such revocation or determination as aforesaid shall prejudice or affect any right of action or remedy which shall have accrued or shall thereafter accrue to either of the parties hereto under the covenants herein contained. Provided also that in case of any such revocation or determination as aforesaid the local authority shall, if so required by the Postmaster-General, sell and convey to the Postmaster-General all such plant as was immediately prior to such revocation or determination in use by the local authority for the purpose of supplying the means of telephonic communication under these presents and as the Postmaster-General may desire to purchase.

29. (1) On, or so soon as may be after the ..... day of ..... aforesaid (unless these presents shall have been previously revoked and determined as in this indenture provided), the Postmaster-General shall buy, and the local authority shall sell and convey, all such plant as is at the date aforesaid in use by the local authority for the purpose of supplying the means of telephonic communication under these presents, and as is suitable for the actual requirements at the date aforesaid of the telephonic service of the Post Office within the licensed area. (2) No plant shall in any case be considered suitable for the requirements of the telephonic service of the Post Office which has been brought into use without the sanction in writing of the Postmaster-General, but subject as aforesaid if any question arises as to the suitability of any of the plant of the local authority for the requirements of the telephonic service of the Post Office within the licensed area, such question shall in case of difference be determined by arbitration.

30. The value of all plant purchased by the Postmaster-General under the foregoing articles shall be deemed to be its fair market value at the time of the purchase, due regard being had to the nature and then condition of such plant and to the state of repair thereof, and to the circumstance that it is in such a position as to be ready for immediate working, and to its suitability to the purposes of a telephonic service, and no addition shall be made to such value in respect of compulsory purchase, or of goodwill, or of any profits which might have been or be made by the local authority from the use of such plant. In case of difference such value as aforesaid shall be determined by arbitration.

31. All matters which in pursuance of the provisions herein contained are to be determined by arbitration shall be referred to arbitration in accordance with the provisions of the Arbitration Act, 1889, or any then subsisting statutory re-enactment or modification thereof.

32. Nothing in these presents contained shall prejudice or affect the right of the Postmaster-General from time to time to establish, extend, maintain, and work any system or systems of telegraphic communication (whether of a like nature to the telephonic business of the local authority, or otherwise) in such manner as he shall in his discretion think fit, neither shall anything herein contained prejudice or affect the right of the Postmaster-General from time to time to enter into agreements for, or to grant licenses relative to, the working and user of telegraphs (whether of a like nature to those worked and used by the local authority or otherwise), or the transmission of telegrams in any part of the United Kingdom, with or to any person or persons whomsoever upon such terms as he shall in his discretion think fit. And (save as in this indenture provided) nothing herein contained shall be deemed to authorise the local authority to exercise any of the powers or authorities conferred on or acquired by the Postmaster-General by or under the Telegraph Acts or any of them.

33. Any notice, request, or consent (whether expressed to be in writing or not) to be given by the Postmaster-General under these presents may be under the hand of any one of the secretaries or assistant secretaries for the time being of the Post Office, and may be served by sending the same by registered post letter to the local authority, and any notice to be given by the local authority under these presents may be served by sending the same by registered post letter addressed to the Secretary of the Post Office at the General Post Office, London.

In witness whereof the above-named Postmaster-General hath hereunto set his hand and seal and the local authority have caused their common seal to be hereunto affixed the day and year first above written.

THE NEW GERMAN ATLANTIC CABLE.

The first report of the German Atlantic Telegraph Company (Deutsch-Atlantische Telegrafen Gesellschaft) deals at some length with the progress of the scheme for the establishment of an independent cable from Borkum, *viâ* the Azores, to New York. It appears that the company, which was formed in February, 1899, entered into an agreement in May of that year with the firm of Felten and Guilleaume and the German Government in regard to the matter, and some of the details of the arrangements will be of considerable interest in this country. The report points out that the concession granted by the Government to the firm for the establishment of the cable is for 40 years from the commencement of working, and that the laying of the cable is to be finished by Oct. 1, 1900. In case the cable is found to be inadequate for dealing with the traffic, the undertakers will be justified in laying a second cable for the duration of the concession. The German Postal authorities will operate the cable from the German terminal point, whilst the undertakers are to work and maintain the line at the Azores and on the North American side. The cable is in the first instance intended to deal with the telegraphic service between Germany or its hinterlands and America, and *vice versâ*, but Peru, Brazil, and the other South American States are excluded from its sphere of activity. As to the working of the line, the German Government will pay to the undertakers a fixed sum of £70,000 per annum until the expiration of the concession, and it will receive the revenue from messages sent in both directions between Germany and America to the extent of £85,000 per annum. When the receipts exceed £85,000 the German Government will, under certain conditions, participate in the excess at the rate of 25 centimes per word. The undertakers are pledged to take over the cable line of the Deutsche See Telegrafen Gesellschaft from Borkum to Vigo not later than by the end of 1904.

After prolonged negotiations, the company has obtained permission to land the cable in the United States, whilst a landing position at the Azores has been secured through the intermediary of the European and Azores Telegraph Company, which will receive £2,500 for affording the necessary facilities. As soon as the working of the cable yields a dividend exceeding 8 per cent., the company undertakes to lay a cable between Fayal and Santa Maria, in the Azores. A further condition for the laying of the cable at the Azores was that the cable should be ordered from the Telegraph Construction and Maintenance Company. The cost of the cable, which will have a length of 4,366 knots, amounts to £935,000, including laying. It is estimated that the cable, which is expected to deal with 8,000,000 words per annum, will be completed and set in operation before October, which month is specified in the agreement. Arrangements have been made with the Commercial Cable Company whereby the latter places its comprehensive network at the disposal of the company for the dispatch of telegrams along the new cable to Germany, and provision has been made for the transmission of messages by other routes in case of any interruption in the working of the new cable. The capital of the new company, whose founders include the Schaffhausen Bankverein, the Dresden Bank, the Diskonto Gesellschaft, and the Darmstadt Bank, is £1,000,000, of which £700,000 has already been paid up.—*Financial Times*.

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LEGAL INTELLIGENCE.

RUCKER v. THE LONDON ELECTRIC SUPPLY CORPORATION.

In the Chancery Division of the High Court of Justice, before Mr. Justice Farwell, this case was commenced on Monday last. The action arose out of the original Zipernowsky and Déri patent for the parallel system of transformer distribution, the interests in which were acquired by Mr. Rucker. The case is one of long standing, commencing in August, 1898. In our issue for Aug. 12 of that year we gave the full text of the patent specification on which the claim for damages was made, and we reproduce again here the specification as amended on April 3rd, 1897:

COMPLETE SPECIFICATION (AMENDED).

Improvements in Distributing Electricity.

I, WILLIAM PHILLIPS THOMPSON, of 6, Lord-street, Liverpool, do hereby declare the nature of this invention (a communication from Carl Zipernowsky and Max Déri, of Budapest, Hungary), and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:

For some time past induction coils consisting of two coils or layers of insulated copper wires with a common iron core similar to the Ruhmkorff apparatus, have been used for the transformation of alternating electric currents.

By means of such transformation electric energy can be cheaply conveyed over lines of considerable length and be utilised in a number of local circuits for lighting and other purposes.

The distribution of electrical energy by such means has, however, not succeeded in such a manner as to satisfy the requirements of everyday practice, because it was not possible to increase or diminish the number of points of consumption in operation without affecting the working of the others in a marked degree, and it was therefore necessary to use mechanically acting regulating devices at the different points of consumption to compensate for the variations caused by the changes in the quality of electrical energy used.

In the same manner the efficiency of the systems hitherto used was greatly dependent upon the number of points of consumption in activity.

Now the object of this invention is to make all individual points of consumption of electrical energy quite independent from one another, all necessary regulation being made by or at the generator of electricity.

We group the induction coils or transformers so as to constitute secondary distributing stations or local centres. The primary coils of the several transformers of such a local centre may be arranged either in series or in multiple arc circuits. In the former case the secondary or induced spires of all the transformers of the respective station form a single local circuit irrespective of whether these induced spires are connected up in quantity or in series. In the second case, however—*i.e.*, when the primary coils of the several transformers constituting a local centre are connected up in multiple arc—either each individual induced coil may form a separate secondary circuit or any number or all of the induced coils of the transformers of a local centre may be connected to form a single local circuit.

The apparatus for the actual utilisation of electricity, as incandescent and arc lamps, electromotors, etc., are in all cases connected up in multiple arc in the local secondary circuits.

But the distinctive feature of our system of distribution is, that each group of induction coils or transformers of the several stations of second order shall merely constitute branch circuits of the main line for the primary current—*i.e.*, the primary circuits of the several local centres—any one of these being taken as a whole are connected in multiple arc.

In this manner we have conductors distributing the primary (high tension) current in as many branch circuits as there are local centres and any desirable number of secondary (low tension) circuits.

Now the electromotive forces of the two coils of a transformer bear a constant ratio to one another: therefore if the internal resistance of such an apparatus is very low, the secondary tension will remain almost unaltered, if we only have a constant difference of potential at the terminals of the primary coil.

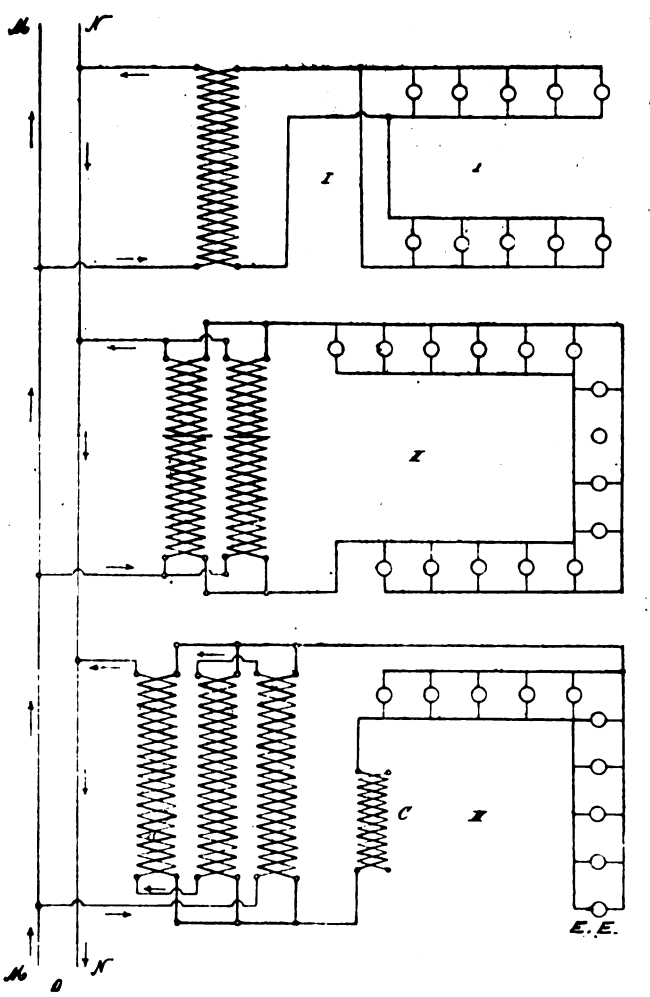
The individual points of consumption in the several local circuits are independent of one another by reason of their distribution as branch circuits derived from the secondary line—*i.e.*, connection in multiple arc—provided only that the internal resistance of the transformers be relatively low, and the primary tension at the station invariable.

If the independence of individual groups of lamps must be still more perfect, it will be advisable to feed such a group by an independent line, as any desired number of secondary circuits may be derived each separately from one transformer.

It follows from the foregoing that our system of distributing electrical energy by means of alternating currents and induction coils or transformers is based upon having a constant difference of potential in the primary conductors as well as in the secondary ones.

In a distribution of current according to our system there will be a variable intensity of current in the main line as well as in every branch circuit of it, in contradistinction to the systems of distribution by inductional transformers hitherto known or proposed, all of these being based upon constant intensity of the primary current; in our system the intensity of the primary current varies in the same way as the number of points of consumption in activity. This is caused by the counter electromotive force of the transformers somewhat increasing when the intensity of the secondary current diminishes and *vice versâ*. The consumption of energy for each local station varies in the same manner as the current in the corresponding local circuit, and consequently the total consumption of power varies in accordance to the total supply of current in the secondary circuits.

The drawing is a diagram showing the manner in which we supply local centres from the main line. At O is the central station. Between the main lines M and N the tension is invariable. Three local centres or secondary stations are shown: Station I. consists of a single transformer; at Station II. there are two transformers with their primary as well as their secondary coils connected up in multiple arc; at Station III. there are three transformers, with their primary coils in series, the secondary ones in multiple arc. As it will be seen, all the branch circuits leading to the several local centres are derived as parallel circuits from the main line—*i.e.*, connected up in multiple arc.



We desire it distinctly to be understood that the form of the induction apparatus or transformers used may be of any kind whatever, without departing from the principle of our invention.

Having now particularly described and ascertained the nature of the said invention and in what manner the same is to be performed as communicated to me by my foreign correspondent I declare what I claim is:

In the application of induction coils or transformers for alternating electric currents the arrangement of several stations of second order as branch circuits of the main line—*i.e.*, connecting up the local centres with the main line in multiple arc—to which main line is supplied an alternating electric current of a tension as constant as possible, substantially as described and shown in the drawing.

Dated this 12th day of December, 1885.

W. P. THOMPSON.

(Per his agents, W. P. Thompson and Boult).

The counsel for the plaintiff were Mr. W. R. Bousfield, Q.C., Mr. A. J. Walter, and Mr. H. Gray, who were instructed by Messrs. Hind and Robinson, solicitors; while for the defence appeared Mr. Fletcher Moulton, Q.C., Mr. Cripps, Q.C., Mr. J. C. Graham, and Mr. Fletcher Moulton, jun., these being instructed by Messrs. Deacon, Gibson, Medcalfe, and Goddard.

Mr. Bousfield, in opening the case on Monday, drew the judge's attention to the similarity of the present action and the action by which the late Dr. John Hopkinson's rights to the three-wire system were established some years ago. He explained that the patentees, Messrs. Zipernowsky and Déri, after patenting the transformer system in this country in 1895, were obliged to undertake a good deal of litigation on the Continent with reference to similar patents. They had succeeded in this in Italy and France. As they were also engaged in business on the Continent, they had

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not until the last few years undertaken an action to maintain their rights in England. He explained that in amending the patent the alterations had been entirely with a view to cutting out specific apparatus in order to reduce the points at issue, and to remove the matters which were not of much importance. After a question as to the publication of the shorthand notes had been settled between the leading counsel on each side, the case was adjourned until Tuesday.

TUESDAY.

On the opening of the second day's proceedings, **Mr. Fletcher Moulton** announced that Mr. Zipernowsky was very ill with influenza, and that probably he would not be able to attend the case. His evidence would be wanted with respect to prior publication of the subject matter of the patent if the same was not admitted by Mr. Bousfield. It was agreed that the inconvenience of an adjournment should be avoided if possible, but the question at issue was not gone into.

Mr. Bousfield then reopened the case for the plaintiffs by explaining to the judge the essential points connected with electric distribution. Commencing with analogies from the flow of water in pipes, he proceeded to illustrate by diagrams and models the primary facts connected with the distribution of electricity and the calculation of currents from the E.M.F.'s and resistances by means of Ohm's law. He explained that in the first systems of electric distribution a constant current was kept going through a single circuit, the lamps being connected in series. He showed that the increase in the number of lamps was limited by the dangerous voltages which would have to be used. He then described the constant-potential system of distribution with the lamps in parallel as devised by Edison, and explained the difficulties with this system of maintaining a constant potential at the lamps when large currents were being dealt with. The limited range of a simple two-wire system of parallel distribution was referred to in the course of this explanation. The next development of the system was shown by the Edison system with low-tension feeders supplying limited areas, after which Mr. Bousfield explained to his Lordship that while personal danger limited the series system, the question of economy of copper and waste of energy limited the parallel system of distribution at low voltages. The next improvement was the introduction of the Hopkinson three-wire system, which was explained in detail, as it was the subject of somewhat similar litigation. In introducing the alternate-current system of working, Mr. Bousfield explained the units of measurement employed and the action of transformers. He stated that transformers were known to electricians a great many years before the date of the Zipernowsky and Déri patent, and proceeded to explain the systems of working transformers which had been employed previous to the plaintiffs' inventions. These systems, such as the Gaulard and Gibbs and the Jablochkoff, used transformers with their primary coils in series, and with single lamps as a rule connected to the secondary coils of these transformers. In certain cases a number of lamps in series were used on these secondary coils of the transformers. Mr. Bousfield stated that while this system was good when all the lamps were in use, when certain lamps were switched off the transformers supplying them developed a choking effect, which interfered with the current passing in the primary circuit of the other transformers. (This was illustrated by experiment.) He then proceeded to explain that at the time that the plaintiffs' invention was introduced in England, the system of connecting the primary of transformers in parallel was not generally appreciated. Thus, while Lord Kelvin might have thought such a procedure quite obvious, other electricians did not. For instance, Prof. Forbes discussed the question adversely even after the system had been shown at work at the Inventions Exhibition. He hoped to be able to show by his witnesses that while the various details of the system were known, no one at the date of the patents had put these elements of knowledge together in such a way as to form a practical system of electric lighting. Mr. Bousfield went on to review the patent specification which we print above, and laid special stress on the extract which reads as follows: "In this manner we have conductors distributing the primary (high-tension) current in as many branch circuits as there are local centres and any desirable number of secondary (low-tension) circuits. Now the electromotive forces of the two coils of a transformer bear a constant ratio to one another. Therefore if the internal resistance of such an apparatus is very low, the secondary tension will remain almost unaltered if we only have a constant difference of potential at the terminals of the primary coil." The illustrations in the amended specification were also described in detail to his Lordship, and Mr. Bousfield read the claim at the end of the specification in the following way. He considered that the claim consisted of three elements: (1) apparatus giving alternating high-tension currents of constant potential in the main line; (2) local transformers with primaries connected to the main line in multiple arc; and (3) local secondary low-tension circuits with lamp connections in multiple arc. These three things were essential to the system. The defendants' system of distribution contained all these elements, as they generated current at Deptford at 10,000 volts and transformed it at Trafalgar-square down to 2,400 volts, and also transformed from 2,400 volts to a lower pressure of about 100 volts to supply the consumers. They thus used the plaintiffs' system twice between the generating machine and the consumers' lamps. He claimed that the slight variations required in the pressure at Deptford did not amount to a variation from the constant-potential system. As in the plaintiffs' specification, it was explained that the secondary pressure would remain almost constant only if the internal resistance of the apparatus used was very low. That showed that the inventors recognised the need of slight variations in the primary pressure. He claimed that in making their amendment to the original specification he would be able to satisfy the Court that the original scheme was framed in good faith, and with reasonable skill and knowledge. The claims which they had cut out referred to specific apparatus, the abandonment of which was not inconsistent with the above requirements. He showed that the same kind of amendment had been made in other cases without damaging the validity of the patent.

Mr. Jas. Swinburne was the first witness called by the plaintiff, and he was examined by Mr. Walter. In answering the questions, he still further explained to Mr. Justice Farwell the essential principles of electrical transmission through wires. He was then questioned by Mr. Walter concerning the state of electric lighting at the Paris Exhibition of 1878. Jablochkoff arc lamps were first displayed at this exhibition, and it was usual to have a dynamo for each individual lamp. At that date the sub-division of electric lighting was not understood, but Jablochkoff had shown that several arc lamps could be run in series on the same circuit. He also introduced parallel circuits with several lamps in series. Mr. Swinburne proceeded to describe the system used in 1884 and 1885 at Brighton, Hastings, and Eastbourne—of running groups of incandescent lamps in series arc light circuits. Incandescent lamps when first made were worked at about 50 volts, but Mr. Edison introduced 100-volt lamps in order to reduce the cost of the copper mains. Mr. Swinburne was then asked to describe the Edison system of low-tension feeders designed with the object of keeping a constant potential on the lamps. It was realised by Edison in 1880 and 1881 that the increase of voltage would economise the copper, and Mr. Swinburne explained that doubling pressure on the lamps enabled four times as many lamps to be supplied with given mains and the same percentage loss. The dangers of using higher pressures with the lamps in series was also referred to, as was the inconvenience of running parallel groups of incandescent lamps in series with the arcs. The alternating-current system for parallel lighting was largely used from 1883 to 1885, the alternators supplying incandescent lamps without intervention of transformers. Transformers were used in the Gaulard and Gibbs system, but he did not think that the design of transformers was understood by electricians, except by the plaintiffs, at the time that their patent was taken out. He did not think the transforming ratio of a transformer was understood generally by electrical engineers before 1886 or 1887. In reply to a question by Mr. Moulton, Mr. Swinburne said that the engineer in 1885 would not have known that the ratio of volts in the different windings varied as the number of turns. In reply to Mr. Walter, he did not consider that Gaulard and Gibbs and Jablochkoff understood the back pressure found in the primary of a transformer when the secondary circuit was open. Those electrical engineers laid great stress on the continuous primary circuit, and did not understand the back pressure which was said to be in the transformer. He described the Gaulard and Gibbs installation on the Metropolitan Railway, by which Edgware-road, King's Cross, and other stations were lighted from a dynamo at Edgware-road. Those transformers were connected in series and the lamps were not required to be turned out, hence the system worked in an ideal way. In an ideal system of electrical distribution the lamps should be independent of each other, so that the turning out of one lamp should not affect the neighbouring ones. In his opinion Messrs. Zipernowski and Déri realised the solution of this difficulty by using high-tension constant potential on the primary side of the transformer and getting constant pressure at a low voltage on the mains. The specification showed that they contemplated a general system of distribution with several transformers in parallel. The objection of the invention was to make the individual consumers independent of one another, which was not the case with the Gaulard and Gibbs system. With the plaintiffs' system the apparatus for using electricity was in all cases connected in parallel on the local secondary circuits and worked at constant potential. In his opinion the invention was new at the date the specification was filed, and it was also his opinion that the system used by the London Electric Supply Corporation was the same as that described in the specification. He thought that about one-half the lights in the United Kingdom were run on this system. He had carefully gone through the particulars of patents, and the invention described in the specification was not described in any prior publications. He said that sufficient instructions were given in the specification to enable the invention to be worked out.

Mr. J. Swinburne was then cross-examined by Mr. Fletcher Moulton. He said that from about 1881 people were talking about the sub-division of electric light, but that was not the same problem as its distribution. The first Electric Light Act was passed in 1882, and by it any member of the public was free to use the supply of energy for any purpose whatever. He did not agree with Mr. Fletcher Moulton's question that electricity was supplied exactly the same way as gas or water, as it was not necessary that the supply should be in parallel. The parallel system of distribution was recognised in the Act, the supply being given at two metallic poles in the consumer's house. These poles were maintained at a constant difference of potential, but under the Act the standard pressure might be different for different points of any main. Any pressure from 30 volts to 200 volts could be used for continuous currents, and from 50 to 100 volts for the alternating. There was nothing to prevent a man connecting an induction coil or transformer across the poles of an alternate-current supply. He would then have a transformer in parallel with the lamps and other electrical apparatus, but he did not think that that was the equivalent to what was shown in the patent specification of the

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plaintiff. If two people each wanted to use a transformer and both sent them across the mains at the same time, they would then be in the position claimed in the patent. The two poles in the consumer's premises were practically equivalent to the two poles of an alternate-current dynamo. He could not conceive any object for connecting a transformer as suggested on to low-pressure mains.

The hearing of the case was then adjourned to the next day.

WEDNESDAY.

Mr. Jas. Swinburne, further cross-examined by Mr. Moulton, said that at the date of the patent it was known that current could be transmitted over a considerable distance through transformers in series. He did not agree that there was sufficient information at that date to make transformers to fulfil a given object. He was a witness at the Gaulard and Gibbs litigation in July, 1888, when he stated with respect to induction coils that the proportion between the volts in the primary and the volts in the secondary was as the number of turns respectively in those circuits. His evidence then referred to induction coils and not to transformers, and was incorrect. He also stated at that time that the rule was a very old one. He had also seen an article in the October number of 1894 of the *Lumière Electrique* describing the transformers of Messrs. Gaulard and Gibbs. In that article the rule for varying the pressure on the secondary of a transformer was given. Even then they stated that there was no necessary relationship between the pressure in the primary and secondary circuits. He thought that in 1885 an electrical engineer would have been afraid to connect a transformer direct across the supply terminals of an alternator without placing a resistance in series. He did not agree that Mr. Fuller's specification described the plaintiffs' system of distribution. He considered from the descriptions given that Mr. Fuller proposed to place a number of transformers in series across the mains. With respect to the Brush patent for working with series alternating currents, he believed that Mr. Brush did not understand what would happen with the arrangements as proposed by him. He seemed to think that with a number of transformers in series the current would be constant even if arc lamps on the secondary circuit were switched out. Mr. Edison's 1882 patent provided high-tension direct-current mains, a commutator to commutate this current into alternating current, after which it was passed through transformers in the same way as in the plaintiffs' specification. Mr. Swinburne did not agree that the transformer indicated by Mr. Edison in his patent would work satisfactorily, and said that the commutator would spark so seriously as to render the system of no use. Mr. Edison also proposed to recommutate the current before supplying the lamps. The article quoted in the *Zeitschrift fuer Elektrotechnik* was really a description of the Zipernowsky system, but the writer's description was by no means a correct one. He agreed that the effects described would only be produced with the plaintiffs' system. The article by Mr. Rankin Kennedy in the *Electrical Review* of June, 1883, described the choking action of an induction coil with a movable core. The incandescent lamp indicating this action was placed in the primary circuit. An engineer could not have calculated the choking coil for a certain effect at that date, as Dr. Hopkinson had not then published his work on the permeability of iron. He did not agree that Mr. Rankin Kennedy's description of the choking actions were correct, and his descriptions showed clearly that he had not any definite ideas on the subject. He noticed a paragraph which stated that "in parallel work, however, the secondary generator was a beautiful self-governing system of distribution." From the drawings and descriptions Mr. Swinburne considered that the author proposed to put the primaries in parallel and to connect the lamps on the secondary side in series. The arrangement would not then be self-governing, as was suggested, but the switching out of a lamp on one transformer would not influence the lamps supplied from another transformer. It was not known, in his opinion, at that date that the transforming ratio of a transformer was practically independent of the load. He read Mr. Kennedy's remarks as to the large size of conductors required with the parallel system to mean that he would distribute at low tension and transform up to supply the lamps in series with high-tension current. Switching out one lamp of a series would then affect others in the same circuit.

Mr. Fletcher Moulton then took Mr. Swinburne through the plaintiffs' specification. Mr. Swinburne stated that he considered the use of the high-tension primary was an essential element in the patent, and also the knowledge that transformers had the same transforming ratio at all loads. The comparative advantages of high and low tension for distribution work were known as far back as 1878. He considered that the plaintiffs were the first to understand the laws of distribution with transformers in parallel, and that they had in this way solved the problem which now seemed to be exceedingly simple. The knowledge how to do this was not the common knowledge of electrical engineers at that time. The real invention was a new use of transformers, coupled with the understanding of the above fact. Gaulard and Gibbs's system was not a practical system for distribution in parallel, as the series connections of the transformers stopped their regulation. Certain errors in the drawings of the unamended specification of the plaintiffs' were then pointed out to Mr. Swinburne, who said that he considered them to be mere draughtsmen's errors as to the number of coils in each transformer. He did not read the broad claim for the use of any type of any transformer to mean that the patentees thought that the regulation would be as good even if the internal resistance was not low. He could not show Mr. Moulton any more than the two references to high and low pressure in the whole specification. The broad claim with these qualifications might be taken to include any system using transformers in parallel, and he thought that the patentees were the first to realise the advantage of this method of connecting. In the drawings, transformers in parallel alone were shown. With respect to the defendants' system, he thought that transforming from 2,400 volts in the mains to 100 volts on the consumers' lamps infringed the plaintiffs' patent. He also considered that the transformation from 10,000 volts at Deptford to 2,400 volts in London infringed the patent if more than one transformer were used in London to supply the load, these transformers being connected in parallel. He did not agree with Mr. Moulton that the inequality of the pressure given at times by the defendants prevented their system from being an infringement. The transmission of power by means of high-tension currents was old, and was described in Imray's patent of 1881, in which step-up and step-down induction coils were described. There was not, however, in Imray's patent any question raised as to the constancy of pressure.

Re-examined by Mr. Bousfield, Mr. Swinburne said that the 10,000-to-2,400 transformation used in London by the defendants would be similar to the arrangement described by Imray if one transformer only were used. Imray's description of his apparatus included a Bunsen battery supplying a Ruhmkorff coil, the secondary terminals of which were connected through several thousand yards of wire to another Ruhmkorff coil. A piece of platinum wire across the low-tension winding of this second coil could then be heated to redness. Mr. Swinburne agreed with the description of the claim of the plaintiff as given by Mr. Bousfield in the opening. The three elements of the combination were necessary to the successful application of the system, and the combination of these three elements was, in his opinion new at the date of the invention. The expressions of the specification as to the relatively low resistance in the transformer required to give an almost constant pressure would have been recognised by a scientific man in 1885 if it had been clearly put to him, although he might not have thought of it before. He did not think that a man would have invented the system except by chance, unless he had understood this and also the constant transforming ratio of an alternate-current transformer. He did not think these things were understood at the date of the patent.

The case was then adjourned till the next day.

ALLEN v. PEMBERTON.

A Dispute about Electrical Work.

In the Westminster County Court on Friday his Honour Judge Lumley Smith, Q.C., had before him the case of Allen *v.* Pemberton, in which the plaintiff, an electrical engineer, sued the defendant, who carries on business in Old Bond-street, to recover payment of an account of £4 in respect of electrical work carried out to his order.

The Plaintiff was called, and said that in October of last year defendant instructed him to refix and repair four arc lamps outside his premises. The work, which was very difficult, owing to the bad state of the lamps, was duly carried out at an agreed cost of £4, but after its completion the defendant refused to pay the account.

The Defendant was called, and said he had paid 30s. into Court, and considered that sum was ample. As a matter of fact the plaintiff approached him and told him he could put the lamps in perfect order, but after the completion of the work it was found that they would not burn for more than half an hour or an hour without going out.

His Honour said he had no doubt that the plaintiff had done his best, but he (the judge) thought he was too sanguine in his hopes of turning old lamps into new. On the whole, he thought the amount paid into court was sufficient, and therefore there must be judgment for the defendant.

ST. MARYLEBONE LIGHTING.

The Metropolitan Electric Supply Company, Limited, were summoned last week by Mr. W. J. Godfrey, on behalf of the London County Council, for having on various dates in October and November last failed to supply electric energy to the premises of Sir Felix Semon, physician, of 39, Wimpole-street; Mr. H. T. Butlin, consulting surgeon, of 82, Harley-street; and Mr. Alfred Arthur Hudson, barrister, of 28, Weymouth-street. Mr. Daldy appeared for the prosecution, and Mr. Muir for the defence.

From the report which appeared in the *Standard*, we learn that **Mr. Daldy** stated that the Council had received many complaints of the company having failed in their contract to provide a continuous supply of electric energy for the use of their customers, and that the persons named in the summons were representative of the bulk. The company on a previous occasion had pleaded as an excuse for their default that difficulties in connection with the construction of their new works at Willesden had occurred over which they had no control; but he (counsel) put it that the company had undertaken new business which they were unable to execute except at the expense and inconvenience of their other customers, and to the benefit of the company. This failing of the light had proved a very serious matter, not only for business, but it was stated that it had caused consternation at afternoon teas in drawing-rooms in the West-end, and had led to so much secret kissing between young ladies and young gentlemen that their parents had become greatly alarmed about it. He maintained that the company could have no answer to these complaints, for they were compelled by statutory obligations to keep their contracts with their customers.

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Mr. Hudson and **Mrs. Butlin** gave evidence of the supply of electricity being stopped for varying periods on different dates, on one or more occasions as long as six hours.

Mr. Muir, for the defence, denied that the company had extended their operations at the expense of their other customers. The failure had arisen from other causes. The learned counsel then narrated the nature of many difficulties which had had to be overcome in connection with the erection of works at Willesden, difficulties which no amount of human foresight could anticipate, and over which the company had no power to prevent. Since Dec. 15 last the supply had been constant, and measures had been adopted whereby it would be impossible for failures to recur in the future. He called Mr. E. Cunliffe Owen, the secretary, and Mr. Todd, the chief engineer of the company, who bore out the statement. Ample provision, they said, had been made for the future.

Mr. Curtis Bennett said it was clear that the company had done its best under very difficult circumstances, but, nevertheless, they had not complied with the conditions under which they had obtained their very extensive powers from Parliament, and they were, therefore, liable to a penalty. He gave the company credit for having done their best, but they had failed in their obligations. The company would be fined 10s., with 23s. costs, on each of the six summonses—total £9. 18s.

CARDIFF CORPORATION v. FERRANTI.

In the Queen's Bench on the 18th inst., before Mr. Justice Mathew, the action of the Corporation of Cardiff against S. Z. de Ferranti and others came on for hearing. The action was for damages caused by the defendants' delay in supplying an alternator for plaintiffs' electric plant. Defendants denied liability and counterclaimed.

Mr. A. S. Lawrence, Q.C., and Mr. Leslie were for the plaintiffs; Mr. J. Walton, Q.C., Mr. Laing, Q.C., and Mr. Bulloch were for the defendants.

Mr. Lawrence said that in March, 1896, Ferranti, Limited, tendered to supply a 300-h.p. steam alternator at the price of £3,250. A contract was entered into on June 4, 1896, between the defendants and the plaintiffs, and it was a condition that the work was to be completed to the satisfaction of the borough engineer and handed over by Sept. 15, 1896, or failing that the defendants to pay the Corporation 1 per cent. of the contract price per week during so long a time as the work remained incompleted. The work was not finished in time, and a correspondence was entered into which lasted over three years. The letters were more or less to the effect that the defendants admitted the delay and thanked the borough engineer for his leniency.

Mr. Walton said it was a question when the contract was completed, and that was of importance, as the penalty was £31. 10s. per week, and now amounted to £5,000 or £6,000. The defendants had paid into court £1,500, while not admitting their liability. They had already spent £7,000 on the work. There was also a question of law whether the Corporation could recover damages, the penalty of £31. 10s. a week being in the nature of damages.

Mr. Lawrence stated that the electric light had suffered because of its condition from the competition of the incandescent light, and that might be shown to be a source of damage.

Mr. Walton intimated that it was probable the parties might approach each other.

Mr. Lawrence said he would do all he could to facilitate a reasonable settlement.

The hearing was adjourned.—*South Wales Daily News.*

On the case being called on Friday, it was announced that a settlement had been arrived at between the parties, and his Lordship ordered that the £1,500 in court be paid out to the plaintiffs. The following terms were agreed upon: The defendants to pay the plaintiffs £2,000 (including the money in court). The plaintiffs to pay the defendants the balance of cost price (£325). The defendants to execute the following works within one month from proper facilities given: (1) adjust the governor, so that the engine will govern to Mr. Burstall's satisfaction; (2) make or replace the journals on vertical shafts to Mr. Burstall's satisfaction; (3) put the gearing of the vertical shafts in order to Mr. Burstall's satisfaction. No costs on either side, and the judge's order to be taken if necessary.

MR. CARRUTHERS WAIN'S FAILURE.

The case of W. J. Carruthers Wain, described as a company promoter, financier, and civil engineer, was mentioned on Tuesday before Mr. Registrar Linklater, at the London Bankruptcy Court, in relation to the debtor's public examination. Mr. Wain held the office of chairman of the London, Deptford, and Greenwich Tramways, Limited, and Swan and Edgar, Limited, and was also the receiver for the debenture-holders of the Stockton and Darlington Tramways Company, Limited. As the debtor is at present undergoing a term of imprisonment, the hearing was postponed until Oct. 30.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Wood Green.—The Urban District Council invite tenders for the construction of refuse destructor cells or furnaces. Tenders by Feb. 8.

Croydon.—The Council invite tenders for extending the buildings at the Corporation electric light station, Factory-lane, Croydon. Tenders by 29th inst.

Dudley.—The Electric Lighting Committee invite tenders for the supply and erection of pump, feed-water heaters, and pipe work. Tenders by Feb. 8. Details in our advertisement columns.

Belfast.—The Electric Committee invite tenders for the supply and erection of 400-kw. steam dynamos. Tenders by Feb. 8. Particulars in our advertising columns.

Glasgow.—The Corporation invite tenders for the supply and fitting-up of a hydraulic or electric lift. Tenders by 29th inst. Full particulars in our advertising columns.

Tunbridge Wells.—The Corporation invite tenders for two Lancashire boilers for their electricity works. Tenders by Feb. 5. Full particulars in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply and erection of two overhead electric travelling cranes. Tenders by Feb. 5. Full particulars in our advertising columns.

Stoke-upon-Trent.—The Guardians invite tenders for the proposed electric lighting of a portion of the workhouse premises. Tenders by Feb. 15. Full particulars in our advertisement columns.

York.—The Corporation invite tenders for the conversion of the wiring of the Courts of Justice to suit the higher voltage of the supply mains. Tenders by Feb. 15. Details in our advertisement columns.

York.—The Corporation invite tenders for the conversion of the wiring of the public library to suit the higher voltage of the supply mains. Tenders by Feb. 15. Details in our advertisement columns.

Bootle.—The Corporation invite tenders for the supply and laying, within the borough, of certain underground electric cables. Tenders by Feb. 17. Details in our advertisement columns.

Bradford.—The Tramways Committee invite tenders for the complete electrical overhead equipment of about eight miles of tramway. Tenders by Feb. 3. Full particulars in our advertising columns.

Bath.—The Corporation invite tenders for the supply, etc., of cables (high and low tension), arc lamps, posts, and accessories, transformers, sub-station switchboards, and main works switchboards. Tenders by Feb. 12.

Burnley.—The Urban District Council invite tenders for the construction of refuse destructor works. Particulars may be obtained from Mr. John Gregson, surveyor, Council-chambers, Padiham. Tenders by Feb. 10.

Kingston-upon-Hull.—The Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked, to seat about 51 passengers). Tenders by Feb. 19. Details in our advertising columns.

Hastings.—The Corporation invite tenders for the supply and delivery of 12 20-kw. alternating-current transformers and high and low tension sub-station switch gear. Tenders by Feb. 12. Details in our advertisement columns.

Bedford.—The Electric Light Committee invite tenders for the supply, delivery, and erection of one surface condenser, with air and circulating pumps, and engine for driving same. Tenders by Feb. 6. Details in our advertisement columns.

Great Yarmouth.—The Corporation invite tenders for the supply and erection of two water-tube boilers (Section A); three 200-kw. continuous-current steam dynamos (B) Tenders by Feb. 15. Full particulars in our advertisement columns.

Glasgow.—The Corporation invite offers for the supply of 200-300 motorcar trucks; 200-300 motors and equipments; the supply, delivery, and erection complete of the overhead trolley. Tenders by Feb. 17. Details in our advertisement columns.

Tynemouth.—The Corporation invite tenders for the supply and delivery of electricity meters. Specification, etc., may be obtained from Messrs. Lacey, Clirehugh, and Sillar, 2, Queen Anne's-gate, Westminster, electrical engineers to the Corporation. Tenders by 31st inst.

Yarmouth.—The Town Council invite tenders for the supply of about 800 tons, or thereabouts, of steel girder tramway rails, of from 80lb. to 90lb. per yard, deliveries to commence not later than June 1, and the whole to be delivered on or before Sept. 1, 1900. Tenders by Jan. 30.

Portsmouth.—The Corporation invite tenders for 12 months supply of electrical goods, etc., from April 1 next. Tender are to be endorsed "Stores Tender," and to be forwarded to the Superintendent, Electric Light Station, Gunwharf-road, Portsmouth, not later than Feb. 10.

Keighley.—The Corporation invite tenders for the supply and erection of two Lancashire boilers, with mechanical stokers, economisers, feed pumps, etc.; and 120-kw. and 200-kw. high-speed direct coupled steam dynamos for continuous current. Tenders by Feb. 13. Full particulars in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of tramways switchboard. Specifications and forms of tender can be obtained of Mr. J. F. C. Snell, borough electrical engineer, at his office, Dunning-street, Sunderland, on payment of two guineas. Tenders to Mr. Fras. M. Bowey, town clerk, by 12 noon on 26th inst. Details in advertisement columns.

West Ham.—The Guardians of West Ham Union invite tenders for (1) supply and erection of the plant, etc., for the electric

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lighting of the workhouse and school premises at Union-road, Leytonstone, Essex, (2) erection of the engine and battery house for same. Plans and specifications may be inspected at the Clerk's Office. Tenders by 4 p.m. on Feb. 7.

Middleton (Lancs.).—The Corporation invite tenders for the building of electricity works, in accordance with plans and specifications prepared by Messrs. Lacey, Clirehugh, and Sillar, electrical engineers to the Corporation, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Plans, etc., may be obtained from Mr. Frederick Entwistle, town clerk, Town Hall, Middleton. Tenders by Feb. 14.

Plymouth.—The Plymouth Corporation is prepared to receive tenders for 500-kw. high-speed steam dynamo and motor-generator; 500-kw. high-speed steam alternator (disc armature); 200 accumulator cells for 1,680 ampere-hours capacity; four Lancashire boilers, with mechanical stokers, piping, ejector condensers, valves, economiser; high and low pressure paper-insulated and lead-covered mains, etc. Tenders by Jan. 31. Full particulars in our advertisement columns.

Horsham.—The Urban District Council invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, &c., pipework, etc., in engine and boiler house, two steam dynamos (vertical enclosed high-speed engines), and motor boosters, storage batteries, main switchboard and connections, six-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed type) and posts, station lighting. Tenders by March 1. Full particulars in our advertising columns.

Inverness.—The Town Council invite tenders for the supply and erection of two steam dynamos, each of 200 kw. output; one fuel economiser; one motor balancer and booster; one 1,500 ampere-hour storage battery; three water-tube boilers, each to evaporate 6,000lb. of water per hour, with automatic stokers of approved make; overhead travelling crane; a complete system of switchboards; station lighting; street arc lamps, with accessories, as per schedule; feeders and distributors, as per schedule; joint and service boxes and service cables, as per schedule; meters, tools, and usual accessories. Tenders by Feb. 8. Details in our advertisement columns.

Melbourne (Victoria).—The Corporation invite tenders for the supply and delivery of the necessary plant, and the superintendence of its erection, and of the carrying out of the work in connection with the electric lighting of the city, to specifications as follows: (1) boilers (dry-back or water-tube type, with superheaters) and economiser; (2) steam-engines, dynamos, equaliser, booster, and switchboard; (3) feeders, mains, and arc light leads, with all bitumen or insulating material; (4) accumulators. Specifications, etc., can be obtained from the Agent-General for Victoria, 15, Victoria-street, Westminster, London, S.W., on and after the 28th instant, on payment of £1. 1s. for each specification, to be returned on receipt by the Corporation of a bona fide tender. The specifications and drawings may be seen at (but not obtained from) the office of Dr. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders by March 1. Full particulars appear in our advertising columns.

RESULTS OF TENDERS.

Hereford.—The Herefordshire County Council have accepted the tender of Messrs. Read and Jenkins, at £172, for installing the electric light in the Shire Hall.

Harrow.—The Harrow Electric Light and Power Company, Limited, have accepted the tender of Messrs. Mather and Platt, Limited, for the supply and erection of a 150 kw. steam dynamo and for extension to switchboard.

Hull.—The Electric Lighting Committee have accepted the following tenders (subject to confirmation by the Council on Feb. 1) for the supply and erection of two high-speed vertical engines, three crank, tandem, compound, 750 h.p. each, for coupling direct to dynamos, and two high-tension continuous-current dynamos, and one spare armature, each 460 kw. at 2 250 volts: W. H. Allen, Son, and Co, Bedford, engines, £4,670; T. Parker, Limited, Wolverhampton, dynamos, £4,165.

York.—The following tenders have been received by the Corporation for wiring and fitting-up the Guildhall and municipal offices for the electric light:

Guildhall and municipal offices.

Cooke and Co.	£287	3	0
Ensor, Brentnall, and Co. (accepted)	154	13	0
Porte, Sykes, and Co., casing	188	18	6
Heap and Worthington	193	0	0
Reame, Wokes, and Co.	205	0	0
Porte, Sykes, and Co., Simplex tubing	207	16	4
Middleton and Co.	208	14	6
Benham and Sons	216	0	0
Dickinson	225	3	6
Porte, Sykes, and Co., brazed tubing	226	14	2
Dent and Co.	229	9	5
Eckersley and Co.	249	0	0
Shirras, Laing, and Co.	249	0	0
Dewhurst and Son, casing	257	6	0
Rooper and Robins	258	0	0
National Wiring Company	275	0	0
Lumley and Postlethwaite	281	0	0
Dewhurst and Son, Simplex tubing	284	6	0
Beaumont and Co.	361	0	0
Bakewell and Co.	396	2	6
W. J. Fryer and Co.	730	0	0

Mansion House.

Shirras, Laing, and Co.	79	18	9
Cooke and Co.	117	8	6
Heap and Worthington	129	0	0
Ensor, Brentnall, and Co. (accepted)	144	17	0
Porte, Sykes, and Co., casing	146	18	0
Porte, Sykes, and Co., Simplex tubing	161	11	0
Dent and Co.	163	4	6
Benham and Sons	175	0	0
Rooper and Robins	176	0	0
Reame, Wokes, and Co.	176	0	0
Porte, Sykes, and Co., brazed tubing	176	5	6
Dewhurst and Son	176	15	0
Eckersley and Co.	182	15	0
W. J. Fryer and Co.	186	0	0
Dewhurst and Son, steel tubing	194	15	0
Dickinson	197	2	0
Lumley and Postlethwaite	205	18	2
J. Bakewell and Co.	230	2	3
Middleton and Co.	273	11	6
Fidge and Co.	280	0	0
Beaumont and Co.	282	0	0

West Ham.—The Town Council have received the following tenders for the supply of (A) three 84-kw. steam dynamos, booster, switchboard, steam, exhaust, and feed-water pipes; (B) accumulators; (C) water cooling and condensing plant; (D) motors; (E) telephone:

Section A (Machinery).—Condensing.

Thames Ironworks, Limited (accepted)	£4,627	0	0
Scott and Mountain	4,950	0	0
Dutilh Smith and Co.	3,795	0	0
Mather and Platt	6,055	0	0

Non-condensing.

Verity's	4 144	10	9
Scott and Mountain	4,950	0	0
Dutilh Smith and Co.	3,795	0	0
Mather and Platt	6 055	0	0
General Electric Company	4,888	0	0

Section B.—Accumulators.

Pritchetts and Gold	858	0	0
Hart Company (accepted)	681	0	0
Chloride Electrical Syndicate	1,117	0	0
D. P. Battery Company	802	5	0
Tudor Company	868	0	0
D. Smith McMillan	889	14	0
Electrical Power Storage Company	1,391	0	0

Section C.—Cooling tower, &c.

Klein Engineering Company	638	0	0
Klein Engineering Company	1,222	0	0
Ledward and Co.	560	0	0
Ledward and Co.	861	0	0
Korting Bros.	782	0	0
Worthington Pump Company	621	0	0
Worthington Pump Company	886	0	0
Wheeler Condenser Company	963	0	0
Wheeler Condenser Company (accepted)	845	0	0
D. Smith-McMillan	531	15	6

Section D.—Motors.

C. and A. Musker	702	5	0
General Electric Company	619	2	0
Scott and Mountain	690	0	0
Mather and Platt	730	0	0
D. Smith-McMillan	488	0	0
Verity's	700	7	0
Phœnix Dynamo Company	685	0	0
Bruce Peebles (accepted)	547	0	0
Witting Bros.	548	0	0
Thames Ironworks	660	0	0

Section E.—Telephones.

General Electric Company	137	16	6
Verity's (accepted)	135	3	0
D. Smith-McMillan	116	0	0
Cox-Walkers	128	9	0
Cox-Walkers (if with combined battery box)	141	9	0
Venner and Co.	153	11	6
Western Electric Company	150	0	0
Consolidated Telephone Company	159	0	0
Consolidated Telephone Company	122	9	0

BUSINESS NOTES.

TRACTION.

Burnley.—The Padiham Council intend to oppose Burnley's Tramway Bill.

Ipswich.—The Ipswich Tramways Bill has passed the examiner of private Bills.

Nottingham.—The Nottingham Corporation Bill has passed the examiner of private Bills.

Lincoln.—The Corporation's Tramways Bill has passed the examiner of private Bills.

Aston Manor.—The District Council's Tramways Bill has passed the examiner of private Bills.

Burnley.—The Corporation's Tramways Bill has complied with the preliminary standing orders.

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Huddersfield.—The Huddersfield Corporation Tramways Bill has passed the examiner of private Bills.

Dereham.—A public meeting last week decided in favour of the proposed line from Norwich to Dereham.

Liverpool.—The new Cabbage Hall and Castle-street service, *vid* Everton-valley, was inaugurated on the 19th inst.

Dumbarton.—The Town Council have given their formal consent to the Glasgow District Tramways Company's proposed Bill.

Dumbarton.—The Town Council have passed a formal resolution consenting to the Bill of the Glasgow District Tramway Company.

Lancaster.—A town's meeting has approved the Bill which the Corporation are promoting in Parliament providing for a system of electric tramways.

Dumbarton.—At a special meeting of the Western District Committee of the County Council on Tuesday a resolution was carried dissenting from the proposed district tramway schemes.

Hastings.—The Rural District Council have considered the plans of the Cinque Ports light railway, and resolved to arrange an interview with the representative of the promoter with a view to going into the question.

Norfolk.—The Norfolk County Council offers no objection to the scheme of the East Anglian Light Railway, on condition that the main roads, bridges, and all that appertain thereto be maintained in such a state as meet with the county surveyor's approval.

Sheffield.—The Corporation are about to make a trial with Mr. W. Aldred's invention, which consists of a method of electrically connecting the cars when running to the mains by means of a series of boxes placed in the road between the running rails of a tramway.

Paisley.—At a conference of representatives from the municipalities of Paisley, Renfrew, and Johnstone, on Tuesday, it was resolved to recommend their various constituencies to oppose the scheme of tramways for Paisley and district proposed by Mr. Murphy, of Dublin.

Clerkenwell.—The Vestry has summoned a conference of London local authorities to be held at Clerkenwell Town Hall on Tuesday, Jan. 30, to consider how best to protect the rights of the road authorities in connection with the new tramway schemes of the London County Council.

Maryport.—An application from Messrs. Bennett, Ward, and Thomas, 13, Victoria-building, Manchester, to the District Council for permission and assistance to apply for an order under the Light Railways Act for a line connecting Maryport with Allonby and Silloth has been referred to a committee.

Institution of British Carriage Manufacturers.—The eighteenth annual meeting of the Institution of British Carriage Manufacturers took place on the 22nd inst. at the Westminster Town Hall. Mr. Percy Preston, of London, was elected president, and Mr. Andrew W. Barr re-elected secretary.

Acton.—The Council object to the plans of the London United Tramways Company for tramway extension in the district, especially for the reason that it is proposed to narrow the roadway in certain parts, and it is said that where a double line of rails was laid there would not be a clear roadway of 9ft. 6in. on each side.

Farnworth.—Some delay has been caused in the equipment of the Corporation's new tramways for electric traction owing to the temporary failure of the supply of trolley posts from the makers, but headway has been made with the bonding of the rails despite the bad weather. It is understood that bogie cars will probably be adopted on the line.

Hendon.—At a recent interview between the Council and a representative of the North Metropolitan Tramways Company with regard to that portion of the proposed light railway from Watford to Stanmore Hill which would come within the Council's district, all the members present expressed their conviction that the proposed line was undesirable.

Dundee.—The Bill by which power is sought to construct a tramway from the eastern boundary of Dundee to Carnoustie was discussed by a meeting of the Tramway Committee on Tuesday. The committee agreed to recommend that unless certain amendments were accepted by the promoters the Town Council should petition against the Bill, so that the rights of the city might be preserved.

Hull.—A deputation of the sub-committee of the Hull Corporation Tramways Committee visited Sheffield on Wednesday for the purpose of inspecting the electric system. A similar system is in operation in Hull, and extensions are projected. The members of the deputation were particularly interested in the manner in which the steep gradients are overcome, difficulties which are much worse in Sheffield than in Hull.

Elland.—The General Purposes Committee of the District Council on Monday decided to oppose the application of the Halifax Corporation for statutory powers to construct tramways through the district of the Elland Council. It was also agreed that enquiry be made of the Halifax Corporation whether they would be willing to lease the tramways to be laid by the Elland District Council in their own district.

Hampstead.—The Vestry have decided to oppose the London County Council Tramways Bill in so far as it relates to the existing interlacing lines in Fleet-road and the proposed construction of up and down lines in Constantine and Agincourt roads. The view of the Vestry is that there should be a single line throughout Fleet-road, and another single line throughout the other roads, one line to be used for the up and the other for the down traffic.

Walsall.—At a recent special meeting of the Town Council a resolution confirming the decision to purchase the tramways within the borough, approving the agreement with the company concerned in them, and authorising the town clerk to apply for the sanction of the Board of Trade was carried, and the decision to promote a Corporation Bill for the extension of the tramways and for other purposes in the ensuing session of Parliament was confirmed.

Batley.—From all accounts the application of the Batley Corporation for powers to construct electric tramways within the borough is likely to meet with strong opposition. Several of the local authorities in the district, including Liversedge, Dewsbury, and Heckmondwike, have already passed resolutions in favour of supporting the British Electric Traction Company in their opposition to the Batley Corporation, and others are expected to do so.

Blackpool.—The Corporation, it seems, are adding to their stock of cars for working the promenade line. Ten cars were ordered some time back from the Midland Railway and Carriage Company, Limited, and one of these at least has already been delivered, judging from an article which appears in a local paper. It appears that the new cars mark a vast improvement over those hitherto employed on the line, their appointment being luxurious to a degree, the cars being also considerably larger than anything on the road, each having seating capacity for 93 persons—49 outside and 44 inside. The cars, moreover, are both lighted and heated electrically, everything being done to ensure the comfort of the passengers. The tramways manager, Mr. J. Lancaster, has personally supervised the construction of the cars.

Halifax.—We learn from the *Leeds Mercury* that Messrs. W. C. Hebden, Edward Haley, and J. Asquith have withdrawn their demand for a poll of the ratepayers on the Halifax Corporation Bill. The gentlemen in question objected to the proposed incorporation of Northowram, which the Bill seeks to bring about, but they admit that they withdraw their opposition "in the absence of a larger measure of public support." Mr. Edgar Booth, however, on behalf of the electrical engineers of the town, persists in his opposition to Clause 91 of the Bill, which would give the Corporation power to deal in electrical fittings. A poll, therefore, is still necessary, and would have been necessary in any case now, notice having been given of the poll, and the preparations duly made for it. It is estimated that the poll will cost the town £600.

Burnley.—Included in the parliamentary Bills which have been deposited is the Burnley Corporation (Tramways, etc.) Bill, which seeks power for the Burnley, Nelson, Padiham, Brierfield, and Reedley-Hallows Corporations, Urban District Councils, and Parish Councils, to purchase the undertaking of the Burnley and District Tramways Company, and for all these bodies to construct certain additional lines agreed upon between them. The Burnley Corporation proposes to guarantee interest at the rate of 4 per cent. per annum on all money expended by the other local authorities on the tramways. The total cost is estimated at £146 365. In consequence of the taking over of the tramways it is further sought to extend the electric lighting powers of the Corporation by including that part of Reedley-Hallows which lies to the east of the Leeds and Liverpool Canal.

Bath.—The minutes presented to the Town Council contain a reference to the decision of the Light Railway Commissioners upon Messrs. Davis, Hoskins, and other's application, and also upon the application made by the authority under the Light Railways Act, and the statement that the authority had a right to appeal to the Board of Trade, also that the Board could direct another enquiry. With regard to a letter from the secretary of the British Electric Traction Company, asking for an appointment for Mr. Wharton to meet the committee, and letters from Mr. W. Webb, the clerk's parliamentary agent, on the subject of the present position of the authority and suggesting an arrangement with a responsible company for the development of a satisfactory scheme upon the lines of the Corporation scheme, the Electric Traction Committee recommended that the further consideration of the matter be adjourned, with a view to ascertaining what steps can be taken to secure an efficient system of light railways for Bath and the district.

Runcorn.—The Rural District Council have adopted the following minute: "The Parliamentary Committee asked for and the report of the company promised favourably considering the following points—'that the company take power to acquire lands compulsorily; that the roads over which the line is laid be not in any place less than 30ft. for carriageway, and that they be widened at all curves; that the company complete the works within three years or such extended time as may be allowed by the Board of Trade; that the councils through whose districts the line passes have a voice as to the construction of the cars to be used; that waiting-rooms be constructed in each parish council district; that the various councils be allowed free use of the rails for their own trucks for the purpose of carrying of nightsoil, road material, etc., during the night time.' It was also resolved that it be a recommendation to the Council that subject to the company carrying out the recommendations of the committee no opposition be offered to the scheme."

A Valuable Suggestion.—It is not very frequently that the London County Council can be held up as a shining example for others to follow, but the action suggested by the recommendation of the Highways Committee on Tuesday last is one which is well worthy of consideration by other tramway companies. It is no less than a proposal to issue single tickets available during the day for the whole distance, and return or two-journey tickets, the latter to be available for a second journey in any direction, at any time, by any person, on any one of the Council's cars. Thence it will be only a step to the practice which exists elsewhere, notably

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in Sydney, New South Wales, where tramway tickets at reduced fares may be purchased in any number at various offices, stationers' and other shops. It is held that the reductions in the fares are more than made up by the larger use which is made of the tickets. Often when passing a tram, one of a party who would otherwise have walked, is heard to say, "Jump in, I have got some tickets." It seems so different to paying cash.

Worcester.—A deputation representing the Light Railways Commission attended Worcester last week to enquire into a proposal by the Worcester Tramways Company to provide light railways in the city and the outlying districts, the gauge to be 3ft. 6in., and the motive power electricity. The order provides for the completion of the works within three years, and makes the company permanently responsible for the maintenance of that part of the road where the railway is laid, and the laying of wood blocks between the metals in front of public buildings. The Town Clerk opposed the scheme on behalf of the Corporation, submitting that so far as the city position of the lines was concerned the application should have been made under the Tramways Act rather than the Light Railways Act which did not afford the same protection to frontagers. He urged that difficulties might arise as a consequence of the running both of trams and light railways, and that the city authorities desired to have a complete scheme either of tramways or light railways over the whole city. They had no desire to block any proposal to improve travelling facilities in the city, but they objected to a scheme of this piecemeal description. The Mayor (Alderman J. Millington) and Mr. A. A. Maund (chairman of the Streets Committee) supported the opposition to the scheme chiefly on the ground of its incompleteness. His Lordship suggested that rather than give a decision adverse to the promoters, an adjournment should be taken to allow the promoters and the Corporation to continue their negotiations with a view, if possible, to an amicable settlement. The enquiry was thereupon adjourned to allow the negotiations to be continued. The course which the Commissioners took in postponing their decision, for the Corporation and the tramway company to come to terms, led to an immediate conference. Nothing has been definitely decided, but it is understood that proposals have been submitted whereby the company would agree to pay £5,000 down, avoid questions of wayleave, purchase electric current from the Corporation for motive power at 2d. per unit for the first 200,000 units, 1½d. for the next 200,000 units, and 1¼d. for any further supply. If these terms are accepted the Corporation will withdraw their opposition.

Aberdeen.—The Tramways Committee of the Town Council have resolved to order four new electric cars for the Woodside route, owing to the increase of traffic. The cost of these will be about £2,500, and two of the Mannofield cars will be electrically equipped for the Woodside route, at a cost of £700. A report is to be obtained from the burgh surveyor on the advisability of providing three additional crossings in King-street, one in Great Western-road, and one in Beechgrove-terrace. At a meeting of the committee on 19th inst. the letter from the officers commanding the city volunteer battalions, protesting against the electric tramway to the beach bathing station being taken across the Links instead of round the base of the Broad Hill, was under consideration. The feeling of the committee was that, while they would be very sorry if they did anything to interfere with the parade ground, they could not see their way to depart from the route as described in the Bill now lodged in Parliament. Indeed, they considered it was too late to do so, but it was thought that on parade nights the cars might, as far as possible, be stopped at the end of Constitution-street in order to prevent any interference with the work of the volunteers. The proposal to construct a light railway from Aberdeen to Skene and Echt is, according to the *Scotsman*, beginning to assume a practical shape. Last week the sub-committee of Aberdeen District Committee entrusted with the matter had before them a report by Messrs. Walker and Duncan, C.E., and Mr. George Scott, road surveyor. The main line it is proposed should extend from the city boundary to the Free Church of Skene, and thence by a branch line to Waterton of Dunecht, and by a loop line to the village of Echt, the total distance covered being 13¾ miles. On the railway, which is to be carried alongside the public road, it is proposed to have eight stations, and the rails will be of steel made to meet the Board of Trade requirements. To construct a railway with a standard gauge of 4ft. 8½in., to correspond with that of the tramways in the city, the engineers estimate would cost £39,000, including £12,000 for rolling-stock and other outlays amounting to £1,000. To construct a railway with a 3ft. gauge, the cost, they estimate, would be £31,800, including £9,500 for rolling-stock and £1,000 for other outlays. These estimates do not make any allowance for the purchase of land required, the extent of which might be estimated at about 11 acres. The engineers, after careful consideration, and taking into account the district through which the railway is to pass, the probable passenger and goods traffic, width of road, nature of curves, and cost of construction, recommended the adoption of a 3ft. gauge. The meeting resolved that, before going any further with the proposal, a conference with the Corporation should be arranged, with the object of soliciting the co-operation of that body in the carrying out of the undertaking. It was also agreed to ascertain what pecuniary assistance was likely to be received from proprietors and others interested in the districts to be benefited.

Bolton.—The *Bolton Journal* publishes the opinions expressed with regard to the Corporation's tramways undertaking by a gentleman who, we are told, may be considered an expert in tram work. Asked as to his ideas on the subject of the unsatisfactory state of things prevailing in Bolton he said: "The Corporation policy has been all through a series of blunders. In the first place, it was a great mistake in commencing an undertaking involving some £300,000 or £400,000 of expenditure to think that the engineering supervision could be done for £150 a year, the extra sum given to Mr. Ellis to superintend the tramways undertaking. Such a job ought to have employed three or four engineers, at least, each with a good salary, and all competent for the work. Then again, over these should have been placed a man of undoubted ability, the very best man they could get, at a salary of at least £1,000 a year whilst the work was in progress and until it got thoroughly going. That was blunder No. 1. The next mistake is the track itself. It was all very well for tram horses, but an electrical system is very different. The track has been down some 20 years, and consequently nearly worn out with horses and cars alone. What is the consequence? The grooves in the old rails are not deep enough, and the cars are running on the flange of the wheel instead of on the flat. It is no good trying to adapt the wheels of the cars to the present track. If the committee are thinking of doing any such thing, they are only blinding themselves to consequences. The remedy is to take the matter in hand firmly, and lay down a complete new track on the whole of the old routes. To do this I should advise that the whole of the centre of the town should be, so to speak, shut down to electric car traffic. The present cars I should utilise on the three new routes, Tonge Moor, Great Lever, and Breightmet, where the tracks are suitable, and also on the outside routes. That is to say, for instance, a car might be run from the junction of St. George's-road and Marsden-road to the extremity of the Chorley New-road and Chorley Old-road routes. Both of these are on the straight, there are no curves. Daubhill and Dean traffic might be worked from Great Moor-street. Then the work of relaying the whole of the rails in the centre of the town should be put into the hands of a contractor with plenty of men, so that the work might be effected expeditiously and well. As the centre of the town was completed the other routes should be stopped in turn and dealt with in the same manner. As at present the cars are simply being banged to pieces by a bad track. Then, again, the car is not suitable. I am decidedly in favour of bogie cars, which would have run lovely; you can scarcely feel the motion. The best thing under present circumstances is to go on with what cars we have and arrange for bogie cars for the remainder. If the committee have made an error, why not admit it at once and rectify it as far as possible. I consider the suggestion of Councillor Smith as to a consulting engineer a very good one, but the man should be one in high reputation. The fact of the matter is the committee have attempted too much at a time. What they should have done was to have opened a route or two at once, and got them working before attempting the other routes. Just fancy the Chorley New-road route being opened for traffic when the car had only been over it once. As one route was completed and working satisfactorily, others might have been commenced. But what has been done? The whole of the 10 routes have been opened at once with a deficiency of engineers, the consequence being that mistakes which are inevitable at first, and to be looked for, have occurred simultaneously, and something like a panic has been caused. The overhead equipment has on the whole worked satisfactorily, and there have been fewer stoppages on this account than usual. What is the matter is the track, which will have to be relaid, bogie cars obtained, and the sooner that is done the better."

LIGHTING AND GENERAL.

Ipswich.—A return is to be made of the cost of lighting the workhouse by electricity.

Newington.—The Vestry's consumers' account for the Christmas quarter will total up to about £1,100.

Mediomaley.—The Parish Council will discuss the electric lighting question at their March meeting.

Derby.—The electricity department of the Corporation announce that they are prepared to let motors on hire.

Walsall.—The Council have passed a resolution in favour of increased telephone trunk facilities to London.

London Electric Supply Co.—Sir William H. Preece, F.R.S., has been elected a director of this corporation.

Abercarn.—The District Council have decided to oppose the South Wales Electrical Power Company's Bill.

Belfast.—Two electric arc lamps are to be erected opposite the entrance to the Corporation electric light station.

Dufftown.—The Police Commissioners have appointed a committee to consider the proposed electric lighting scheme.

Chichester.—The City Council have decided to postpone their electric light scheme for six months, as the present time is a bad one for raising money.

Portsmouth.—The Finance Committee recommend the Town Council to make arrangements with the National Telephone Company for a cheaper service.

Oban.—An unexpected hitch has occurred with regard to the Town Council's electric lighting scheme, as the Board of Trade have declined to issue a license.

Waterloo and City Railway Co.—The directors recommend a dividend on the ordinary stock at the rate of 3 per cent. per annum for the half-year ended 31st ult.

Salford.—The Town Council have confirmed their resolution to promote a Bill for powers to supply electrical energy, etc. No memorial has been lodged against the Bill.

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Walker.—Lieutenant-Colonel A. C. Smith, R.E., held an enquiry on Wednesday into the Council's application to borrow £28 356 for electric lighting and dust destructor.

Banbury.—The Town Council have decided to consent to the application of the Electrical Power Distribution Company, Limited, for an electric lighting provisional order.

Henley's Telegraph Works.—We are informed that Sir Henry M. Stanley, G.C.B., M.P., has accepted a seat on the Board of W. T. Henley's Telegraph Works Company, Limited.

Llandudno.—Mr. Morton, the electrical engineer, proposes to place sectional disconnecting boxes in the different lengths of cable, so as to minimise the area of any possible breakdown.

Plumstead.—Mr. J. B. Mitchell, chief electrical engineer to the Southend Corporation, has been appointed electrical engineer to the Vestry. There were 27 applications for the appointment.

Basingstoke.—The Town Council have now definitely resolved to apply for a provisional order authorising them to supply electricity for all public and private purposes throughout the borough.

Rotherhithe.—The Vestry have informed the London Electric Supply Corporation, Limited, that unless the quality of the supply was improved the Vestry would sue them for the penalties provided in the Act.

Dunblane.—At a recent meeting of ratepayers a resolution was carried objecting to the scheme of the Urban Electric Supply Company, Limited, for a provisional order to supply Dunblane with electric light.

Bridgwater.—Mr. Trentham estimates the cost of the proposed lighting scheme at £14,248. A town's meeting is to be called to see whether the ratepayers are for or against the adoption of the electric light.

"English Illustrated Magazine."—The January number is quite up to the usual excellent standard, both in illustrated and printed matter. A number of military articles are sandwiched between some good short stories.

York.—We learn that although the station has not yet commenced supply, rather more than 6 000 8-c.p. lamps have been applied for, which load is purely for lighting, and further extension of mains are being contemplated.

Fireproof Electric Switchboard Co.—This Company has been registered with a capital of £1,000 in £1 shares, the object being to carry on the business of manufacturing electricians and manufacturers of fireproof switches and switchboards.

South Wales Electrical Power Distribution Co.—This Company has been registered with a capital of £30,000 in £10 shares, the object being to produce, store, supply, and sell electrical energy and power and electricity of all kinds for public and private lighting, etc.

St. James's and Pall Mall Electric Light Co.—The directors recommend a dividend for the half-year ended 31st ult. of 7s. 6d., together with a bonus of 2s. per share on the ordinary shares, making, with the interim, a dividend of 12½ per cent. and a bonus of 2 per cent. for 1899.

Birmingham.—The Workhouse Committee have obtained authority to employ an engineer with a view to the reconstruction of their gas apparatus. It has been suggested that the possibility of substituting electric lighting should be taken into account in drawing up the report.

Tynemouth.—The following charges have been fixed for supply of electricity within the borough: 7d. per unit for the first 100 hours per quarter, and 2d. per unit for further supply, for lighting; and 2½d. per unit for the first 300 hours per quarter, and 1d. for additional demand, for power.

Dewsbury.—There seems to be some dissatisfaction amongst the ratepayers of the town in connection with the Town Council's recent decision to reduce the price of electric light to the Pioneer's Industrial Society, preferential treatment being alleged. A deputation has been appointed to wait upon the Council and discuss the matter.

Barking.—The resident engineer's report states that since the last meeting of the Urban District Council applications had been made for 276 8-c.p. lights; 18 connections were made between Dec. 13 and 20, which represented 448 8-c.p. lights. The consumers who have no meters and have not paid for current supplied are to be cut off.

Seaham Harbour.—The County of Durham Electrical Power Distribution Company have applied for a provisional order for the district, but the Council have decided to appoint Mr. F. J. Warden-Stevens to advise whether they should carry out the work; if not, on what conditions they should approve of the company's application.

War Compensation.—President McKinley, in sending to the United States Senate papers bearing on the claim of the Cuba Submarine Telegraph Company for £8,174 damages, arising out of the war between the United States and Spain, recommends, according to the *Daily Mail*, the payment of the sum claimed as an act of comity and equity.

Halifax.—The Bill which the Corporation are promoting in Parliament provides, amongst other things, for the supply of electricity for traction purposes, the making of by-laws for securing the safety of the inhabitants, and the prevention of fires, the supply of electric fittings, etc., and giving discounts on electric lighting and power accounts.

Rowley Regis.—The whole Council has been appointed a committee to consider and take such action as may be deemed advisable for enabling the Council to obtain powers for providing electric lighting for the district, and reporting and recommending to the Council accordingly. The question of dust destructors will be considered at the same time.

Brighton.—The Town Council have confirmed the recommendation of the Electric Lighting Committee to charge the estimated cost (£2,000) of overhauling and testing electricity mains and making new and improved house service joints previous to wood paving being laid to the reserve fund, as also the cost of the change over of voltage, estimated at about £1,500.

Liverpool Overhead Railway Co.—The directors recommend a dividend at the rate of 5 per cent. per annum on the preference shares and 5 per cent. per annum on the ordinary shares, against 4 per cent. per annum on the ordinary shares last year. The accounts for the past half-year show an available balance of £18,841. The balance carried forward is £4,591, against £4,586.

Sevenoaks.—The majority of the ratepayers are said to be dissatisfied with the action taken by the Urban District Council with regard to the application by the Electrical Power Distribution Company, Limited, for a provisional order to light the town with electricity. The general feeling is that the Council ought not to incur the expense of opposing the application unless they will undertake the electric lighting themselves.

Appointments Vacant.—The Electricity Committee of the Southport Corporation invite applications for the post of electrician-in-charge at their electricity works.—Applications are invited for the position of engine-driver for the city of York.—An engineering master is required for a public school. Particulars of the above appointments, and also of vacancies for a shift engineer, wireman, etc., appear in our advertisement columns.

General Tramways Construction Syndicate.—This syndicate has been registered with a capital of £200,000 in £1 shares, the object being to enter into any contract for the construction of rail and tram roads, the subject of the concessions bearing date Dec. 22, 1898, and July, 1899, granted by the Federal Assembly of the Swiss Government Republic to Francois Forestier, for the construction of rail and tram roads in the canton of Geneva, etc.

Institution of Engineers and Shipbuilders in Scotland.—At the fourth general meeting of the forty-third session of the Institution of Engineers and Shipbuilders in Scotland on Wednesday, Mr. Robert Caird in the chair, papers were read by Mr. W. A. Chamen on "The Electric Wiring of Buildings," and by Prof. Jamieson on "The Action of Electric Tramway Currents upon the Working of Submarine Telegraph Cables and other Circuits."

British Compressed-Air Tramways Co.—This Company has been registered with a capital of £75,000 in £1 shares, the object being to adopt and carry into effect an agreement expressed between the Electric and General Contract Corporation, Limited, and to purchase or otherwise acquire, or turn to account, any interests in any patents, etc., in relation to mechanical traction, and the production, distribution, and use of compressed air and electricity, etc.

Dundee.—At their next meeting the Council will be recommended to extend the present electric lighting system and to provide distributing mains. The cost of the necessary plant for the proposed area is estimated at £16,000. To provide the requisite additional generating plant at the station will necessitate an expenditure as follows: condensing plant, £3,500; feed and exhaust piping, £2,000; feed pumps, etc., £1,000; and conduits for cables in Perth-road, £175—a total of £22,675.

Dynamo Brushes.—Messrs. Polland and Co., 5, St Nicholas-buildings, Newcastle-on-Tyne, have issued a new list of arc light carbons and dynamo brushes. Special attention is drawn to the "Vulcanus" type of dynamo brushes, which are made of well-ground pure copper and carbon, thus uniting the advantages both of copper and carbon brushes. These copper-carbon brushes, we are informed, work perfectly sparkless, the carbon acting as lubricator, thus reducing the wear and tear of the commutator as well as of the brushes to a minimum.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to: Aron Electricity Meter, Limited—125,000 vendors' ordinary shares of £1 each, fully paid, Nos. 1 to 125,000; Chelsea Electricity Supply Company—further issue of £50 000 4½ per cent. debenture stock; National Telephone Company—further issue of £670,529 3½ per cent. debenture stock. The committee has further been asked to allow the following securities to be quoted in the official list: Commercial Cable Company—further issue of £230 255 sterling 4 per cent. 500 year debenture stock; Buenos Ayres and Belgrano Electric Tramways Company—further issue of £54,415 5 per cent. debenture stock.

Universal Electrical Directory (J. A. Berly's).—The 1900 issue comprises the names and addresses of the members of the electrical and kindred industries throughout the world. The amount of work entailed in its compilation has again considerably increased, and the alphabetical section now comprises a total of 26,397 distinct names, approximately 933 names of individuals and firms more than were contained in the book for 1899. For simplicity and facility of reference it is divided into four groups—namely, British, Continental, American, and Colonial, which are again sub-divided into alphabetical and classified sections; in the case of the British a geographical section is given, making in all nine sub-divisions. In addition to the new names incorporated in the present issue, much financial information is given, the telegraphic addresses and local telephone numbers are given, and the pages added to the work are 27 in number as compared with that of 1899, making in all about 1,200 pages entirely of directory matter.

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Luton.—Upon a formal report being presented in reference to the contracts and bonds with the firms whose tenders had been accepted in connection with the electric lighting, it was said that the plans and specification of the building would soon be ready.

Hackney.—At the meeting of the Vestry on Wednesday a report was received from the Electric Lighting Committee recommending the acceptance of the tender of Messrs. Hughes and Stirling, of Clock House, Arundel-street, Strand, W.C., at the sum of £24,495, for erection of a refuse destructor. A deed of mortgage for the £30,000 loan from the London County Council was sealed.

Alfreton.—The ballot recently taken on the advisability of superseding gas with the electric light resulted as follows: 751 papers were distributed, and those in favour of electricity voted up to the number of 181, while 106 voted, but did not promise to use it; 56 voted against it; 28 signed, but did not answer the questions; and 380 papers were returned blank. The Council at a subsequent meeting decided to light the town with electric light.

Strike.—The men of the engineering department of the National Telephone Company in Liverpool, numbering about 100, have come out on strike. The grievance seems to be that whereas formerly the men were allowed to stand by on wet days till the weather cleared without loss of pay, they are now liable to be sent home after waiting some time when it is wet, their pay being deducted. The company complain that they have had no opportunity of remedying the grievance.

Assignment.—At a meeting of the creditors of Messrs. Mitchell and Schofield, electric lighting engineers, Brookholes, on the 22nd inst., at the office of Messrs. Armitage, Sykes, and Hinchcliffe, solicitors, Huddersfield, the debtors' liabilities were shown to be £696. 14s. 10d., and the assets about £440. It was resolved that the debtors should execute a deed of assignment to Mr. T. H. B. Tate, accountant, Huddersfield, as trustee, and three creditors were appointed a committee of inspection.

Charing Cross and Strand Supply Co.—The Company's new Bill proposes the provision of a separate generating station for the purposes of the Corporation's undertaking in West Ham, which will be connected with the Company's existing stations in the parishes of St. Giles and St. Martin-in-the-Fields. The Company is taking this opportunity to obtain powers to sell electricity in bulk to any local authority desiring a supply in bulk and having themselves powers of distributive supply.

Walker.—The Walker and Wallsend Union Gas Company in their Bill for extension of powers to supply electricity within the borough of Jarrow and the urban district of Hebburn, propose to raise £250,000 additional ordinary capital and £62,500 of further debenture stock. Power is also sought by the company to enter into agreements to supply electricity in bulk to the Corporation of Jarrow, the Hebburn Urban District Council, and the Newcastle-upon-Tyne Electric Supply Company, Limited.

Church Lighting.—St. Chad's Church, Shrewsbury, was lighted with electricity for the first time last Sunday evening, and was voted on all sides to be a great success. Massive wrought-iron electroliers are used. There are altogether close upon 200 lights fixed in the church, vestries, etc. The contractors for the installation were Messrs. E. M. Evans and Co., of Manchester and Shrewsbury, who carried out the work to the specification and under the supervision of Mr C. M. Johnston, M.I.E.E., borough electrical engineer.

Amalgamation.—We are informed that arrangements have been completed for the amalgamation of the business of the Trusty Engine Works, Limited, Cheltenham, with that of the Shillingford Works Company, Limited, Wallingford, Berks. The title of the combined firms will be the Shillingford Engineering Company, Limited, Trusty Engine Works, Cheltenham. The new company will discharge all the liabilities of the amalgamating companies. Mr. W. T. Gould and Mr. A. G. Halstead, the former managing directors, will act as joint managing directors of the new enterprise.

Hampstead.—At the last Vestry meeting the Lighting Committee reported that the top load at the station during the past year was on Saturday, Dec. 23, and amounted to 1,198 kw., against 917 kw., 632 kw., and 422 kw. in the years 1898, 1897, and 1896 respectively; that the total output of units generated during the 12 months ended Dec. 31, 1899, was 1,545,018, against 1,083,667 for the year 1898, or an increase (approximately) of 50 per cent.; and that the total number of lamps connected on Dec. 31 was equivalent to 100,441 8 c.p., against 78,091 on the corresponding date in 1898, being an increase of 28 per cent.

Rugby.—Recently the Urban District Council sent out a circular inviting likely consumers of the electric light to make the necessary application, but few replies had been received. Many people are said to be prevented from taking a favourable view of the matter because the circular fixed the cost per unit above the average, while the cost of connection at £2. 10s. per lamp is universally considered to be prohibitive. There is considerable justification in the attitude taken by the prospective customers, as the charge of 50s. per single lamp, without reduction for numbers, is an exceedingly high one. About one half of that estimate ought to meet the case.

North Metropolitan Supply Co.—In the North Metropolitan Electric Power Supply Company's new Bill power is sought for the purpose of supplying electrical energy in bulk within the districts of the poor-law unions of Hendon, Barnet, Edmonton, Ware, Hertford, Hatfield, Welwyn, and St. Albans, and within the parishes of Chingford and Walthamstow. The capital of the Company is to be £270,000, with the right to raise, by the issue of debenture stock, a further sum of £90,000. It is proposed to erect two generating stations, one at Edmonton and the other at Hertford. The promoters named in this Bill are the same as those mentioned in the County of Durham Electric Power Supply Bill.

St. Marylebone.—At yesterday's meeting of the Vestry the following resolutions were proposed: (1) "That, in the opinion of this Vestry, it is desirable that immediate steps should be taken to improve the imperfect lighting of the public streets by electric arc lamps, and that it be referred to the Parliamentary Committee to consider the possibility of effecting an arrangement with the Metropolitan Electric Supply Company for the wholesale supply of electricity to the Vestry for such purpose"; (2) "That the Vestry instruct the Parliamentary Committee to take the necessary steps to bring about an immediate reduction of the exorbitant prices charged by the Metropolitan Electric Supply Company for current in the parish."

Carmarthen.—The British Insulated Wire Company have informed the Town Council, in reply to an enquiry, that they were quite prepared to take up and carry through electric lighting and traction schemes for the town, but they were anxious to make sure that they would be of a profitable character, and they could hardly feel sure that this would be so on the figures which had been supplied. The matter, however, should be discussed by the company. At the last meeting of the Council a hope was expressed that when a resolution in favour of electric lighting is brought forward in March every member of the Council would support the same up to the hilt, as the gas company had not met the Council as they desired.

Telegraphists for the Cape.—On Saturday evening the third contingent of the 24th Middlesex (Post Office) Rifle Volunteers, belonging to the Telegraph Reserve of the Royal Engineers, together with a draft of Regular Reservists of the same battalion, embarked at the Royal Albert Docks on the transport "St. Andrew" for South Africa. The detachment numbered 60, and brings the total representation of the 24th Middlesex with the South African force up to 480 men. The commanding officer of the 24th Middlesex has been authorised by the Secretary for War to increase the strength, by an addition of 50 men, of the company of his regiment which supplies the First-class Army Reserves to the 1st Telegraph Battalion Royal Engineers.—*Daily Chronicle.*

Rawtenstall.—At the monthly meeting of the Town Council the minutes of the Electric Light and Tramways Committee were confirmed. It was thereby resolved that the Mayor (Alderman Trickett) be the chairman and Alderman Schofield the vice-chairman of the committee for the current year. A deputation from Accrington, including Mr. J. V. Kitchener (director and representative of the British Electric Traction Company, Limited), which recently conferred with the committee as to the question of converting the Accrington steam tramways to the electric system was also referred to in the minutes. Fresh arrangements have been made for the telephone at Clarke Holme. The Corporation will take the house in which the telephone is at present fixed and the house behind it for a term of 10 years.

Lancashire.—On Tuesday a very largely attended conference was held of representatives of municipal corporations of Lancashire affected by the Lancashire Electric Power Bill, 1900. A resolution was passed protesting against the Bill named as contravening the principle for which municipal corporations had in past years successfully contended, and which had been established by the Tramways Act, 1870, and the Electric Lighting Acts of 1882 and 1888, and expressing a determination to take united action in opposition to the Bill. The resolution was carried unanimously. A copy of the resolution is to be forwarded to the Prime Minister, Mr. Balfour, the President and Secretary of the Board of Trade, and to all Lancashire Members of Parliament, and an executive committee was appointed to act in opposition to the Lancashire Bill, and also the similar Bills affecting other parts of the United Kingdom now before Parliament.

Gas and Allied Trades Exhibition.—Mr. Ritchie has succeeded in bringing together at the Aquarium a remarkably beautiful collection of apparatus and lamps coming under the above category. The rooms are brilliantly resplendent with blazing light, and, unfortunately, also with ditto heat. Amongst the working machinery we noticed a 12-h.p. high-speed (electric light) Otto gas-engine, of Messrs. Crossley Bros., and an eight effective horse-power ordinary Stockport, exhibited by Messrs. Billis, Hobson, and Co. Messrs. Thorpe and Salter exhibit their Ruby gas-engine, which only weighs ½cwt. and can be attached to any gas burner. It uses only five cubic feet of gas per hour, at which consumption it is capable of pumping 700 gallons of water, and it is largely in use in driving small dynamos (⅛ h.p.) and in laboratories, and also in domestic use for the driving of knife-cleaning machines, punkahs, etc. This machine is extremely easy to adjust and to oil, the parts requiring the latter being easy to get at.

Deptford.—At a recent meeting of users of electric light in New Cross and Deptford, Mr. J. S. Redmayne, secretary to the Goldsmiths' Institute, said that he had called the meeting at the request of several of the chief consumers of the electric light in the district. Tests had been taken in the institute, which showed that the voltage fluctuated from 100 to 75. He believed the Board of Trade made a stipulation that companies must not give less than four below 100 volts—anything below 96 was bad light. A resolution was carried urging on the Greenwich District Board the desirability of taking legal proceedings against the London Electric Supply Corporation for the statutory penalties for default of supply, and it was also resolved that all consumers who have suffered from default be recommended to deduct not less than 25 per cent. from their quarter's bills, and to inform the

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company of the reason. A committee was formed to carry on the agitation for better light and take such steps as may be possible for the defence of the consumers.

Croydon.—The Board of Trade have given their formal consent to an extra high-pressure electricity supply being given to certain transforming stations. Application is to be made for a loan of £50 550 for extensions as follows: Direct-current plant for tramways—Extension to engine-room, boiler-house, and pump-room, £5,000; foundations, £1,595; engines and generators, £12 430; switchboard, £920; pump-room, centrifugal pump and engine, etc., £1,150; boilers, £4,280; economiser, £640; cooling tower, £980; hot-well, sundry connections, £50; coal track and weighbridge, £75; oil filter, £60; condenser and feed-water heater, 20,000lb. capacity, £1,000; traveller, rails, extensions, £620; extras and contingencies, £1,000—total, £29,800. Alternating-current mains—New feeders to West Croydon, Mint-walk, and Crown-hill, £2,700; new transformers and switch gear, £1,250—total, £3,950. Alternating-current plant—One triple-expansion 500-kw. alternator and engine, £4,800; steam and exhaust pipes, etc., £800; pumps and condenser plant, £1,200; for house service and transformers, £10,000. Total, £50,450.

Northallerton.—Last week a meeting of the Northallerton Electric Light and Power Company was held to consider a proposal to increase the capital of the company to £10,000 by the creation of 8,000 shares of £1 each. From a memorandum prepared by the secretary it appeared that the works were opened in September last, and the company had already secured the lighting of 34 houses, while there were several consumers waiting to be connected. In addition the company has supplied and fixed two motors. The company last month tendered for the lighting of the town, and the tender was accepted. This contract alone should yield the company a substantial revenue. It is considered that the company has a good prospect of making a substantial profit. The directors do not propose to issue the whole of the £8,000 capital at once, but only sufficient to pay for further necessary plant, and to hold the balance in reserve in case of further extension of the premises. On the motion of Major Chauncy, seconded by Mr. Baigent, it was unanimously resolved that the capital of the company be increased to £10,000 by the creation of 8,000 shares of £1 each. Another meeting of shareholders is to be held on Feb. 1 to confirm the above resolution.

Huddersfield.—A deputation of the Huddersfield Tradesmen's Association has waited upon the chairman of the Corporation Electric Lighting Committee in reference to the proposed local telephone exchange, which is to include the whole of the borough of Huddersfield, and the townships of Brighouse, part of Elland, Kirkheaton, Farnley Tyas, Skelmanthorpe, Honley, Holmfirth, Meltham, Milnsbridge, Golcar, Slaithwaite, Marsden, and parts of Mirfield and Ravensthorpe. The majority of the members of the association strongly favour the Corporation scheme of establishing an exchange independent of that worked by the National Telephone Company. The great majority of the tradesmen's calls were of a local nature, and they therefore desired the Corporation to proceed with their scheme. After discussion it was decided that the exact requirements of the Tradesmen's Association should be drawn up and submitted to the Town Council. The County Borough Council have confirmed the decision of the Electricity Committee to oppose the following Bills: Midland Electric Power Distribution and Lighting, the County and City of Dublin Electric Lighting, the Tyneside Electric Power, South Wales Electric Power Distribution Company, and the Lancashire Electric Power Bills.

Worcester.—Last week Mr. W. O. E. Meade-King held an enquiry on behalf of the Local Government Board into the application of the Corporation for sanction to borrow £4,000 for the purposes of their electric light undertaking. Among those present were the mayor (Alderman Millington), the chairman of the Electricity Committee (Mr. A. H. Parker), the town clerk (Mr. Southall), the electrical engineer (Mr. Hoadley), and Mr. Cardin (electricity department). Mr. Southall stated that the population of Worcester at the last census was 42,980, and was now estimated at 45,000. The ratable value was £179,265, while the balance of outstanding loans under the Public Health Act and the Electricity Act was £125,030. The application was for a loan of £4,000, to be repaid in 30 years, for extensions of mains already laid, for mains proposed to be laid, and for meters and indicators, to meet the demand for light in streets in which there were no mains. Mr. Hoadley said the present plant was capable of supplying 26,000 8-c.p. lamps. About 30,000, or the equivalent, were connected with the mains, but the greatest demand at any one time represented 12,000 8-c.p. lamps. About 2,000 of the total connected were represented by motors, over the most important of which the Corporation had control—motors for pumping at the waterworks—and these were never at work in the evening. There was no opposition, and the inspector afterwards visited the works.

London County Council.—The Highways Committee's report, adopted at Tuesday's meeting, stated that they had considered a notice from the Charing Cross and Strand Electricity Supply Corporation under the City of London Order, 1899, of their intention to lay mains from the corner of William-street, along the Victoria-embankment, as far as Temple-avenue; and along William-street, John Carpenter-street (each side), Carmelite-street (each side), and Temple-avenue (each side). Under the order the Council had power only as regards the work affecting the Victoria-embankment, in respect of which it was the road authority. They recommended: "That the sanction of the Council be given to the portion of the works referred to in the notice (registered No. 1,691) dated Jan. 3, 1900, of the Charing Cross and Strand Electricity Supply Corporation under the City of London Order, 1899, which is within the Council's jurisdiction, such sanction being, however, subject to the following conditions: that the company do give two days' notice to the Council's chief engineer before commencing the works; that the mains be laid under the footways wherever it is found practicable to do so, and be placed at least 12in. below the underside of the paving; that no street boxes be constructed until full details shall have been submitted to and approved by him; that the concrete floors of the street boxes be 9in. thick, and the York stone at the top 4in. thick; that the longitudinal girders (if used) in the boxes be laid on 3in. stone templets, the full thickness of the brickwork, which shall be 9in. thick; and that adequate means be taken to prevent the accumulation of gas in the boxes and conduits; and that the work be carried out in all respects to the satisfaction of the proper officers of the Council."

Govan.—The municipal works in Govan for the supply of electricity have now been completed, and the regular supply of current to consumers was formally inaugurated on Saturday last. The ceremony, which, says the *Glasgow Herald*, was very largely attended, took place at five o'clock. Mrs. Wightman, wife of the convener of the Electricity Committee, turned on the current in the lamp at the eastern corner of Albert-street and Govan-road, and the new illuminant succeeded the old amidst cheers. The installation, which, like that of Glasgow, is on the three-wire continuous-current 250-volt system, is naturally a modest one, for although the field seems a promising one, the Commissioners have deemed it wise to proceed cautiously. In making it, however, they have left abundant room for expansion, as with very slight structural alteration the capacity of the works, which is for 10,000 8-c.p. lamps, may be greatly increased to meet applications for more power. The supply station in Helen-street is a brick building, containing boiler-room, engine-room, accumulator-room, and offices. The frontage, however, is of stone, and the end, to facilitate the enlargement of the station at some future time, is of corrugated iron. There are two boilers of the water-tube type, by Messrs. Babcock and Wilcox, and two engines, each of 150 h.p., by Messrs. Bellis, of Birmingham. The electrical machinery is by the British Thomson-Houston Company, the accumulators by the Tudor Company, and the switchboard and connections by the Edison-Swan Company. The cables, of which there are about 28 miles, are the Callender Company's, but they have been laid by the burgh's own employés, under the supervision of Mr. Arnot, M.I.E.E., who has directed the whole undertaking from its beginning. The distributing cable runs the full length of Govan-road and Paisley-road West, and feeding cables connect with it at three different points. In all there are 85 arc lamps in the two thoroughfares, which formerly were lighted by 296 gas lamps. The arc lamps are Messrs. Crompton's, and the posts are somewhat similar in design to those in use in the city. The cost of the installation is expected to be about £26,000—something like £8,000 more than was originally estimated. After the ceremony the Commissioners and their guests dined in the burgh hall. Provost Kirkwood presided, and Bailie Wightman, convener of the Electricity Committee, was croupier.

COMPANIES' MEETINGS AND REPORTS.

EASTERN TELEGRAPH.

The directors in their report for the six months ended Sept. 30, 1899, state that the revenue for the period amounted to £474,950. 8s. 2d., from which are deducted £121,630. 3s. 8d. for the ordinary expenses and £33,096. 17s. for expenditure relating to repairs and renewals of cables, etc., during the half-year. After providing £6,117. 18s. 5d. for depreciation of spare cable and £7,215. 2s. 2d. for income tax, there remains a balance of £306,890 6s. 11d., to which is added £3,536. 0s. 9d. brought from the preceding half-year, making a total available balance of £310,426. 7s. 8d. From this balance there has been paid interest on debentures and debenture stock, £29,133 16s. 4d.; dividends on preference stock, £30,632 8s.; two interim dividends of 1½ per cent. each on the ordinary stock, £100,000—total, £159,766. 4s. 4d. After carrying £10,000 to the reserve fund for maintenance ships, £5,000 to the reserve fund in connection with the removal of head offices, £2,000 to insurance of goods in transit fund, and £100,000 to the general reserve fund, there remains a balance of £33,660. 3s. 4d., which is carried forward to the next account. The revenue includes £24,054. 18s. 5d. dividends for the half-year upon the Company's shares in other telegraph companies. In July last the directors offered to the holders of the 5 per cent. debentures, repayable at par on Aug. 1, 1899, the option of exchanging the debentures for a like amount of 3½ per cent. of the Company's preference stock. The total amount of the debentures outstanding was £89,600, of which £32,900 was exchanged into 3½ per cent. preference stock, and the balance paid off at par in accordance with the terms of the issue. With the view of providing additional security to submarine telegraph communication between this country and South Africa, landing rights at Cape Town have been obtained from the Government of the Cape of Good Hope for a third cable between this country and South Africa. The first section, from Cape Town to St. Helena, was completed on Nov. 26 last, a further section being laid from that island to the Island of Ascension on Dec. 16. The continuing cable to be laid thence to St. Vincent is now being manufactured, and it is expected the expedition will leave the Thames the end of this month. Reference was made at the last general meeting to proposed new cables between South Africa and Australia, and a proposal has been submitted by the Eastern

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Extension, Australasia, and China Telegraph Company, in conjunction with this Company, for carrying out this important extension. By the terms of the proposed agreement the tariff is to be reduced at once between Great Britain and Australia to 4s. per word, to be followed by further reductions on a sliding scale to 2s. 6d. per word, according to the growth of revenue from this traffic. The companies have made this offer conditional on the Eastern Extension Company being granted the same rights in dealing direct with the public in Australia as is enjoyed in this and other countries. In accordance with the terms of the trust deeds the first quinquennial examination of the staff pension and superannuation funds has recently been made, with the result that the funds are reported by the actuary to be in a satisfactory condition; they do not, however, admit of the retiring age being reduced from 60 to 55 years, which experience proves would be most desirable. The actuary advises that in order to bring about this change the contributions by the staff and the Company to the pension fund would have to be increased from 2½ per cent. to 4 per cent. respectively. It is believed that the staff will readily agree to assume this additional liability, and a resolution will be submitted to the meeting authorising the directors to increase the Company's contribution from 1st inst. to 4 per cent. and provide a sum sufficient to enable the trustees to pay the pensions which have already been purchased to Dec. 31, 1899, at the age of 55 instead of 60 years. The shareholders will also be recommended to approve of an alteration in the superannuation trust deed by which the age limit will be reduced to 55 years, the Company guaranteeing to make up the loss (if any) that there might be in the fund on account of such reduction. In accordance with the provisions of the articles of association, two of the directors, Sir John Wolfe Barry, K.C.B., and Francis Alexander Johnston, Esq., retire by rotation at this meeting, and, being eligible, offer themselves for election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., and Messrs. Welton, Jones and Co., retire and offer themselves for re-election.

DIRECT UNITED STATES CABLE.

The report for the half-year ended 31st ult., to be presented at the meeting on 30th inst., states that the revenue amounted to £56,800, as compared with £54,366, an increase of £2 434. The expenses amounted to £20,416, leaving a balance of £36,383 as the net profit, making, with £3,177 brought forward, a total of £39,560. Interim dividends of 3s. per share for the quarter ended Sept. 30, 1899, and of 3s. per share for the quarter ended 31st ult., together amounting to £18,213, have been declared. Fifteen thousand pounds has been carried to the reserve fund account, and a balance of £6,347 brought forward. The reserve fund account, which now amounts to £401,693, has been debited with £1,989 for cost of cable repairs, and after being credited with interest on the investments and amount set aside from revenue.

ANGLO-AMERICAN TELEGRAPH.

The directors recommend, after placing £12,000 to the renewal fund, for the past half-year a balance dividend of £1. 8s. 6d. per cent. upon the ordinary consolidated stock, making £3. 13s. 6d. for the year 1899; a balance dividend of £1. 10s. per cent. on the preferred stock, making £6 per cent., and a first and final dividend of £1. 7s. per cent. on the deferred stock for the year ended Dec. 31 last, carrying forward a balance of about £1,355.

CITY AND SOUTH LONDON RAILWAY.

The accounts for half-year ended Dec. 31 last show a balance, after providing for the debenture interest and the full dividend on the 5 per cent. preference stock (1891), sufficient to allow the payment of a dividend on the consolidated ordinary stock (increased to £855,000) at the rate of 1½ per cent. per annum, carrying forward a balance of £1,267. The dividend for the corresponding period last year was at the rate of 2 per cent. per annum, the balance carried forward being £1,419.—*Financial News.*

BIRKDALE AND SOUTHPORT TRAMWAYS.

The report for the half-year ending Dec. 31, 1899, states that the traffic receipts amounted to £2,549, as compared with £2,190 for the corresponding period of the year 1898, and the profit on revenue account was £1,008. The British Electric Traction Company, Limited, having forfeited the £500 deposited with the Company under the agreement for option of purchase, that amount had been credited to profit and loss account, which showed a credit balance of £1,435. Out of this the payment is recommended of a dividend of 7½ per cent. per annum, absorbing £217, the sum of £500 being placed in the reserve fund, £680 allowed for depreciation, and £37 carried forward. The number of passengers conveyed during the half-year was 471,314, an increase of 105,075 on the corresponding period of the previous year.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS.

The annual report states that during the past season the line was worked for 133 days. The mileage run was 37,593. The total passengers carried reached 100,769, and the gross traffic receipts made £4,444. The tolls payable to Douglas Head Drive Company were £740, and other expenses left £1,706 for division, out of which a dividend of 6 per cent. is recommended on the 7 per cent. preference shares.

PROVISIONAL PATENTS, 1900.

JAN. 15.

862. Improvements in phonographic diaphragms for combining two glass diaphragms in one cell, thus obtaining more than twice the usual volume of sound. William Bradley, 41, Wennington-road, Southport, Lancs.

888. A method of receiving, storing, and reproducing messages, signals, and the like by magnetic influence upon magnetisable bodies. Peder Olaf Pedersen, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

892. Improved trolley for overhead electric tramways. Richard Humphries, 1 and 4, Mitre-court-chambers, Fleet-street, London.

JAN. 16.

927. Improvements in machinery for double wrapping and insulating electric cable wires. Charles Wilson and Joseph Marriott, Bank-buildings, George-street, Sheffield.

945. Electric bell-push indicator for front doors when out of order. Charles Caulton and Clement Caulton, 37, Mill-lane, Liscard, Cheshire.

949. Improvements in telephony. Dane Sinclair, Oxford-court, Cannon-street, London.

956. Improvements in telephone apparatus. David Henry Wilson, 46, Lincoln's-inn, London. (Complete specification.)

1009. Improvements in electrically or magnetically operated locks. Charles B. McCabe and Levi Goughenour, 18, Buckingham-street, Strand, London. (Complete specification.)

1012. Improvements in electricity meters. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

1022. Improvements in the mounting of electric arc lamps. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (Continentale Jandus Electricitats A. G. (Société Anonyme), Belgium.)

1024. Improvements in electrical switches. Sidney Harper Heywood and Herbert William Heywood, 31, Southampton-buildings, Chancery-lane, London.

JAN. 17.

1063. Improvements in wiring electrical installations. Frederick Bathurst, 73, St. Stephen's-road, Upton Park, London.

1078. Covering wires with insulating material for electrical purposes. Henry Andrew Kent, 59, Mydleton-road, Bowes Park, London.

1089. Improvements in electrical conductors or cables. Henry Edmunds, 47, Lincoln's-inn-fields, London.

1100. Improvements in electric motors and dynamos. Walter Langdon-Davies and Alfred Soames, 24, Southampton-buildings, Chancery-lane, London.

1101. Improvements in electric switching apparatus. Walter Frederick Jones, 322, High Holborn, London.

JAN. 18.

1133. Improvements in or relating to incandescent electric lamps. Alfred Julius Boult, 111, Hatton-garden, London. (Maurice Sauvalle, France.) (Complete specification.)

1134. A coin-freed phonograph. The Berliner Electro-mechanische Werkstätten (G. m. b. H.), 55, Chancery-lane, London.

1147. Improvements in electric motors for rotary dental tools and the like. Peter Jensen, 77, Chancery-lane, London. (The Browning Manufacturing Company, United States. (Complete specification.)

1148. An improvement in troughs for electric cables. Siemens Bros. and Co., Limited, Arthur Ernest Foster, and Henry John Nott, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1159. Improvements in telephone receivers. Herbert John Robson, 46, Lincoln's-inn-fields, London.

1160. Improvements in or connected with dynamo-electric machines. Alexander John Protheroe, 4, South-street, Finsbury, London.

1167. A new or improved adjustable suspension device for electric lamps. Antipas Jean Fabre, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

1168. Registering apparatus and circuits for telephone measured service. John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

JAN. 19.

1170. Automatic electric alarm. Edmund William Moore, 27, Westgate, Bradford.

1174. The electric nightlight. Alfred Rickard Taylor, Overdale, Bakewell, Derbyshire.

JAN. 20.

1245. Improvements in arc lamps. Joseph Devonport Finney Andrews, 45, Fulham Park-gardens, London.

1267. Improvements relating to permanent way for tramways and points therefor, specially applicable to electric tramways. John Alexander Brodie, 34, Castle-street, Liverpool.

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1284. Improvements in electric switches. Walter Frederick Jones, Albert Works, Hammersmith.

1289. Celluloid drums or platens for phonographs and process of preparing same for the reception of sounds. Karl Löschner and Otto Wilhartitz, 19, Holborn-viaduct, London.

1297. Improvements in conduits for underground pipes, mains, electric cables, and so forth. Amos Vickery, 70, Chancery-lane, London.

1309. Improvements in the manufacture of compound tubes suitable for gas and electrical conductors. Joseph Earle, 46, Lincoln's-inn-fields, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1898.

27390. Coin-freed apparatus for electric and fluid meters. Abel. (Soc. Anon. Continentale pour la Fabrication des Compteurs a Gaz et autres appareils.)

27541. Detachable and swivelling electric light fittings. Wakelin and Weston.

1899.

153. Dynamo-electric machines or motors. Monnard.

903. Telephone exchange switchboards. Eckstein and Guthrie.

2426. Electric switches. Gover and Huisman.

3032. Printing telegraph machines. Telescriptor Syndicate, Limited, and Shepard.

4124. Electric stoves. Dowsing.

5707. Electric fuses for firing, blasting, and other explosives. Smith and Corrie.

14207. Telephone apparatus. Louis Gabriel Benard.

19354. Thermopher with electric heating arrangement Timar.

20753. Lanterns or globes chiefly for incandescent gas lights, arc electric lights, and the like. Biheller.

21966. Arc lamps and roller-clutch mechanism for feeding and controlling the electrodes therein. Leigh. (Drohan.)

22088. Incandescent electric lamps. British Thomson-Houston Company, Limited. (Steinmetz.)

22257. Means for mounting electric lamps on signs, letters, and other articles and surfaces. Harter.

22534. Means for generating alternating electric currents. British Thomson-Houston Company, Limited. (Steinmetz.)

23283. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Thomson.)

23285. Electric arc lamps. British Thomson-Houston Company, Limited. (Rice.)

23286. Enclosed electric arc lamps. British Thomson-Houston Company, Limited. (Wiswell.)

23290. Regulating rotary electric converters. British Thomson-Houston Company, Limited. (Berg.)

23291. Systems of electrical distribution. British Thomson-Houston Company, Limited. (Steinmetz.)

23313. Electrodes for medical applications of electricity. Houghton.

23493. Electric igniting apparatus useful for lighting cigars or for similar purposes. Lake. (Abbott.)

23633. Running gear frames for road vehicles. Justice. (Columbia and Electric Vehicle Company.)

23713. Electrically illuminated advertisements or signs. Tripp, Stephenson, and Lartz.

23723. Manufacture of lead plates for secondary batteries. Wuillot.

23739. Electric railway systems and cars. British Thomson-Houston Company, Limited. (Potter.)

23755. Electrolytic apparatus. Darling and Harrison.

23813. Galvanic batteries. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Jan. 20	4,029	3,745	+ 284	11,943	11,351
Blackpool-Fleetwood	,, 20	140	129	+ 11	423	410
Bradford City Trams	,, 19	354	246	+ 108	689	—
Bristol Tramways Co.	,, 19	2,715	2,578	+ 136	—	—
City & South London	,, 21	1,111	1,133	− 22	3,379	3 383
Dover Tramways	,, 20	150	148	+ 2	455	454
Dublin U.T., elec. cars	,, 19	2,865	577	+2,288	—	—
Dublin S.D. Electric	,, 19	608	630	− 22	—	—
Halifax Corporation	,, 14	554	233	+ 321	24,419*a*	7,589*b*
Hull Corporat'n E.S.	,, 13	682	—	—	—	17,711*c*
Liverpool Corporat'n	,, 13*d*	6,631	5,832	+ 799	13,405	11,900
Liverpool Overhead	,, 21	1,471	1,326	+ 145	—	—
Sheffield Corporation	,, 21	1,785	—	—	—	—
South Staffordshire	,, 19	603	679	− 76	1,615	1,765

a Since April 1, 1899. *b* Since June 29, 1898.
d Partly electrical. *c* Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Tuesday.
Commercial and Industrial.—		
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¾-⅞
British Insulated Wire, Ord., 1-40,000	5 ..	11½-12⅝
—— 6 per cent. Cum. Pref., 1-27,500	5 ..	6-6½
British Electric Works, Ordinary, 50,001-95,000	1 ..	¾-⅞
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	¾-⅞
—— 4½ per cent. First Mortgage Debentures	108 ..	97-99
Brush Electrical Engineering, Ordinary	2 ..	1¾-2
—— Non. Cum., 6 per cent. Pref.	2 ..	2½-2⅝
—— 4½ per cent. Debenture Stock	100 ..	110-115
—— 4½ per cent. 2nd Debenture Stock	100 ..	102-105
Callender's Cable, Debentures	100 ..	110-115
—— Ordinary	5 ..	13-14
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	3½ 4 xd
—— 5 per cent. Debentures	— ..	98-101
Edison and Swan United, Ordinary	3 ..	2-2½
—— 5 per cent. Debentures	5 ..	3½-4½
—— 4 per cent. Deb. Stock, Red.	100 ..	92-94
Electric Construction	3 ..	2-2½
—— 7 per cent. Cumulative Pref.	3 ..	2⅞-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	103-106 xd
Giffre Electro-Chemical and Power, Ordinary	1 ..	½-1½
W. T. Henley's Telegraph Works, Ordinary	5 ..	12½-13½
—— 4½ per cent. Preference	5 ..	5½-5⅝
—— 4½ per cent. Debentures	100 ..	111-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	20½-21½
—— 4 per cent. Debentures	100 ..	100-104
Telegraph Construction and Maintenance	12 ..	26 40
—— 5 per cent. Bonds	10* ..	102-105
Telegraph Manufacturing, Ordinary	5 ..	9-10
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	7-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	104-106
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	½-¾
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	10-11
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	..	8½-9½
Charing Cross and Strand	5 ..	10 11
—— 30,001-50,000	5 ..	9½-10½
—— 4½ per cent. Cum. Pref.	5 ..	5½ 6½
Chelsea Electricity Supply	5 ..	7½-8½
—— 4½ per cent. Debentures	100 ..	100-111
City of London, Ordinary	10 ..	10½-11½
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	123-127
County of London and Brush Provincial, Ordinary	10 ..	9½-10½
—— 6 per cent. Cum. Pref.	10 ..	13-14
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	— ..	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	4½-5½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	8 ..	8-8½
London Electric, Ordinary	3 ..	2-2½
—— 6 per cent. Pref.	5 ..	5½-5⅝
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	101-103
Metropolitan, Ordinary	10 ..	14½-15
—— 62,501-85,000	10 ..	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	115-117
—— 3½ per cent. Mortgage Debenture, Red	100 ..	95-97
Notting Hill Electric Lighting	10 ..	15½-16½
Oriental, 1879	1 ..	1½-1¾
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,810	5 ..	6½-7½
River Plate Electric Light and Traction, Deb.	100 ..	80-90
Royal Electrical Company of Montreal	10 ..	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
South London, Ordinary	3 ..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15½-16½
—— 40,081-52,080	5 ..	15½-16½
—— 7 per cent. Pref.	5 ..	9-9½
Westminster, Ordinary	5 ..	14½ 15½
Electric Railways.—		
Central London, Ordinary	10 ..	9½-10
—— Pref. Half-Shares	5 ..	4½-5
—— ,, ,, deferred	5 ..	4½-5
City and South London, Consolidated Ordinary	100 ..	59-62
—— ,,	5½ ..	4½-5½
—— 4 per cent. Debenture Stock	100 ..	125-130
—— 5 per cent. Pref. Stock '91	100 ..	143-148
—— ,, ,, ,, '96	100 ..	135-140
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
Waterloo and City, Ordinary	100 ..	101-104
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10 ..	17-19
Brisbane Tramway	100 ..	104-106
British Electric Traction, Ordinary, 1-30,000	10 ..	16-17
—— 60,001-75,000	10 ..	15½-16½
—— 6 per cent. Cm. Pf. 30,001-60,000	10 ..	13½-13¾
—— 5 per cent. Perpetual Debenture Stock	100 ..	125-128
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4½-5
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
Costa Rica Electric Light and Traction, 5 per cent. First Deb., 1-1,000 of £100 and 1,001-1,600 of £50 each	— ..	75-85 xd
Kidderminster and District Lighting and Traction, Pref.	8 ..	8-8½
New General Traction, Ordinary	5 ..	3¾-4
—— 6 per cent. Cum. Pref.	5 ..	5-5½
North Staffordshire Trams	6 ..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	18-19
—— Preference	10 ..	10½-10⅞
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
Telephones.—		
Consolidated Telephone Construction and Maintenance	½ ..	⅛-¼
National Telephone, Ordinary	5 ..	5½-5⅝
—— 6 per cent. Cum. First Pref.	10 ..	14-15
—— 6 per cent. Cum. Second Pref.	10 ..	14-15
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5½-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 ..	98-100
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

Congo Telephones.—The *Daily Chronicle* states that telephonic communication has been established on the Congo Railway between Boma and Kwamouth, a distance of 450 miles.

Electric Lighting in Bradford.—We are exceedingly sorry to note that the Bradford Electrical Committee have had to issue a circular asking consumers not to use more lamps and motors than are absolutely necessary between the hours of 4.30 and 7 p.m. This is said to be due to the excessive demand and to non-deliveries of machinery, but the committee hope to have more plant at their disposal in about a fortnight.

Cheap Telegrams in Ceylon.—The *Financial News* states that one of the items that contribute to the remarkable financial prosperity of Ceylon is the telegraph. According to the annual report of the island, recently issued, receipts from telegrams show a phenomenal increase, due almost entirely to the success of the experimental reduction to the four anna—*i.e.*, fourpence—telegram, which is described as the cheapest in the world.

The Paris Exhibition.—At the last meeting of the Huddersfield Chamber of Commerce, in view of the lack of enthusiasm shown by the manufacturers in the district, it was decided to abandon the proposed collective exhibit from Huddersfield. This is, we think, quite a natural result of the attitude which the French papers have taken with respect to the war in South Africa, and to the disgraceful cartoons which have but recently appeared in the Parisian Press.

Niger Telegraphs.—A report, which was, however, not officially confirmed, has reached the Press to the effect that trouble has been experienced by the telegraph construction staff which is laying wires up to the Benin River from Lokoje. The military escort of 150 men attached to the telegraph staff is stated to have had a serious conflict with some 2,000 tribesmen, these latter having apparently determined to resist the introduction of the telegraph into their country.

Postal and Telegraph Workers.—The joint committee of combined postal and telegraph associations met last week in London, Mr. J. C. Brown, of Glasgow, in the chair. The meeting discussed the necessity for supporting or opposing Mr. S. Wood's amendment to the Address in favour of a parliamentary committee of enquiry into the grievances of Government workers generally. It was decided to decline to tender any evidence before any general enquiry, and to reassert adherence to the policy of trying to secure the appointment of a committee to deal solely with the grievances of postal employés.

The Electric Motor.—An amusing anecdote is told in connection with the new electric tramway system just opened on a section of the Aberdeen lines. Two farm servants came to Aberdeen to spend New Year's Day. Arriving by train, they immediately made their way to the terminus of the electric tramway circuit, where, after looking at the new creation with much wonder, they decided upon having a ride. Getting on to the top of the car, and after getting well along George-street, "Wull," said man Jock, "this is a graun' invention. In Edinbugh I saw them drive the cars wi' an iron rape aneth street, in Dundee they pu' them wi' an engine, but, michty man, wha wad a' thocht they could ca' them wi' a fishing-rod."

Swiss Engineering.—A general meeting of the Manchester Society of Junior Electrical Engineers was held on Saturday evening last at the Engineering Laboratories, Whitworth-street, Manchester, when a discussion was opened by the president, Mr. W. W. H. Gee, B.Sc., on electrical engineering in Switzerland, and who with the aid of lantern illustrations was able to show and describe the chief electrical items seen by the Institution of Electrical Engineers during their visit to Switzerland last year. A very interesting discussion on the subject followed. A presentation of books was then made to a member of the committee, Mr. S. Payne, who leaves for South Africa shortly for the benefit of his health. All present joined in wishing Mr. Payne a safe journey and good health in the new country he had chosen.

The Proposed Philippine Cable.—It is stated by Reuter's Washington correspondent that a representative of the Eastern Extension Telegraph Company has submitted a notice of prior rights to the Commerce Committee of the House of Representatives in the matter of the cable to the Philippines. It is maintained that the Spanish grants are binding on the United States, which could not lay a cable to Manila without extinguishing existing rights in some regular way. A Bill to pay the company its expenses for repairing the Manila-Hong Kong cable cut by Admiral Dewey has also been discussed in the House. It was proposed to represent the payment as an act of grace. It was also pointed out that the business of the cable company had greatly increased owing to the American occupation. No action was finally taken on the Bill.

Telegraph Traffic.—At a recent social meeting of the Aberdeen Postal Telegraph Clerks' Association some interesting figures were given as to the work done by the Post Office in that important Scottish centre. The figures were complete up to the end of 1899, and showed that those in charge at Aberdeen have no difficulty in completing quickly their records for the past year. For instance, the number of ordinary telegrams dispatched from Aberdeen during 1899 was over 380,000, while almost half a million messages were received. The largest number of telegrams handled were those which had to pass through the office, as there were over 1½ millions of such messages. The total number of telegrams handled throughout the year was 2,552,470. These show an increase of 56 per cent. over the messages dealt with in 1889.

Flashlight Signalling.—Some interesting experiments have recently been made at Chelmsford on signalling by flashlight from arc lamp projectors in the same way as is being done in Africa from Kimberley to the Modder River and from Ladysmith to the camp at Chievely. The experiments were made by some of the staff of Messrs. Crompton and Co. who are members of the Electrical Engineer Volunteer Corps, and it is probable that five or six of these gentlemen will be amongst the first division of that corps to be sent to the front. The signalling took place between the old Arc Light Works in Moulsham-street and a temporary plant erected about five miles away on Danbury Hill. The experiments were continued for several evenings, and it was found that the bright moonlight seriously hampered the signalling on one occasion. We gather that the heights of the clouds have also a considerable effect on the speed and ease of signalling.

Faraday House Journal.—The January number of the *Faraday House Journal* contains some interesting articles, and in the editorial notes the institution is congratulated on the success of past students. It is stated that 80 per cent. of the students passing through Faraday House hold more or less remunerative positions, while, as is well known, a large number are in charge of important municipal electrical undertakings. The balance of 20 per cent. is a very small proportion in view of the

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fact that there are always a number of wasters who will not work and duffers who cannot, entering any institution. The articles in this month's issue are well chosen to represent every branch of electrical engineering, and we notice particularly a description of the building up of a large flywheel in the works of the London Electric Company. This description, by E. A. Thompson, is well written, and contains information which is of distinct technical value to engineers.

The Manchester Regulations.—We have received from Mr. C. H. Wordingham the last edition of the regulations as to the supply of electric energy which appertain in Manchester. These rules, which we have reviewed before, deal extensively with the work on the consumers' premises, and with the character of the fittings to be supplied by the contractor. As will be remembered, Mr. Wordingham has introduced into Manchester a complete system of testing the various instruments required in electric light installations, and refuses to have connected to his system any instruments which have not passed the required tests. With the rules we have received the list of approved fittings, from which we gather that a large number of makers have received approval for the various articles they manufacture. With this list before them contracting firms in Manchester should have no difficulty in carrying out their work to meet the requirements.

Newcastle Tramways.—We are pleased to see that the Tramway Committee at Newcastle-on-Tyne is now supporting its technical advisers, and that in consequence rapid progress is being made with the plans for the power station, and also with the placing of contracts for the permanent way and for the machinery to come in the power-house. Thus at their last meeting tenders for electric generators were placed with the British Westinghouse Company, while a 2,000-h.p. engine was ordered from the Wallsend Slipway Company. We are glad to know that this enterprising company is undertaking the manufacture of engines for driving electrical machinery, and are sure that the excellent practice they have had in the design of marine engines will enable them to compete successfully with American manufacturers. We also note that at the same meeting further tenders were accepted for smaller generating sets in which Colt engines are used. An offer from a German firm, which would have saved about £1,000, was passed over in favour of English manufacturers.

South African Cables.—It is curious to note how frequent the breakdowns in the cables connecting us to South Africa have been, and how these breakdowns have synchronised with the periods in the war when it has been important to have the news through promptly. As soon as the East Coast cable, which broke down at the beginning of last month, was repaired, faults developed in the West Coast line, which is now out of order. We learn, however, from the Eastern Telegraph Company that these faults are soon to be put right, and that they hope to have the Ascension and St. Vincent portion of the new line to the Cape completed and opened for traffic by Feb. 24. We are also informed that the steamship "Anglia," belonging to the Telegraph Construction and Maintenance Company, left Greenwich last week with about 1,900 miles of cable aboard for St. Vincent, where it is expected the "Anglia" will arrive about Feb. 9. After two days for coaling she will start towards Ascension, paying out cable, and if all goes well the section should be completed by the above date.

Invisible Light.—Mr. R. C. Quin delivered a lecture before the Literary Society of Fleetwood recently on "Invisible Light and Kindred Phenomena," which attracted an appreciative audience. He explained that by invisible light he meant those forms of ether waves which did not excite sensation in the human eye. He then proceeded to describe to his audience the composition of light, both visible and invisible, and afterwards treated of electrical developments from 1845, when Michael Faraday discovered that a magnet was able to influence light. The concluding part of the lecture was devoted to Röntgen rays and wireless telegraphy. Mr. Quin concluded by saying that much had been done in the world of science, much was being done, and much remained to be done. The corner of the veil had been lifted, but beyond was a vast and unexplored territory. Should we prove capable of elucidating the structure of matter itself? If we succeeded, we should find ourselves in the presence of a much more complex problem when we attempted to solve the problem of the nature of energy.

Electric Automobiles.—The discussion on the question of electric automobiles before the Franklin Institute again brought up the rivalry between vehicles propelled by means of electricity and those using steam and oil engines. We notice that those speakers who prophesied that the future automobile would be driven by electricity looked for great improvements in the accumulators to enable this to be done. A speaker who had had considerable experience with electric vehicles echoed the opinion expressed by us from the recent trials of electrical vehicles in France. This was to the effect that with the present types of accumulators using lead the weight of the batteries cannot be reduced to any great extent without sacrificing their efficiency and life. The advocates of electric vehicles drew attention to the objections to those motors using oil as a motive power. The offensive smell and constant vibration make such vehicles far from enjoyable to everyone but the racing man. In this respect sufficient stress was not laid on the fact that a large number of automobile users prefer comfort to cheapness, and that on the score of comfort electricity is easily first.

Electric Lighting Licenses.—The Oban Town Council has expressed the wish to have an installation of electric light, but its advisers have been rather backward in making application to the Board of Trade for electric lighting powers. In consequence of this it was resolved to write to the Board of Trade for the procedure as to the granting of an electric light license to the Town Council. In answer to this letter the Board of Trade state that electric lighting licenses will no longer be issued, as the longer tenure given by a provisional order is more advantageous in every way. The Board explain that the licenses were intended to be given in order that experiments might be made, and that the days of experiments are over as far as electric lighting is concerned. Unfortunately for the inhabitants of Oban, an application for a provisional order cannot now be made in time to be considered this year, and the electric lighting of this fashionable watering place and point of call in Scottish tours will in consequence have to be deferred for some considerable time. If the Town Council had only taken some expert advice last year, all this delay could have been saved.

Electric Railway Development. — Mr. J. R. Chapman, in the *Western Electrician*, gives a general review of the electric railway designs of the United States and of the improvements which have been standardised during the past year. The first amongst these is the cast-welded joint, which the author states is now coming into almost general use. He also claims that with these cast-welded joints, if properly made, conductivity equal to 95 per cent. of the conductivity of the rail can be obtained. After dealing with the increased size of tramcars on all lines, the author refers to the fact that the term "deadly" as applied to the

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trolley has almost become obsolete, even in the Chicago papers. It is stated that in Chicago there are fewer accidents involving personal injury in the 450 miles of overhead trolley system than on the 47 miles of cable tramway. It is also stated that the fire department have not found it necessary to cut down a trolley wire or a feeder cable even once in the last five years. In conclusion, the author remarks that the year closed with all the materials that enter into the construction of electric railways standing 60 per cent. higher in cost than they did at the beginning of 1899.

Telephone Rates.—It will be remembered that in June, 1898, the United States Congress passed an Act regulating the telephone rates to be charged in certain parts of that country. In the district of Columbia these rates ranged from £10 per annum for a single connection, down to £8 where two subscribers use one wire, and £6 where three subscribers use one wire. The result of this is a lawsuit, as the Chesapeake and Potomac Telephone Company refused to be bound by the Act, and threatened to disconnect any subscribers not paying the old rates. Amongst the evidence brought forward are some interesting figures as to the actual cost per subscriber per annum to this company, corresponding to the increase of the connections. For instance, when the company had some 523 subscribers the annual outlay was slightly over £7 per annum per subscriber. When after several years the connections had increased to 1,000, the cost per subscriber had gone up to £13. The exchange has now some 2,700 subscribers within a six-mile radius of their exchange, and their lawyers declare that a charge of £10 per annum will not leave the company a profit. The case will be one of interest when it is tried, and we fancy that the legality of the Act should be one of the points at issue.

Municipal Electricians.—We understand that Captain W. Brophy, the president of the International Association of Municipal Electricians, has made arrangements for the next meeting to be held in Pittsburg. Some interesting papers have been promised for this meeting, and a vast amount of information is being collected from the different electric lighting stations throughout the States and Europe. From the report of these preliminary arrangements given in our contemporary *Electricity*, we gather that Captain Brophy is hardly an expert electrician himself. His views on electrolysis are explained in the following paragraph, from which it will be seen that he believes that electricity can be weighed: "Electrolysis may come up for discussion, and I consider its study intensely interesting. Certainly a grave problem is presented where a municipality finds its vast systems of gas and water pipes and all iron underground being eaten away by that queer little 'electric bug.' If we knew how to prevent electrolysis economically we would know how to prevent the leakage of electricity, but we haven't reached either point perfectly. It will be a great day, indeed, when we are able to produce energy at one point and transmit it, no matter how many miles, in its original force, without the loss of an ounce."

Earthing Devices.—The best means of protecting telephone instruments from damage when the telephone wires have come into contact with the trolley wires of electric tramways is still an open point. There is no doubt that the earth wires required by our Board of Trade do not offer the requisite protection, and they are in consequence likely to be replaced in future. We notice in the *Elektrotechnische Zeitschrift* a lecture by Mr. Canter, of the German Postal Department, on the providing of such protection. He proposes to protect the telephones by placing an earthed conductor transversely under the wires to be protected, and at short distances from the supporting insulators. The average distance advised is about 7in. from the insulator, the earthed wire being about 1in. below the telephone wire. In order to avoid the spring in the wire itself preventing contact being made with the earthed conductor when a given span is broken, Mr. Canter suggests placing a lead weight round the wire at about 2ft. from the insulator. This weight should be between ¾lb. to 1lb. This system of protection has been tried at Frankfort-on-Oder since last July with success. It will be seen that by this, as soon as a span of the telephone wire breaks, the lead weight earths the same at each of the nearest supports, and thus prevents any damage being done to the telephone instruments even should the loose ends come in contact with the trolley wires.

The Kinloch Telephone System.—A description of the Kinloch telephone system as in use in St. Louis has appeared in several of our American contemporaries. The interesting feature in this exchange, which differentiates it from any that we know on this side of the Atlantic, is in connection with the switchboard arrangement. The trouble with large telephone exchanges when more than 5,000 or 6,000 lines are brought to one exchange is in arranging all the line connections within reach of a single operator. It is this difficulty which has led in many cases to the extension of the trunk-line system, involving considerable complication in the switching operations from one subscriber to another. In the Kinloch system the whole exchange is divided up into four sections, labelled A, B, C, and D respectively. Any subscriber is then able to call up another, and in giving the call he distinguishes as to which of the four sections the subscriber he wishes to communicate with is on. For this purpose four keys are provided on the subscriber's instrument, by means of which currents of either polarity may be sent along either of the line wires. For this purpose an earth connection is used. It will be seen that in this way the operator, in an exchange of a certain size, has only one-quarter of the plugholes in front of her which she otherwise would have; and although the system involves a certain amount of additional care on the part of the subscriber in calling, it must cheapen considerably the cost of the switchboard equipment.

The Wehnelt Interrupter.—Mr. R. H. Cunningham advocates in the New Year double number of the *Electrical Review* of America a new and durable form of the Wehnelt electrical interrupter which he has devised to get over the frequent breakdowns in the older form. These breakdowns, due to fractures in the glass tubing and to mechanical injuries, the author gets over by making his interrupter in the following way: The acid electrolyte is contained in a hard-rubber cell, with a tight-fitting top that is perforated for the insertion of the anode and for the two ends of the coil of small lead pipe that forms the cathode. A short tube of hard rubber is screwed into the top, and through this the fumes escape *vid* a flexible rubber tube into a jar containing a number of sponges moistened with a strong solution of washing soda. By siphoning water through the lead pipe any desired temperature of the electrolyte can be maintained for hours. The adjustable anode is made of a brass rod threaded with a long thread at the upper end for the adjusting thumb nut, and into the lower end the requisite sized platinum wire is brazed with silver solder. After thoroughly coating this rod with some thick unguent—for instance, with vaseline—it is inserted into a thick-walled, closely-fitting, hard-rubber tube that has a lava bushing firmly screwed and cemented into its lower end with some acid-proof, non-conducting cement. The

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hole through this bushing should be smooth, and the platinum wire should fit snugly. If a thick platinum wire (No. 6 or No. 8) is used, this form of the interrupter is capable of passing heavy currents without the least danger of breaking down.

The Magnetic Elements.—At the Académie des Sciences, in Paris, on the 8th ult., Mr. Mascart presented a note by Mr. Morcaux on "The Absolute Value of the Magnetic Elements at the 1st of January." The observations were made in the observatories at Parc St. Maur, Perpignan, and Nice, where regular records are taken throughout the year. These three stations are provided with identical apparatus for making corresponding measurements of the declinations, inclinations, and horizonal components of the magnetic field of the earth. Careful measurements made at these three observatories from Dec. 27 to Jan. 3, were used to determine the absolute value for Jan. 1. These values were as follows: At the first observing station, Parc St. Maur—declination, 14° 47·56′; inclination, 64° 55·2′; horizontal component, 0·19711, and total intensity, 0·46501. At Perpignan, the measurements were—declination, 13° 40·25′; inclination, 59° 59·5′; horizontal component, 0·22421, and total intensity, 0·44831. At Nice there was a declination of 12° 1·86′; inclination, 60° 10·4′; horizontal component, 0·22416, and a total intensity of 0·45069. Some interesting figures were also given as to the variation of the elements during 1899. Thus the average variation in the declination since Jan. 1, 1899, is 4·33′. The inclination has also decreased on the average by about 2·2′, but the horizontal component has increased by ·00029 at Parc St. Maur, and by ·00051 at Nice. The total intensity of the earth's field is also increased at every station, but the increase is represented by about ·00005 in every case. We note, however, that the vertical component shows a slight decrease on the value for Jan. 1 last year.

Constant-Current Transmission.—At the Société International des Electriciens on the 10th ult., Mr. Cuénod read a paper on the transmission of power to great distances by means of the continuous-current series system. The paper was nominally a description of the work which has been done by Mr. Thury in transmitting energy on the series system, and the author gave comparisons between the cost of working of this system and the cost of working a transmission with alternating currents. He estimated that the cost of energy to the consumer should not be more than £4 to £6 per horse-power per annum, and that the first cost of the installation should not be more than £40 per horse-power. He stated also that the efficiency of the dynamos and motors was at least equal to that of the best alternators, that the series system does away with the use of transformers, and the line does not present any induction troubles. He estimates the economies arising in consequence of the above to be from 15 to 20 per cent. The brief *résumé* of this paper which appears in *L'Industrie Electrique* does not give full details of the author's estimates, but he evidently neglected to point out the faults of the series system in that the high voltage is brought on to the consumer's premises, and also that a fault in one consumer's apparatus may cause an interruption to the supply of other motors connected in series with this consumer. Mr. Thury was present, and in the discussion stated that he had used voltages up to 12,000 at present, but that he saw no difficulty in going as high as 22,000 volts. Personally, we think that this voltage is much too high to use in any manufacturing works. It certainly would prevent the motors being used to drive individual machines, as can be readily done with other systems of power transmission and distribution.

Devulcanising Rubber.—Mr. J. B. Hohn contributes some interesting notes on indiarubber manufacturing to the *Gummi Zeitung*, which are condensed in *Kühlow's Review*. Dealing with the question of the devulcanising of vulcanised rubber, the author points out that a number of the mechanical processes for working vulcanised rubber, although successful to a certain degree, do not remove any appreciable portion of the sulphur. If, however, vulcanised caoutchouc is dissolved in benzine or some other solvent in which the solubility of sulphur and caoutchouc is different, the separation out of the sulphur can be effected. If the solvent be benzine, the author states that the process of solution and re-evaporation must be repeated four or five times. After each repetition the caoutchouc becomes more and more soluble, and becomes gradually devulcanised. This is a strong point against there being a chemical combination between the caoutchouc and sulphur, and this assumption is strengthened by the behaviour of unvulcanised caoutchouc. In treating the latter simply mixed with sulphur, but unvulcanised, in the same manner, the sulphur mechanically mixed with it will separate as though it had been vulcanised, except that this occurs more rapidly, and after one repetition of the above operation. Caoutchouc recovered by any process will have lost some degree of elasticity, and it especially loses its capacity to take up sulphur as readily as raw rubber, and on this point a chemical combination theory must, in a great measure, be based. But to this modification of its most valuable property any rubber substance after being so treated must be exposed even when brought into contact with the least amount of sulphur. The normal structure of caoutchouc even suffers through the powerful mechanical action as well as through the heat, and, more especially, the solvents used. These circumstances are analogous to the fact that caoutchouc, when brought into a fluid or soft state by strong heating, becomes absolutely useless.

Institution of Junior Engineers.—The fifteenth anniversary dinner of this institution was held on Saturday evening at the Westminster Palace Hotel. The Hon. Charles A. Parsons, president, occupied the chair, and there were present, among others, Mr. T. G. Bowles, M.P., Mr. J. Macfarlane Gray, Dr. S. P. Thompson, Major R. E. B. Crompton, Mr. A. A. C. Swinton, Mr. H. B. Vorley, Mr. Rickman, Prof. H. Spooner, Mr. W. J. Tennant, and Mr. S. Boulding. The usual loyal toasts having been duly honoured, Mr. T. G. Bowles, M.P., in proposing "Our Imperial Defences," referred to the services rendered by engineers in the extermination of our foes. Major Crompton replied to the toast. "The Institution of Junior Engineers" was given by Mr. A. A. Campbell Swinton. Mr. B. H. Joy responded. He said that the progress of the institution had been most satisfactory, the membership having increased to 576, a growth of 8½ per cent. on the year. Other toasts followed. During the evening a selection of vocal and instrumental music was rendered by members of the institution. On Monday last a large number of members inspected the operative department of the Royal Mint, Tower-hill. The superintendent, Mr. Rigg, received them. The foundry was first seen, in which the alloys are cast into bars 12in. long and ⅜in. thick, the width varying from 1¼in. to 2⅝in., according to the coin to be manufactured. Passing to the rolling-house, the successive operations therein were witnessed, strips being rolled from which the blanks to form the coins are cut. The annealing of the blanks was shown and also the house containing the presses. Here the blanks are automatically placed between the dies, the impression on both sides and the milling on the edge being imparted in one operation; the speed of production

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being about 90 coins per minute. The engines driving the machinery were seen, and the electrical plant was likewise specially open for the members' inspection.

Helios.—We have received from Leipzig a copy of a weekly journal which is called *Helios*, and which is said to be "a periodical of exportation for electrical engineering." The columns of this contemporary are filled with short articles and notices connected with electrical engineering, which are reproduced in three languages—German, English, and French. While the English in certain cases is good, in others it falls short of what one is led to expect from a language-gifted people like the Germans. For instance, we are informed that "the export journal *Helios*, of which the present number begins the sixth year, will be a weekly paper in future. This augmentation in number will have the consequence of a considerable increase and enrichment of the redactorial contents. We consequently transfer the management of the technical part to the care of Mr. Josef Krämer, chief engineer, and that of the commercial part to Mr. Dr. Richard Bürner, a first-rate capacity in political economy and commerce. By this change we hope to gain an always increasing number of readers within the country and abroad. As in the foregoing years, our principal aim will be the fastening and augmenting of our connections with all in whose interest our paper was founded. Forming a medium part between producers and purchasers, we shall always be disposed to give our readers any information desired as to the most convenient sources of production and proceedings; we further place at the disposal of all a letter-box in which we shall answer any question referring to matters of general interest." We notice elsewhere in the paper a description of the Parsons turbine which was naturally written in English and translated into the other languages. The idea of having the articles so translated renders the paper of great value to electrical engineers in a case like this, but if the translation into English of German articles is not more carefully looked after the paper may be the means of misleading English engineers who may wish to use it as a means of picking up a knowledge of German technical terms.

Electrical Car-Driving.—We have received from Mr. Edwin W. Elsley, of the Corporation tramways at Tinsley, Sheffield, a copy of his "Novice's Guide to Electric Car-Driving," which we have read with great interest. The little booklet of 40 pages is filled from start to finish with practical advice, and it may be read with advantage by drivers of electrical tramcars even if they have already had considerable experience. It is curious to note that Mr. Elsley starts his remarks with some notes on drunkenness, in which he is careful to point out that three months' hard labour, without the option of a fine, is the right and suitable penalty for the drunken driver of a tramcar. He proceeds to describe the various handy tools which a motorman should be provided with in order to get over little defects which may occur in the course of the day's work, and which will enable him to bring home his car in spite of minor accidents. The author's remarks on the proper way to stop and start a car are good, and his rule, that in a fog the speed of the car should be reduced to correspond with the limit of vision, is based on sound principles. Thus he states that in a fog the speed should depend on the fact that the driver can stop his car from that speed within the distance that he can see. This distance of stopping naturally depends on the braking power. High speeds in heavy fogs have been and will be the cause of serious accidents. Hints as to what to do when the trolley leaves the wire are most practical, and the need of the motorman accustoming himself to quickly ascertain what has happened is set forth. The remarks as to the causes of breakdowns and failures will, we expect, be objected to by certain engineers who do not believe in drivers investigating failures in electric apparatus. When, however, the failure is confined to the blowing of fuses and similar small derangements, we think it quite right that the motorman should know how to quickly localise and repair the fault. The booklet is concluded by some examples of faults which the author met with in daily practice and removed, and which give interesting examples of what might happen even with the best-equipped and well-organised lines. We can highly recommend this little booklet to all tramway engineers.

The Lancashire Power Bill.—An influential meeting of the Lancashire municipal corporations was held last week at Manchester in order that concerted action might be arranged with respect to the opposition to the Bill of the Lancashire Electrical Power Distribution Company. The towns represented comprised Liverpool, Manchester, Salford, Accrington, Blackburn, Bolton, Burnley, Oldham, Rochdale, St. Helens, Stockport, Warrington, and Wigan. The following were the reasons brought before the meeting as to why the Bill should be rejected on the second reading: (1) That where Parliament has authorised a municipal corporation to borrow money for a municipal undertaking on the security of the rates, and the corporation has established their undertaking, special parliamentary powers ought not, in the interest of the community, to be granted to a company trading for profit to execute works of a similar character within the borough, or to enter into competition with the corporation without the consent of the council of the borough. (2) That special parliamentary powers to break up the streets ought not to be granted to a company trading for profit without the sanction of the community expressed through the council. (3) That the Bill proposes to effect a practical repeal of the general law, on the faith of which millions of pounds throughout the kingdom have been borrowed by local authorities on credit of the rates. The Electric Lighting Acts make special provision with regard to the consent of the local authority for the express purpose of protecting local authorities, and it is submitted that such provisions ought not to be overridden to the extent proposed by the Bill for the benefit of a company trading for profit. (4) Parliament has already expressed a decisive opinion upon enterprises of a similar character by the rejection of the General Power Distributing Company's Bill on the second reading in the House of Commons on March 3, 1899. Powers similar to those sought by the present Bill were also refused by Parliament in the case of the County of London and Brush Provincial Electric Lighting Bill in the session of 1899. (5) It is proposed by the Bill to incorporate a company for the purpose of supplying electrical energy for lighting and power purposes in large areas, with power to break up or cause to be broken up public streets, and to occupy space therein without the consent of the local authority, and without any compensation in respect thereof. It was also urged that the undertaking was not likely to be able to supply electrical power at cheaper rates than the corporations themselves, as it was stated that the increased cost of mains would quite counterbalance the decreased cost of the fuel and land of the supply company. In the speeches at the conference great stress was laid on the interference with the streets, and it was ultimately decided to take united action in opposing the Bill, and to forward a copy of the resolution to members of the Government and to all the Lancashire members in Parliament. The resolution will also be sent round to the various municipal corporations throughout the kingdom.

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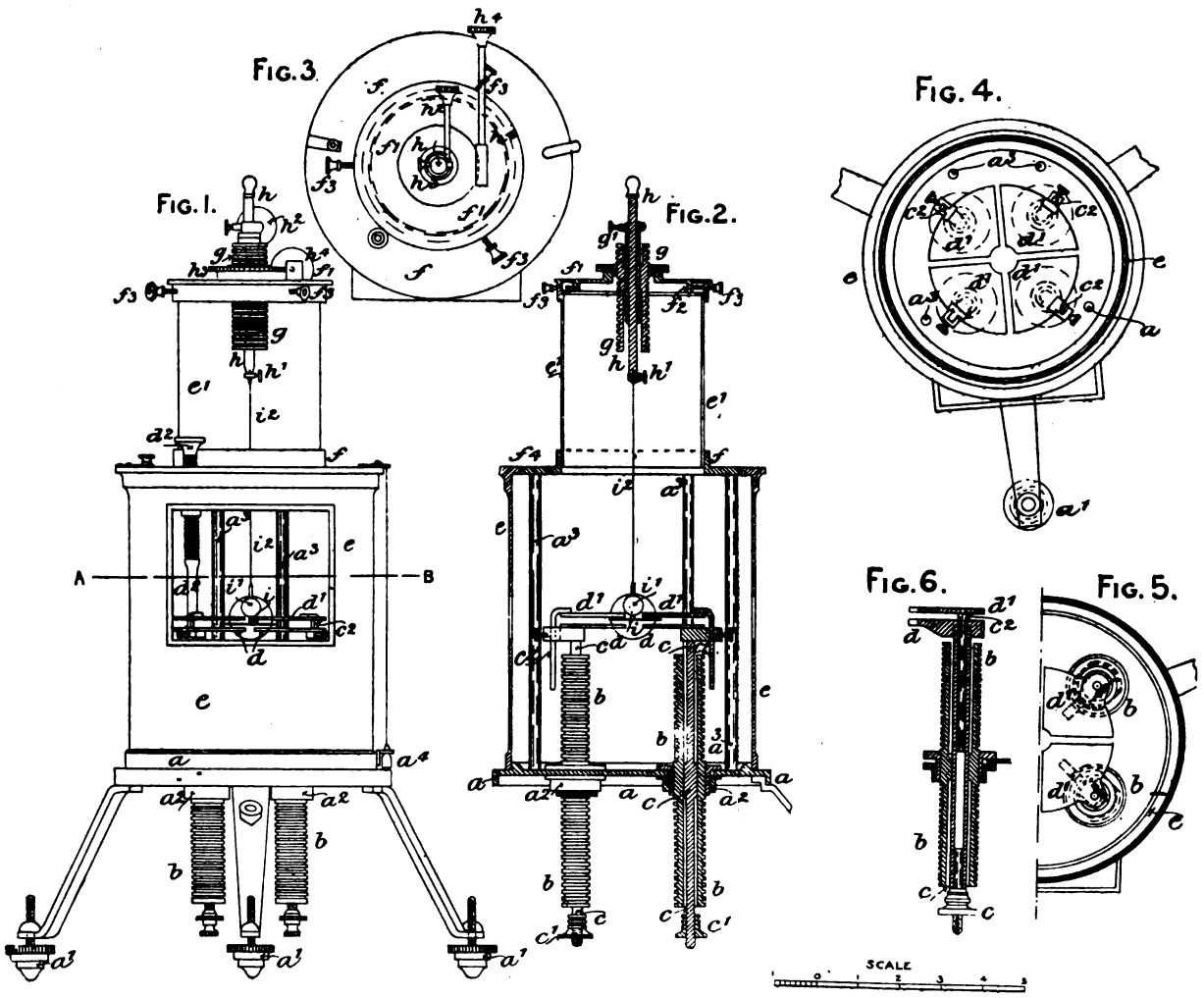
THE ADDENBROOKE ELECTROMETER.

It is known to many of our readers that Mr. G. L. Addenbrooke has been engaged for several years past in endeavouring to perfect a system of alternating-current measurement. Thanks to the courtesy of that gentleman, we are now able to publish a report of the progress made and results so far obtained towards this desideratum. His system is based on the use of electrostatic instruments, and is the outcome of very careful consideration. It will be remembered that the general type of instrument evolved by Mr. Addenbrooke for the purpose in question was shown at the Physical Society in May last, when an alternating wattmeter was the principal feature of his exhibit. But during recent experiments the desirability of what he terms an "electrostatic ammeter" has become increasingly apparent to Mr. Addenbrooke in connection with this system of measurement, what is meant by the term being really an electrostatic voltmeter capable of showing the small fall of potential across a low resistance. For this purpose he has been engaged during the past year in trying to increase the sensitiveness of an electrostatic instrument which can be used either as a simple voltmeter or as an electrometer, and suitable for use with alternating currents. The success obtained was such that in an early stage of the experiments involved, readings as high as 30mm. for one volt difference of potential on a reflecting instrument with the scale at a distance of 2m. were obtained. Later on the sensitiveness was still further improved, readings as high as 80mm. for one volt with an instrument coupled up idiostatically or as a voltmeter having been obtained. With care Mr. Addenbrooke does not despair of this deflection being doubled.

Before the Physical Society in May he stated that his instrument was then about 12 times as sensitive as the types of electrometers usually employed, but as now arranged the instrument is from 200 to 250 times as sensitive as the Mascart type of instrument. Under these circumstances it is possible to detect voltages as low as one-tenth of a volt alternating, and since the capacity of the instrument is of the order of one-hundred-thousandth of a microfarad, an extremely minute quantity or amount of electricity can be detected by its means. Having got so far, Mr. Addenbrooke saw himself within measurable distance of being able to measure the voltage of telephone line currents, an object on which he started working about 15 years ago. Accordingly, a short time since, he coupled up a telephone transmitter to the instrument, and commenced singing sustained notes into the mouthpiece. The first attempt was successful, a good deflection being obtained. The experiments having been since repeated before several well-known engineers, Mr. Addenbrooke feels himself justified in giving publicity to the results. With the usual type of instrument he estimates that the impressed voltage on the circuit when speaking into the transmitter in the ordinary way is between one-quarter and one-half of a volt. This is the average voltage produced on the secondary of the transmitter coil by singing into the transmitter a note of about the same loudness and pitch as the average voice. Knowing the other conditions of the circuit, a number of deductions can readily be made from this fact, but Mr. Addenbrooke prefers to await the results of more careful experiments before generalising further.



A description of the instrument employed may not, however, be out of place here. Fig. 1 is a front elevation of an electrometer embodying the improvements introduced and patented by Mr. Addenbrooke; Fig. 2 is a vertical section of the same; Fig. 3 is a plan of the instrument omitting the legs; Fig. 4 is a plan on the line A B, showing the quadrant plates; Fig. 5 is a half plan taken at the same relative position, but showing a modification of the quadrant plates; Fig. 6 is a sectional elevation through a pair of the quadrant plates shown in Fig. 5, together with the means for supporting the same; Fig. 7 is a sectional elevation of the key used for operating the electrometer; and Fig. 8 is a plan of the same. A glance at these figures will make the constructional details of the instrument sufficiently clear. On the base, *a*,

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four hollow columns of ebonite, b, are mounted, and each adapted to receive a brass rod, c, within, which rod is either turned with an enlarged portion at some part of its length to fit tightly in the bore of its corresponding column, or if turned of the same diameter throughout, each column is bored larger than the rod, except at one portion of its length (conveniently situated at the centre), where it should fit the rod closely. This is done to provide an air insulation for a large proportion of its length between each rod and its column. The exterior of each column is also turned with a series of narrow grooves close together, as shown, also for the purpose of surface insulation, thus preventing leakage. Each rod, c, carries a pair of quadrants. It will be seen that these quadrants are not made in the usual box manner, in which the top and bottom surfaces are fixed rigidly apart, but are made as flat plates capable of adjustment between their contiguous surfaces, and are even adapted for the upper plates, d^1, to be lowered upon the lower ones, d, in order to secure the needle from injury when travelling. The instrument is adapted for use

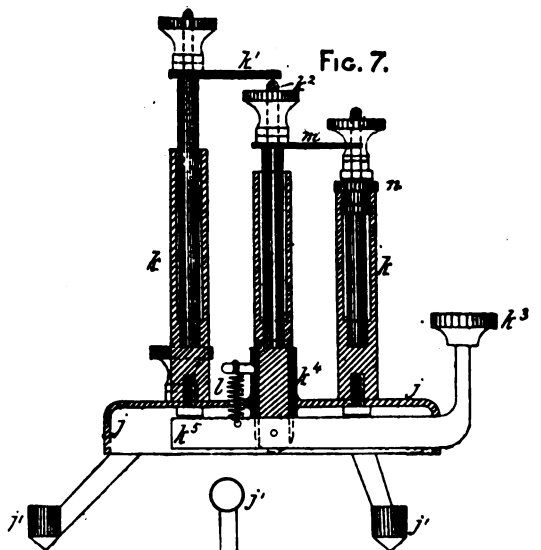

FIG. 7.

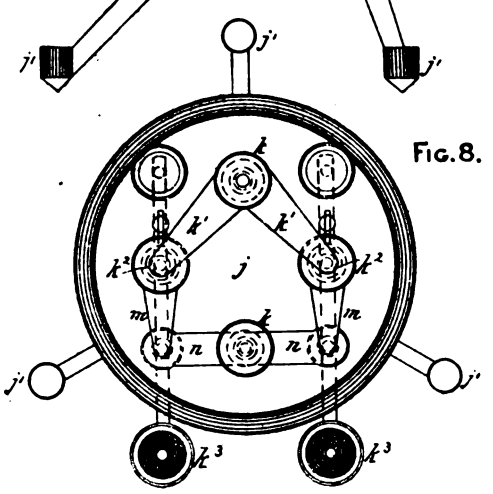

FIG. 8.

for some purposes with the lower quadrants only, the needle being adjustable in relation thereto. By means of a ebonite milled head on the outer end of the spindle, h^4, the latter is turned to rotate the worm-wheel, h^3, thus providing for a rapid circular adjustment of the needle below on a horizontal plane, in addition to the vertical adjustment of the needle through the flat rack rod and pinion, h^2. The needle, i, is made of very thin aluminium. In the central hole of the disc plate, f^1, is fitted an ebonite tube, g, bored and turned with grooves in a similar manner to that already described for the ebonite columns, b, thus giving high insulation to a metal socket, g^1, and long flat rod, h, fitted therein. The flat rod, h, extends above and below the upper and lower ends of the ebonite tube, g, being formed at the top with a knob or terminal, and at the bottom with screw clamping device, h^1, for holding the fine wire or strip used in suspending the needle. The flat rod, h, has also formed a fine rack on one edge, and a pinion with thumb milled head, h^2, engaging with the rack, is adapted for raising and lowering rod, h, in the socket, g^1, and with it the suspension point of the needle. On the disc plate, f^1, is mounted a brass worm-wheel, h^3, which supports and is connected with the ebonite tube, g, and the other devices named for carrying the needle. A bearing block for carrying a spindle, h^4, is secured to the disc plate, f^1, engaging with the teeth of the worm-wheel, h^3. By means of an ebonite milled head on the outer end of the spindle, h^4, the latter is turned to rotate the worm-wheel, h^3, thus providing for a rapid circular adjustment of the needle below on a horizontal plane, in addition to the vertical adjustment of the needle through the flat rack rod, h, and pinion, h^2. A further horizontal adjustment of the suspending portion of the instrument is provided by forming a circular groove in the flange, f^2, of the disc plate, f^1 (Fig. 2), and this being formed as a loosely-fitting cover to the upper case, e^1, three or four thumb-screws, f^3, fitted edgeways in the vertical flange of the top of the case are made to bear upon the flange groove, f^2, and thus by screwing them in and out adjustment of the plate, f^1, is made to accurately centre the needle between the quadrant plates below. The plate, f^1 (Figs. 1 and 2), can be moved on a horizontal plane for adjustment, or entirely taken off to withdraw the needle, if desired. In Fig. 6 the upper plate, d^1, can be lifted against the friction of its supporting rod and swivelled round so as to be clear of the needle. Any change or rearrangement of the needle, or its suspending wire, or mirror, or clamping device, h^1, can thus be attended to readily, and the convenience of manipulating the instrument is further added to by making the lower or main case, e, removable. The needle, i, which, as previously mentioned, is of aluminium, is attached to a light aluminium wire axis. Part of the vertical wire axis is filed flat to receive the mirror, i^1, while the upper end of the wire axis is attached to the suspending fine wire or flattened strip, i^2. With the needle hung, as shown, between the contiguous faces of the lower and upper quadrant plates, d and d^1, placed ½in. apart, coupled up idiostatically, and the electrometer used as a reflecting instrument, with scale 2m. distance, a deflection of 3mm. to 5mm. is obtained, with an E.M.F. of one volt applied to the terminals. The dimensions may be varied to suit the exact purposes for which the instrument is employed, and wire may be used for suspending and electrically connecting the needle to enable it to be charged directly from its highly insulated support, without using a bath of sulphuric acid as hitherto. Consequently the needle can be fully charged when using the electrometer idiostatically or otherwise for measuring alternating currents of high frequency. By making the needle of aluminium, its momentum is so reduced that it comes to rest in a reasonable time without employing any other damping device, while, in addition, the lightness of the needle improves its sensitiveness. In working the instrument any suitable key may be employed, but Mr. Addenbrooke has designed a special form which gives high insulation, and affords facility in manipulation, as shown in Figs. 7 and 8, which are self-explanatory. It might, however, be mentioned that by manipulating the two keys, k^3, separately in conjunction with the side columns, k^2, the latter operate as current reversers, and by a side detent in the flange of the base, j (not shown), the two keys can be independently held in a neural position, no contacts being made at the terminal ends.

BELFAST ELECTRIC LIGHTING.

We have received from Mr. Victor McCowen an interesting summary of the receipts for electrical energy in Belfast for 1899. Mr. McCowen has analysed these most carefully in order to show the influence of the system of charging on the actual quantity of energy sold to consumers.

We give the table in full so that our readers may see for themselves how largely this increase has been fostered by adopting the maximum demand indicator system. In 1898 the current was sold during the first half-year on a discount system, charging 7d. per unit for lighting and 4d. per unit for motor loads, with discounts varying from 2½ to 17 per cent. During the second half of 1898 the maximum demand system was employed, the first 1½ hours' average

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SUMMARY OF ELECTRIC LIGHT RECEIPTS AT BELFAST FOR YEAR ENDING DEC. 31, 1899.

Half-year ending 1899.	Units Sold for: Lighting. At 7d.	At 6d.	At 5d.	At 2d.	Street lighting at 1·3d.	Total units.	£	s.	d.	Motor. At 4d.	At 2½d.	At 1½d.	Total units.	£	s.	d.	Total units.	Current. £	s.	d.	Meter and motor rents. £	s.	d.	Current and meter and motor rents. £	s.	d.
June 30	122,229	29¼	3,392	88,077	—	213,727¼	4,390	2	8	8,349	10,561	11,952	30,862	347	7	5	244,589¼	4,737	10	1	151	1	1	4,887	11	2
Dec. 31	156,286	91	4,695	167,554	6,192	334,818	6,092	14	10	17,151	9,723	16,200	43,079	498	11	11	377,897	6,591	6	9	166	12	8	6,757	19	5
Total for 1899	278,515	120¼	8,087	255,631	6,192	548,545¼	10,482	17	6	25,500	20,289	28,152	73,941	845	19	4	622,486¼	11,328	16	10	316	13	9	11,645	10	7
Total for 1898	256,998¼	137¼	3 986	50,531	—	311,652½	8,003	6	11	28,045¼	14,069	4,760	44,874½	630	0	7	356,526½	8,633	7	6	162	13	3	8,796	0	9
Increase	21,516¾	—	4,101	205,100	6,192	236,892¾	2,479	10	7	—	6,220	23,392	29,006¾	215	18	9	265,959¼	2,695	9	4	164	0	6	2,849	9	10
Decrease	—	17	—	—	—	—	—	—	—	545¼	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Increase per cent.	—	—	—	—	—	76%	31%			—	—	—	65 %	34·2 %			74·5%	31·2 %			95 %			32·4%		

use of the maximum demand for 182 days being charged at 7d. per unit, while all excess current was charged at 2d. per unit. A similar scale was used for the motor load, with 4d. per unit for the first 1½ hours and 1¾d. per unit afterwards. During the past year all current was sold on the maximum demand system, but the average daily supply at the higher rate was reduced to one hour, after which the reduction was given. The scale is, therefore, 7d. per unit for the first hour and 2d. afterwards for lighting, while for the average supply to motors 4d. per unit is charged for the first half-hour and 1¾d. for all energy for these for the first half-year and 1½d. per unit for the second half-year. The result of the alteration in scale has been that while the average price obtained in 1898 was 6·163d. per unit for lighting and 3·369d. for power, the average prices for 1899 were 4·586d. per unit for lighting and 2·746d. for power. In spite of these great reductions, it is interesting to note that the income of the undertaking has gone up by 32 per cent., while the units supplied have increased by nearly 75 per cent. This shows that the consumers have been greatly encouraged to extend their lighting, and that profitable consumers have been secured by the system of charging. We should expect that this increase will be maintained, and trust that the motor load will this year go up considerably.

THE DESIGNING OF ELECTRICAL GENERATING STATIONS.*

BY A. ROBERTS, M.S.A.

The first matter to be considered, which naturally largely affects the design, is the selection of site. In doing this many matters of vital importance to the ultimate economical working have to be considered. It should, if practicable, be near a river, canal, or railway, so that coal may be unloaded direct from the barges or trucks into the coal bunkers, preventing the necessity of cartage, which involves a large extra outlay each year. It should not, if possible, be in the centre of a residential neighbourhood, as this involves many difficulties, such as complaints as to alleged vibration, noise, smoke, condensed steam, etc., in most cases unfounded, but at the same time involving cost to refute. One instance in this respect came under my notice where adjoining owners brought an action for damages in respect of vibration. They stated they had kept careful note of the times when the vibration complained of was extremely bad, and the worst period was when the company in question were able to prove that no engines were running. Another instance was a chimney shaft in the centre of a residential neighbourhood in connection with a generating station, which had been disused for this purpose on account of the company requiring much larger works, the chimney shaft therefore being entirely out of use, and having no flues or boilers connected therewith; notwithstanding this, complaints were made by adjoining owners of the smoke, etc., but in this case, happily, it was not difficult to refute the alleged nuisance. Another consideration in selecting a site is possible actions for damage to ancient lights. Care, of course, is necessary in all cases, but more particularly so in the case of an electric light company, most people thinking that a company of this description with a large capital behind them are "fair game to shoot at," and therefore endeavour to obtain injunctions and other pleasant legal hindrances which are annoying to the architect, who is generally pressed to rush the building up as quickly as possible. One other, and, although last, by no means least important, thing to be considered in selecting a site is space for future extension. In starting, a company usually does not wish to overburden itself with a large capital, and therefore the ground taken is often only sufficient for the building immediately required; in the course of a few years, as the company grows and has to meet a larger demand for supply of current, more generating plant is required and further building becomes necessary, and this then means either having two or more stations with a larger staff required than is concentrated in one station only, or in obtaining statutory powers (in itself an expensive luxury), and the compulsory purchasing of the various interests of adjoining owners and occupiers, when enormous claims have to be met and compensations paid. It is, therefore, false economy in the first place not to acquire a large enough site for all contingencies of extension and growth which may be anticipated for many years to come. Other matters in selecting a site have to be considered, such as the nature of subsoil, facilities for drainage into parish sewers, etc., but as these are common to all building operations and not special to electric light buildings I will make no particular reference to them.

Having considered the questions relating to acquisition of site, the next matter for consideration is the design and

* Abstract of a paper read before the Society of Architects.

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construction of the buildings. In the first place, it is usual for an electrical engineer to decide upon the system of supply to be adopted, and to formulate a scheme and prepare sketch plans showing disposition and space required for machinery, plant, etc. The architect then has to design his buildings to meet the requirements of the engineer, and practically as a shell to cover and protect the engineering plant. The ideas and wishes of the electrical engineer should therefore always be studied and adopted, as the primary function of a building of this description is the supply of current, and not as a testimony of the architect's artistic taste (if he has any). Engineers' architectural ideas, however, as a rule do not run on parallel lines with those of an architect (for instance, Vauxhall Bridge), but the *suaviter in modo* system is far more preferable than endeavouring to force one's own taste and inclinations. The plan of necessity depends to a large extent upon the shape of site, but simplicity and economy of working should be the keynote. It is needless to say that in the London district the buildings must be planned in accordance with the Factory Act and also the London Building Act, the latter, however, having special clauses relating to electrical generating stations, whereby the Council have power to authorise buildings to be erected of greater cubical dimensions than 250,000 cubic feet, and in other respects to exempt such buildings from any of the provisions of the Act if they think fit. The following are the principal departments for which provision must be made in the plan: (1) coal stores; (2) boiler-house; (3) engine-house; (4) workshops; (5) stores; (6) meter and testing rooms; (7) engineers' apartments; (8) offices and also battery rooms, if any batteries are proposed to be erected at the generating station.

Coal Stores.—These should be situated adjoining and readily accessible from the boiler-house. They should be divided into a number of bunkers to obviate danger of fire and for other reasons; one to each pair of boilers is a convenient arrangement, so that a check may be kept upon the consumption per boiler. Generally, however, from contingencies of site the coal bunkers cannot all be placed near the boilers, in which case it is necessary to have a system of iron tip-up trucks running on narrow-gauge rails from the vaults, with turntables at any point where the trucks have to turn at right angles. The doors to bunkers should be of iron, hung to lift with counter-balance weights; the flooring is usually of concrete or blue Staffordshire bricks. Where the coal is shot into bunkers out of carts, it is well to have several removable coal plates and shoots to each bunker rather than one central one, as in the latter case it is difficult to fill the coal bunker to its utmost capacity without trimming the coal, which entails much labour. As to capacity of coal vaults, sufficient coal should be accommodated to supply the boilers for at least three weeks or a month, and, of course, if space be available the greater amount of coal storage capacity the better.

Boiler-House.—A convenient arrangement is for the boiler-house, where practicable, to run parallel with the coal bunkers, also with the engine-house—it is usual to sink the level of the boiler-house floor some 8ft. or 10ft. below that of the engine-house, so that the steam-pipe from the crown of the boilers may be conveniently placed with regard to the engines, also so that coal may be shot down from the ground level into the coal bunkers beneath, the flooring whereof necessarily being at the same level as the boiler-house floor for ease of stoking. The space required in the boiler-house depends upon the type and size of boilers, but there should be at least a space of 16ft. to 18ft. between the boiler and wall opposite firedoor for convenience of stoking, also so that boilers, drums, and tubes may be conveniently removed, swung round, and replaced with new ones, and for this purpose also large doors must be provided for ingress and egress of new and old boilers, as may be required in the course of years. The boiler-house should be lofty, well lighted, and ventilated by a continuous skylight running from end to end of the building, with louvre boarding at the sides, the skylight being glazed with one of the many patent systems of glazing, rather than by the old-fashioned wooden bar. Space must be provided in the boiler-house for further engineering plant, in addition to the boilers, such as feed-water heating and detartarising apparatus, Green's economisers, etc., depending upon the scheme adopted, and particulars of space required for these must be obtained from the engineer when planning the building. Stokers' lavatory and urinals should be provided readily accessible from the boiler-house, also a stokers' messroom with cooking range, etc. With regard to the chimney shaft or shafts, if a single shaft is decided upon, it is best to place it in the centre of the range of boilers, with the horizontal flue running right and left thereof so that boilers may be added as the works grow, and in selecting the position of the shaft future extension must be borne in mind. It is, however, advisable where funds and space permit to have two shafts of smaller capacity rather than one shaft of large capacity, so that in the event of repairs being necessitated through damage from lightning or other causes, one may be shut down whilst the other is working. The area of the shaft should also be amply large enough to provide for all future boilers that may be required, and in the London districts particularly it is advisable to carry up the shafts at least 150ft. to 200ft., so as to distribute the products of combustion at as high a level as possible. The shaft must also, of course, be designed in the London district in accordance with the regulations of the Building Act. I fear it would be wearying, and extend this paper too much, to touch upon the calculations requisite in designing a shaft relating to draught, wind pressure, stability, etc., all of which, however, are of much interest, but I must content myself this evening by making a few general remarks relating to construction only. There is a diversity of opinion as to the best form of chimney, some authorities arguing that a circular chimney is better than a square, but the shape usually adopted for electrical stations, however, is an octagonal form of unequal sides, or, rather, a square chimney with the corners taken off. In calculating the area it must be borne in mind that the actual effective area of a chimney is less than the entire internal superficial area of the shaft, as the velocity of the gases is retarded by friction on the sides of the shaft, and it is usual to take for the effective area the total area less 2in. all round. The horizontal flue conveying the gases from the boilers to the shaft should be of a larger sectional area than the shaft, as these get constricted by deposit of soot, and if entering the shaft from opposite sides a midriff or central division wall should be carried up the centre of the shaft some 15ft. or 20ft., constructed of firebrick. The shaft foundations of necessity are of vital importance, and must be of sufficient area to carry the load, which is usually very great, without sinking into the ground beneath. They should be allowed to stand some months before the brickwork of the superstructure is commenced, as it takes some time for a large body of concrete, 30ft. or 40ft. square by 8ft. or 10ft. deep, to set. The bricks should be specially selected, particularly at the base, to withstand the load, which often amounts to eight or ten tons or more per foot super; they must not, with the exception of the cap and footings, be laid in cement, on account of its unyielding nature, and its not withstanding heat so well as lime mortar, also a shaft built in cement usually cracks. The materials should be frequently tested during the erection of shaft, particularly bricks for crushing strains. An extremely good mortar for shafts which I have used, and which is used largely in the North, is composed of blue lias lime, sharp sand, and foundry ashes, in the proportion of 1 of lime, 1 of sand, and 2 of ashes; the joints should be kept thin, and to prevent the shaft being blown out of the upright before the mortar has set, the brickwork should not be carried up too quickly. A special bond is often adopted for shafts, in which a large number of stretchers are used, as longitudinal tenacity is required to prevent a shaft splitting; for this reason hoop-iron bond, well tarred and sanded, should also be built in at frequent intervals. In selecting the position for a shaft it is preferable that it should stand alone, and not be attached to any buildings. If, however, from necessity of plan it must be in continuation of walls of a building, there should be no bond between the shaft and the wall adjoining, but a

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straight joint to allow the shaft to expand and contract; also it should be built first so that any settlement may take place before walls are built adjoining. The cap should be of simple design, not of too great projection, and little or no stonework employed in its construction, as in the event of this becoming disintegrated by frost it is costly and difficult to repair, and a heavy cap causes the shaft to oscillate in a wind with longer pulsations, and there is more chance of its being overthrown. A cast-iron capping, built up in sections and bolted together, forms to my mind the best finish at the top, and to this the lightning conductor may be readily fixed and stayed. The shaft should be frequently plumbed to ensure a uniform batter, and great care should be taken in its construction to see that no bats are used. A firebrick lining is necessary, which should be carried up according to the height of the shaft some 80ft. to 100ft., the firebricks being laid in fireclay, and usually carried up perpendicularly—*i.e.*, with no batter—with a space averaging about 2in. between the outer wall and the lining. It must have no bond with the outer wall, and to steady it, headers are usually projected through the 2in. space at intervals to touch the lining with sand joints. To prevent soot and cinders falling and blocking up the 2in. cavity, the brickwork of the shaft must be racked out to cover up the cavity at the top, but room must be left to allow the firebrick lining to expand. It is essential in firing a chimney for the first time that heat should not be applied too suddenly, or there is danger of the chimney splitting, so it is well to allow a little heat to pass up for some weeks before it is necessary to use it to its full capacity. Foot irons are usually built into the interior of the shaft from base to cap to afford access for repairs, etc., and in most electric generating shafts the exhaust steam-pipe is carried up the centre of the shaft, and the stays to keep same upright must not be bonded into the firebrick lining or main walls, but should rest on the offsets where the brickwork is reduced in thickness to allow the exhaust pipe to expand and contract. As this exhaust pipe and the heated column of steam inside forms the readiest path for a flash of lightning, it must be carefully earthed and connected up to the lightning conductor.

Engine-House.—This, as I before said, should be parallel, if possible, with boiler-house, so that steam-pipes from boilers are as short as possible, and may be carried direct through the wall separating same to engines; its dimensions, of course, depend upon the number of engines and type proposed, and here the engineer must again be consulted. It must provide accommodation not only for the engines and dynamos, but for switchboards, and should also either contain engineers' messroom and lavatory or have same conveniently adjoining. It should be lofty, well lighted, and ventilated by either skylights or ranges of windows so planned that through ventilation may be obtained, as it is essential not only for the personal comfort of the staff, but also for the plant, that the temperature should not be too high. Cleanliness is of extreme importance in the engine-house, as dry gritty particles in the atmosphere, or blowing about in the wind, would shortly do irreparable damage to the bearings of the machinery, revolving at such high speeds as it does. For this reason, therefore, it is usual to face the walls (and where stores and other departments are over the engine-house, the ceiling also) with glazed bricks, which are cleanly and reflect the light, ensuring a bright engine-house. These may also be easily wiped down, and therefore save the annual cost of distempering or painting the wall surfaces that would otherwise be necessary. Window frames in the engine and boiler house should be of steel or iron rather than wood, as the unavoidably high temperature causes the latter to shrink and wind, and the former are also more fireproof. An overhead traveller is essential in an engine-house for erection and removal of engines, dynamos, etc., and corbels should be built in the walls as the works proceed, or some provision made for carrying rails thereof upon which it travels. The flooring of engine-house must receive careful consideration. It should be carried entirely independently of the engine-beds, so that the vibration set up by the engines may not be transmitted thereby; and it should be paved with some cleanly, insulating material—if possible, non-slipping. Wood block flooring soon gets greasy and unsightly, and the best material I have found so far is unglazed red tiling, although this has the objection of not being a good insulating material. The engine-beds are usually constructed of a continuous block of concrete (not separate beds for each engine), which is carried down 6ft. or 8ft., and carefully constructed and planned, so that vibration shall not be transmitted to the ground beneath, many methods having been tried successfully, and otherwise, to prevent the transmission of vibration. That adopted at the Chelsea station, which has proved very satisfactory, is to first construct a foundation of concrete 9in. deep; on this sheet lead is placed, then two layers of continuous matting similar to an ordinary doormat, but very much thicker; on this lead sheeting is again laid, and on these insulating layers the concrete superstructure of the engine bed, about 7ft. deep, is erected. The position of the holding-down bolts for the engines must be ascertained, boxes constructed and accurately placed in the right position before the concrete is shot into the beds, so that after the concrete has set the wooden boxes may be taken out and the holding-down bolts, with anchor plates attached at the bottom, may be let into the cavities thus formed, and grouted in with fine concrete and cement. Switchboards should be constructed of some fireproof material, slate slab in timber framing being one of the best forms of construction. The switchboards should be raised one step above the engine-house floor-level on a continuous platform, so as to isolate the switches and enable the operator working same to have a good view of engine and dynamos. Indiarubber mats are provided to stand on when operating the switches. A convenient office should be arranged, if practicable, for the electrical engineer in charge, with a window looking into and commanding the working of the engine-house.

Workshops.—These must be provided for carpenters, engineers, and fitters, etc., with lavatories, messroom, and office for foreman, the floor space for these depending upon the size of the works, and there is little in the construction of these of special interest.

Stores.—These are an essential department of an electrical station. They should be conveniently situated near the workshops; also, if on the upper floors, lifts and hoists must be provided in connection with same. Racks are requisite for the various articles stored, and an office for storekeeper at the entrance. The stores generally, like the whole of the building, should be of fireproof construction, and a special store, provided with iron doors, for oil. In calculating the strains and stresses in steel construction carrying floors of stores, it is well to err on the side of excess, as the loads carried are usually very great.

Meter and Testing Rooms.—These have nothing special to call for remark. Stoves should be provided here for warming purposes and benches for storing meters, testing, etc.

Engineers' Apartments.—These apartments should be situated naturally with the best outlook, and if over the engine-house, made sound, as well as fireproof as far as possible. The accommodation required, of course, depends on the number of the staff.

Offices.—The offices are often situated away from the generating station, and must provide accommodation for secretary and staff, chief engineer and staff, draughtsmen's rooms, and Board-rooms, and have nothing special to call for note. Battery-rooms must be well ventilated to allow of the escape of gases, and the floors should be of cement or acid-proof asphalte, with channels therein to carry off contents of the cells if they should get broken. Accommodation must be provided on the roof, in some convenient and accessible position, for water-tanks, as a large storage of water is essential, so that in the event of burst mains or other causes preventing supply no inconvenience is occasioned.

With regard to construction generally, an electrical generating station should be substantial, and of fire-resisting materials, as it is of extreme importance to prevent fire, not only on account of the damage done to works, but as a fire would damage plant and prevent the supply of current, which is a most serious matter. Also the premiums charged by insurance companies for electrical buildings are extremely high in any case, and would

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be more so unless the building throughout was of a fireproof nature. A system of fire hydrants should be fitted throughout the building, and in most electrical stations the staff are exercised in fire drill. All walls (at any rate, those of engine-house) should be carried down to same level as foundations of engine-beds, and a clear space should be left all round the building between external walls and those of adjoining buildings to prevent transmission of any vibration.

There are many other points in the planning and construction of electrical generating stations that require consideration, but I hope to have given some general idea of the special matters to be thought of, which may prove of interest.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the Institution meeting yesterday week, before the adjourned discussion on the Swiss visit report, Prof. THOMPSON said that he regretted that there was a sorrowful duty thrust upon him by the loss which the Institution had sustained by the death of Prof. Hughes. He felt a deep sense of personal loss, as he was always in contact with the deceased gentleman. Prof. Hughes was one who never missed a Council meeting, and was an earnest and sincere worker. He need not recount the claims put upon them by the name of Prof. Hughes, as his fame was world wide. Starting with the printing telegraph, which brought him honours and recognition from nearly every government and postal authority except our own, he invented the microphone, synometer, and induction and magnetic balances. He also managed to send signals over 200 yards without wires, and his arrangements were very similar to those of the system now so widely known. His inventions placed him in the first rank of the pioneers of electric work. Some years ago Prof. Hughes gave an address to the Institution which had the effect of increasing the research in the direction of induction. Since then he had read a paper on the "Faults of Oil Insulation." The President moved a vote of sincere sympathy with Mrs. Hughes.

Major-General WEBBER, in seconding the motion, said that many of the members of the Institution would remember the way in which Prof. Hughes had given them the results connected with his own inventions. He remembered him when at college in Berlin in 1866, and the professor was at that time teaching the telegraph staff at Berlin the use of his telegraphic machines.

The motion, on being put, was carried unanimously by all the members rising in their places.

The PRESIDENT gave notice of the arrangements for the funeral at Highgate Cemetery, and said that Mrs. Hughes would wish them to be represented at the ceremony.

The SECRETARY then read the names of the gentlemen who had been elected officers and committees of the local sections of the Institution in Dublin and Glasgow. At Dublin the chairman was Prof. G. F. Fitzgerald, and the vice-chairman Colonel C. F. C. Beresford, R.E. The committee included Prof. W. F. Barrett, Messrs. C. P. C. Cummins, R. Humphries, M. C. Olsson, G. F. Pilditch, A. E. Porte, M. Ruddle, and P. S. Sheardon; the hon. secretary being Mr. F. Gill. At Glasgow the chairman was the Right Hon. Lord Kelvin, and the vice-chairman Prof. Magnus Maclean. The committee was composed of Prof. A. Jamieson, Messrs. W. A. Chamen, W. W. Lackie, H. A. Mavor, J. M. M. Munro, W. B. Sayers, F. Teague, and J. Young; Prof. W. H. Watkinson acting as hon. secretary for this section.

Mr. S. Z. DE FERRANTI, in reopening the discussion on the Swiss visit report, said that the principal thing which struck him with regard to that visit was the great facility for doing all sorts of electrical work on a large scale in Switzerland. It was not merely the fact of their having the advantage of a large water power available, but the customs of the country enabled the people or groups of people to carry out work most useful to the country in the way of development. That was, he thought, the most important thing he had found there, and it impressed him more than the installations he saw. He regretted that in this country there did not seem to be that desire for progress. The whole tendency in Switzerland seemed to be for everybody to help everybody else to make improvements, but here there was great obstruction experienced, and the country at large suffered very much from this terrible obstruction. Thus they had seen Switzerland more ahead in some ways than England. The question was not, he thought, a question of the comparative cost of coal and water power, but of the general obstruction to everything new experienced in this country. With regard to some of the details of the work they saw, he was very much impressed with the complication of the work on some of the installations, such as that used for the Burgdorf-Thun Railway. The generating arrangements, no doubt, were very nice, but upstairs there was a regular chamber of horrors. The switching on and off was a very momentous problem. The greatest defect in the systems they saw was the complication which was found there. At Manchester very recently he had spoken of the complications found at a place like Glasgow. This was done to save copper, but in order to do this, a great mass of very complicated machinery was required. He did not say it was a bad thing, but still it was very complicated. If it was possible to reduce the complication and expense and simplify the matter, they would be in a much better position to distribute electrical energy over large areas.

Mr. E. KILBURN SCOTT then spoke, and illustrated his remarks with views on the lantern screen. The first slide showed a locomotive on the Jungfrau railway and a portion of the track. The speaker pointed out that on each side of the locomotive were four brake drums, and on either side of these four brake drums were four grooves into which brake blocks fitted tightly. Another slide showed the motor fitted on the truck, which was used to force air through the resistance coil fixed immediately above it. He then showed the resistance in position. Views of the brake gear were shown, the speaker explaining that the brake was of cast iron lined with copper. He pointed out also the tachometer gear by which the driver could see the speed of the rotor. The weight which switched in the rotor resistances was also mentioned, and a view of a complete locomotive shown. This locomotive was said to weigh 17 tons, and was of 200 h.p. with a motor speed of 500 revolutions. The connections were then illustrated by diagrams, and the speaker stated that in the Brown-Boveri type of locomotive there was one resistance for both motors, but in the type just shown there were separate resistances for each motor. A drill for rock boring was then illustrated. This drill was stated to drill out 2mm. of rock per revolution, and it would drill a hole a metre deep in 10 minutes. The rock, however, was very favourable for the work.

Mr. M. B. FIELD said that Mr. Crompton expressed his surprise at the simplicity of the construction of the overhead line. The simplification was effected very easily by the use of a separate stirrup. He then sketched a diagram of a line on which the use of this stirrup was shown. This was so arranged that when a car was crossing a point, it would just clear the line. When it was in this position the current was only flowing through one wire, and the motor would run as a single-phase motor for the time. This was got over by the use of two stirrups one behind the other, so that the current was collected by the one behind while the forward stirrup was lifted. With this method it was almost impossible to get a short-circuit, and the device worked extremely well. Some engineers, after visiting Switzerland, were too apt to jump to the conclusion that English roads would be better if equipped with three-phase motors, because these avoided the use of rotary converters, without considering the great dissimilarity between Switzerland and England. The different characteristics of different districts determined which type of motor was best suited. Thus there was one region where three-phase motors should be used, and another, series motors. No one would question the advisability of putting series motors on lines like those at Liverpool and Leeds, where the lines were small, and where everything was in favour of the continuous current. When they came to mountain railways, they had to admit

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the claims of three-phase motors. On these railways the generating station was often miles from the line, and the sub-stations often right up on the hillside, perhaps half covered in snow. In this case transformers were necessary. The stations were far apart, and a constant speed was desirable. In fact, it was looked upon as advantageous to have a constant speed, as it stopped any tendency to panic amongst the passengers if the motorman could not increase his speed, say, on a 25 per cent. down grade. This was the region where the claims of the three-phase motor were paramount. When, however, they came to systems like the Central London and the Middlesbrough, in view of the variable speed required, continuous-current motors with series-parallel controllers were wanted. Taking the Central London Railway, which had a total length of about six miles and 13 stations, an average speed of 14 miles was to be maintained, while the maximum possible speed of the motor was 40 miles. Consequently an enormous amount of power had to be wasted in the motor resistances. Comparing this with the case of the three-phase railway, where there were not many stops and getting an almost constant velocity, would give them an idea of the lost and used power in the two cases. Before jumping to the conclusion that the three-phase system was the best even for the Burgdorf-Thun Railway, they should consider the problem before Messrs. Brown, Boveri, and Co. While with three-phase motors they were not behind any other firm in the world, they knew practically nothing of small series motors. On the one hand, they were nearly certain of success with three-phase motors, and, on the other hand, to have used series motors would have been quite in the nature of an experiment with them. Before the matter could be properly discussed, however, a Board of Trade report, giving the costs, etc., per ton-mile for different systems, was wanted.

Mr. A. E LEVIN said that at the last meeting Mr. Hammond had suggested that a few details as to the cost per kilowatt-hour would be of interest. It was difficult to give these with regard to lighting circuits, but the charge for motors was made according to a graduated scale for large or small motors. For small motors £8 to £10 per brake horse-power installed per annum was the average, and for large motors £6 or £7 per brake horse-power. These prices were based on factory use, or about 3,000 hours per year. The fair average was about ½d. per brake horse-power hour. This brake horse-power would approximately correspond to about one kilowatt-hour in the power-house. In a certain calcium carbide works a charge of £2. 8s. was made per brake horse-power per annum, but this was an exceptional case. As to the great impression produced by the three-phase work, he agreed with Mr. Field that a much too great point had been made of this three-phase work. The system had been worked up and improved to suit the conditions found in Switzerland, but it was open to many objections. The most important difference between the two systems which had been mentioned was their behaviour at reduced pressures. A continuous-current motor would run at a slower speed, but it made no difference to its torque if the pressure were reduced. A three-phase motor was limited, however, by its torque, which failed in proportion to the terminal voltage. They must also take into account that the drop of voltage must not at any one time be very heavy, or the three-phase motors could not do their work, and it might be necessary, in order that this might not happen, that a large amount of copper should be used. With series-parallel motors, however, these would run while there was any voltage on the line, even if going but slowly. As to the capacity of the motors, he thought a continuous-current motor might be built for 750 volts as well as a three-phase motor. There was, in view of the Board of Trade requirements, no reason why on interurban lines motors should not run at a high speed at 750 volts, while within city limits they could run at 500 volts at a slower speed.

Mr. A. P. TROTTER said he was surprised to hear in the previous discussion mention made of three-phase traction on the Central London Railway. Those who had studied questions connected with that and similar railways saw of what enormous importance speed was. He thought it would want considerable explanation to show how three-phase motors could be used economically on the Central London Railway. The three-phase work at Burgdorf was a splendid piece of work, but the question of economy was not of much importance in that case. Mr. Ferranti had spoken also of the enormous complication of the switching work, and the lantern slides had shown what a tremendous handicap in this direction the engineers in Switzerland had to struggle against. He thought there was room for considerable simplification in the motor work and switch gear.

Mr. G. L. ADDENBROOKE said there were one or two points brought forward at the last meeting which he might comment upon. Mr. Swinburne spoke of the development of electricity in Germany and Switzerland in comparison with this country. It was a curious fact that although the large proportion of the lighting in Germany was done by municipalities, it had been done in such a way as to strengthen the electrical industry, while in this country municipal action had the opposite effect on the industry. In Germany the contract was usually let to one large firm, with an arrangement for running the installation for a series of years. These firms were financed by the banks, and the method had been successful. They had succeeded much better than the English. It was also easier to get electrical projects carried through. He hoped something would be done soon to enable England to be placed on an equal footing with Germany. As to the Swiss water power being represented here by steam, the two things were not quite the same. It was advantageous to the Swiss to utilise their water power, but the question in England was whether we could replace isolated steam-engines with power generated in a large power station. As Mr. Hammond said, the cost of coal per unit was small, and the question seemed to be one of capital cost.

Mr. L. GASTER said he thought the technical institutes had been of great help to the electrical industry in Switzerland. The student could there learn cheaply and well. This, he thought, accounted for the ordinary engineers being well up in their work. Diplomas were also to be given for technical subjects, and no doubt they would soon have "Doctors of Electrical Engineering." He wished to say that he was favoured in that he had experienced English hospitality, and that he knew the English as they were, and not as they were represented in certain Continental gutter journals. He was sure if the Swiss engineers came over here they would receive a warm welcome.

Mr. W. M. MORDEY said that, as a member of the Swiss Visit Committee, he wished to say that practically the whole of the work was done by the President, assisted by his able lieutenant, Mr. McMillan. On this visit they saw a great deal that was worth studying, and they would all watch with great interest the future development of what they had seen. One of their lessons was that they had to look to Switzerland rather than to America for future guidance. He thought the Americans seemed to have one fixed idea, and that was to sell what happened to be the American standard-pattern machines at the time. The English were still under the American influence. They were forced to take American machinery because their manufacturers were not able to produce the apparatus required by the English market. His own opinion as to Swiss practice agreed with that of Mr. Ferranti, in that there was too much complication. A great deal of the space used might be saved if the plant were simplified. A great advantage in Switzerland, however, was that practical men ran the business, and they were not under the direction of directors who had not had a technical education. People asked why the banks in Germany supported the manufacturers. It was because they knew them to be good men and true, and not under the control of directors with interests entirely different to those of the banks. Another thing which the visitors saw, also, was how well electrical engineers got on with a minimum of control by the authorities. It was also noticed that the scientific institutions did not hamper the engineers' efforts. The former helped the electricians, instead of stopping them owing to scientific instruments being disturbed. If the lines affected the instruments, the latter were shielded.

Prof. PERRY here said that there was one thing which they could not shield—namely, terrestrial magnetism.

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Mr. MORDEY said that if people wanted to measure terrestrial or other magnetism the observatories should be taken to a place like the Highlands of Scotland, and not put down in the midst of a growing community. Scientific measurements should not be allowed to interfere with useful industrial projects. As to the use of the three-phase system on the Central London Railway, the engineers had to put down something which would work, and not make an experiment. The plans for the Central London Railway had been prepared for some years, and the Burgdorf-Thun had not been running many months. They were grateful to their Swiss hosts, and those who did not go to Switzerland had missed a great deal. In this connection he would quote the words of Byron:

"How much a fool who has been to Rome
Excels the fool who has stopped at home."

Mr. COWPER COLES then read his paper on "An Electrolytic Centrifugal Process for the Production of Copper Tubes."

The PRESIDENT announced that the next meeting would take place on Feb. 8, when a paper by Mr. R. P. Sellon, on "Standardisation of Electrical Engineering Plant," would be read.

The following is a list of the candidates balloted for at the meeting:

Members.—C. A. Burge, 97, Leinster-road, Rathmines, Ireland; G. Cheetham, Shubra, Balmoral, Belfast, Ireland; J. Macintyre, M.B., M.Ch., F.R.S.E., etc., Royal Infirmary, Glasgow; H. S. Russell, B.Sc., Summerfield, Wallington, Surrey; J. J. Steinitz, Surrey House, Victoria-embankment, W.C.

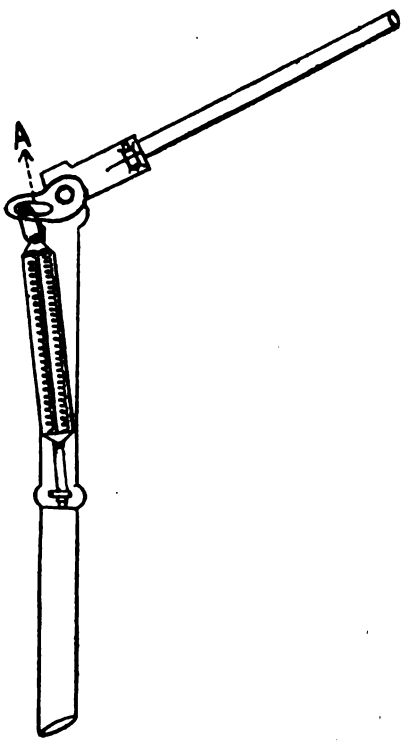
Associate Members.—Captain C. W. Davy, R.E., 28, Newgate-street, E.C.; H. F. D. Jacob, 14, Old Court House-street, Calcutta; Lieutenant G. S. Knox, R.E., Ordnance Survey Office, Ennis; J. McCaffery, Westminster Electric Supply Corporation, Davies-street, W.; J. E. D. Neale, 36, Moore-street, Cadogan-gardens, S.W.; J. J. Smith, 7, Seybourne-terrace, Yarm-lane, Stockton-on-Tees; C. E. Williams, 145, Dulwich-road, Herne Hill, S.E.

Associates.—W. H. Ashman, 18, Stewart-street, Auburn, Victoria; E. A. Barker, Electric Light Station, Barnsley; R. L. Bendall, Trescoe, Wootton-gardens, Bournemouth; R. G. Botting, 14, Mount-street, Aberdeen, N.B.; J. E. Dawson, 3, Gloucester-terrace, Armley-road, Leeds; W. B. Edmunds, City Power Station, Osborn-street, Hull; A. M'A. Fyfe, 19, York-place, Perth, N.B.; E. Garton, 39, Josephine-avenue, Brixton Hill, S.W.; J. B. Gibbons, 103, Gloucester-road, S.W.; D. Henriques, Postal Telegraphs, Aldborough House, Dublin; J. M. Hincks, Brantwood, Brook-lane, Chester; A. T. Kinsey, Engineer-in-Chief's Department, G.P.O., E.C.; H. I. Lewenz, 33, Belsize-avenue, N.W.; S. L. Macfarlane, 17, Lawrence-street, Glasgow, N.B.; W. N. Price, 100, Bothwell-street, Glasgow, N.B.; F. W. Rayner, 58, Canbury-avenue, Kingston-on-Thames; A. E. Salisbury, Limbrick Hall, Harpenden, Herts; H. Sandwith, 3, Albany-mansions, Battersea Park, S.W.; S. G. Starling, Municipal Technical Institute, West Ham E.; G. Stannage, Postal Telegraphs, Aldborough House, Dublin; R. M. Wilson, Westwood, Brownside-avenue, Cambuslang, Scotland.

Students.—H. L. Brooke, 46, Claremont-road, Highgate; M. A. Codd, 5, Roxborough-park, Harrow; E. S. Conradi, 131, Brecknock-road, N.; E. S. Lance, 13, Gresley-road, Whitehall Park, N; J. B. Langford, 19, York-road, Erdington, Birmingham; J. Milton, Brymore, 52, East Park-parade, Northampton; C. Stewart, 71, Wood-lane, Treeton, Rotherham, Yorkshire; H. D. Symons, 12, Loraine road, Holloway, N.; C. F. Thatcher, Harbour View, Cork, Ireland; A. I. Tracey, Electrical Engineering Department, Northern Polytechnic Institute, Holloway, N.; R. H. Waite, 47, East Mount-road, York; J. Warrack, 44, Dalmarnock-road, Glasgow, N.B.

A TROLLEY SAFEGUARD.

The following arrangement has been devised by Mr. R. Humphries, of Ballsbridge, Dublin, to prevent a trolley damaging the overhead construction when it leaves the trolley wire. The illustration shows the position of the trolley pole under running conditions, and with the trolley wheel on the wire. When the trolley leaves the wire from any cause, the catch which holds the springs in position at the far end of the slot, A, is lifted automatically by a releaser fixed to the back of trolley stand. The springs (running on a steel roller) immediately close in to the end of the slot nearest the pivot, and the trolley falls into a position 2ft. or 3ft. below the wire. All that is necessary to replace the trolley in position is to push up the pole until the springs roll back into their original position, where they are caught and held automatically by the catch. The releaser (which is hinged) is then pushed up, and the car again started. The inventor claims that the whole operation can be performed easily in two minutes, which seems to us to be much too long for a car to be kept waiting. With this device the trolley rope can be tied up to pole out of the way of passengers and accidental pulling and catching.



The overhead construction is safeguarded by this device, which acts instantaneously. In the lower position we understand that the weight of the trolley pole is balanced by the spring, so that it can be pushed up again by hand until a point is reached at which the roller moves the point of the spring attachment out to the limit of the slot. Further drawings are required to make this replacing action clear, and to show how the trolley is prevented from dropping down on to the passengers' heads when the release takes place.

DYNAMO TESTING.

An ordinary meeting of the Glasgow Technical College Scientific Society was held on Saturday last. The president, Mr. David Home Morton, M.I.C.E, M.I.M.E, occupied the chair. A paper on "Dynamo Testing" was read by Mr. Norman Charles Woodfin. The lecturer dealt first with the equipment of the testroom, in which there should be a shaft running about 200 revolutions per minute, with pulleys 2ft., 4ft., and 6ft. in diameter, for testing belt-driven machines; this shaft could be driven off the shop shafting or by a separate engine, the latter course being preferable. For testing steam dynamos a few lengths of flexible steam-pipes were necessary. A battery of secondary cells capable of giving 120 amperes for four hours would be useful for separately exciting the field magnets and for testing small motors. Speaking of instruments, Mr. Woodfin said that a Wheatstone bridge and D'Arsonval galvanometer and a box of comparatively low resistances would prove useful, together with several ammeters of good type, ampere-meters of the following size being suggested: one each of 60, 100, 150, 300, 500 amperes, with a pretty clear scale about the figures just mentioned. Two voltmeters and two speed counters would, with three reliable thermometers, complete the equipment. An ohmmeter and generator would, however, prove very useful for rapid tests, though their accuracy was not always to be depended upon to the same extent as the instruments already mentioned.

The lecturer then proceeded to detail the various

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methods adopted in testing, and with the determination of hysteresis, eddy-current, and other losses. Examples of results on various types of machines were given, together with instances of some rapid tests for total efficiency, etc.

Proceeding to speak of the treatment given to electrical apparatus in engineering works and shipbuilding yards, Mr. Woodfin gave some interesting information of the faults developed under very adverse conditions of service.

At the close of an interesting discussion, during which Prof. Magnus Maclean, M.A., D.Sc., gave some useful information on the testing of low-resistance armatures, Mr. Woodfin was awarded a hearty vote of thanks for his valuable paper.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be in *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

Questions.

241. If a supply company charged its consumers 2d. per unit in the daytime and 6d. per unit at night, would it pay large consumers to charge a battery of accumulators from the supply mains in the daytime and use these accumulators for their own lighting at night?—J. C. R.

242. How is the efficiency of a live steam injector for boiler-feed purposes determined? Give results of tests if possible.—J. G.

Answers.

Question No. 235.—I have a bar drum armature which gives off 400 amperes 110 volts. After a 12 hours' run the temperature rise was 50deg. F. The other night the load was 300 amperes for only six hours; upon stopping, the temperature rise was found to be 155deg. F. There had been no sparking during the run. The electrician found, upon testing, nothing wrong, except that one or two connections were discoloured; he remade these joints, and since then the machine has run as well as ever. Account for this phenomenon.

Best Answer to No. 235 (*awarded* 10*s.*).—The fact of the dynamo having for some time run without any excessive rise in temperature shows that the armature is wound with a wire of sufficient cross-sectional area; hence if on one occasion the temperature rise was of the nature indicated in the question, it is apparent that some fault must have developed either in the machine or the external circuit. If a double earth had developed in the outer circuit the machine would have to give a much greater output, but this would be shown by the ammeter, unless the double earth had occurred between the machine and the ammeter; or provided the instrument was in the positive main, a leak on the positive brush lead, and also on the negative external main, would, for the leakage current, cut out the ammeter. This might possibly be the cause, but as the question states that upon testing no fault was found, this is hardly likely; we must therefore look for the cause in the machine itself.

A short-circuit in the armature would cause such excessive heating in the faulty coils that they would burn out, and so at once show themselves. Supposing, however, one connection was broken, one side of the armature would have to carry double current, and so would generate greater heat, and this heat would be spread equally over all the armature, as the coils forming the current-bearing half would be rapidly altering, one being dropped and a new one taking its place, until all the coils, with the exception of the broken one, had been in this half. Against this theory is, however, the fact that no sparking was discernible, and an armature with a broken coil will spark every time the commutator segment connected to the broken coil passes under the brush, as the current is then transferred to the other half of the armature. Let us assume that the resistance of either half of the armature is ·001 ohm, and, further, let us assume that owing to an imperfect connection in one joint there is a resistance equal, say, to one ohm, then the resistances of the two halves will be ·001 ohm and 1·001 ohms respectively, or one side will carry a thousand times more current than the other. In this case there will be, with 250 amperes, practically one side carrying all the current, but there will be no sparking, as the current will not be broken immediately, but the increased resistance will act as a damper, and owing to its presence the majority of the current will change to the other side, while the coil is under the brush.

The result, then, of such a bad joint will be that the armature will get very hot all over, but more especially at the point of bad contact, which will heat sufficiently to get discoloured. As this is exactly what the question states did occur, it may be assumed that this is the true solution. Probably two of the joints were dirty, or imperfectly made, and had heated from the commencement, but had not been noticed. Gradually the solder had, owing to this heat, melted away, until the joint had become most imperfect with a very high resistance. The fact that the making of these joints again cured the fault helps to prove this reasoning.—F. J. A. M.

Answer to No. 235 (*awarded* 5*s.*).—As far as can be gathered from the limited amount of data given in question, the most feasible explanation of the abnormal rise in temperature is that a temporary short-circuit occurred between one or two conductors which had only a slight difference of potential between them. There are one or two other possible but less likely faults that might give the same results. These can be dealt with later. The above-mentioned condition of affairs seems the most likely, for the following reasons: (1) It is stated that one or two connections only were discoloured; this points to these having had an excessive current passing through them. (2) There had been no sparking during the run; this is quite possible under these conditions. If the machine is well designed with a good brush-shifting range, the short might not disturb the field sufficiently to cause sparking at first, although it is probable that if the same conditions had continued, flats would have gradually developed, with consequent sparking. The writer has seen a machine with three adjacent commutator segments shorted under collar, while for three weeks the only indication of anything wrong was the excessive heating of commutator; after this period, however, flats began to develop.

As to the probable cause and locality of the short, the likely places would be either the commutator or the butterfly (or equivalent type) end connections. The possibility of the first of these being in fault depends a good deal on the construction of the commutator. The type of machines that have an air-space under segments admit of loose bits of solder, etc., getting in and bridging across undersides of the commutator bars; if solder, it might roll or revolve with the commutator until the temperature rose sufficiently to allow it to stick, when it would form a short until it fused, then the fault would disappear. The other likely place to look for the fault would be at the end connections. The sketch shown in Fig. 1 points to it not being a difficult matter to obtain a short in these parts, for although the butterfly pieces, which are packed rather closely, are insulated up to the end connections, B B, a slight mechanical injury due to careless lifting of the armature or a like cause might make a temporary or permanent fault. When looking for this fault, however, it would save time to remember that in this case it could not be between any bars of appreciable potential difference, otherwise a burn-out would have occurred. Again, solder or any piece of metallic substance falling in the tangle of end connections might give the same result.

Turning now to the less likely explanations of the phenomena: (1) It is possible that if the armature has a bad earth somewhere on winding, and that on the particular run in question a point in the outside circuit was put to earth by a mischance, then a current, the magnitude

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of which would depend on the resistances of the two faults, would flow, and (if ammeter was on opposite pole to external fault) would not be registered (see Fig. 2). In such a case sparking would probably occur at each revolution, but in certain exceptional cases might not do so; beating would cease with removal of external fault. (2) It

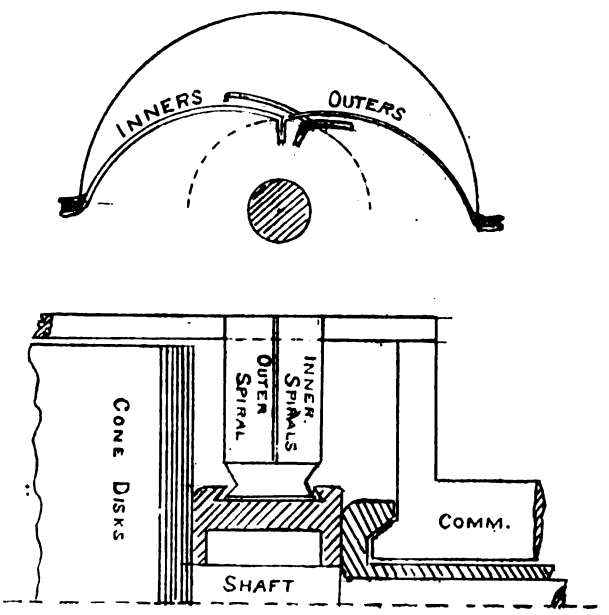

FIG. 1.

is not stated whether the machine has two or four poles; if four-pole, a satisfactory explanation could be given if sets of brushes were not equidistant, for then one set of, say, + brushes might be at a potential higher by the fraction of a volt than the other + set, in which case heavy local

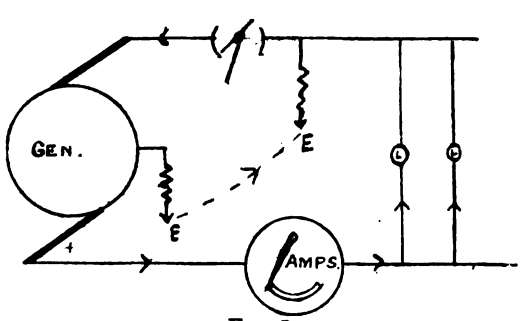

FIG. 2.

currents might pass with consequent heating. (3) One of the brush-holders might be earthed, in which case, if a temporary fault occurred on the main of opposite sign, it would be possible for a heavy current to flow without being registered; this might be sufficient to account for the overheating (see Fig. 3).

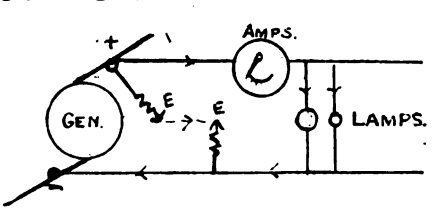

FIG 3

The objection to these latter explanations (at least 1 and 3) is that the machine being overloaded would show it either by slowing up of motor, drop of volts, or external heating; but as it is not stated whether or no anything of this sort was noticed, the above is put down for what it is worth.—L. M.

Question No. 236.—In a smooth-core two-pole drum armature what advantage is gained from the lamination of the copper conductors? Give figures, and state if the same apply to the conductor in slot-wound armatures.

Best Answer to No. 236 (*awarded* 10*s.*).—The advantage of the lamination mentioned in the question is that it permits very much larger dynamos to be built than would be the case if solid conductors were used. This may seem a strong statement, but it is actually the case. Single copper bars of a greater width than 0·2in. are quite inadmissible in a dynamo. Unless such a conductor were made very high it would not carry much current; and if it were made high, then the air-gap would be tremendously increased, and the machine would require enormous magnet coils.

Assume that a wide conductor is used—much wider than 0·2in.—and consider what happens. Imagine that the conductor is just entering the field, and that it is as shown in Fig. 1. The edge A is already in the main field of the machine, while the edge B is still in the stray field, which is much weaker, or ought to be. Evidently, then, A is

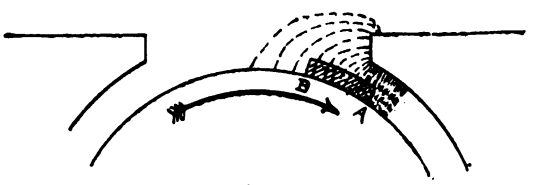

FIG. 1.

cutting lines of force much quicker than B, and therefore a very much greater E.M.F. is induced in A than in B. This is shown diagrammatically in Fig. 2, where the long thick arrow shows a large E.M.F., and the short thin arrow shows a small E.M.F. The greatest difference of E.M.F. will be between these two outside layers. But evidently differences will exist all over, as the E.M.F. diminishes gradually from A A′ to B B′.

Consider the case where the machine is running on open circuit, but with excited field—say, a shunt machine. Then the armature current is equal to the shunt current, and is very small. In this case we have these E.M.F.'s set up practically in a conductor in which a negligibly small current is flowing. The result is that they can set up a current on their own account. The difference of E.M.F. may be very small, but the resistance of the possible circuit is comparatively much smaller, and so a very large current

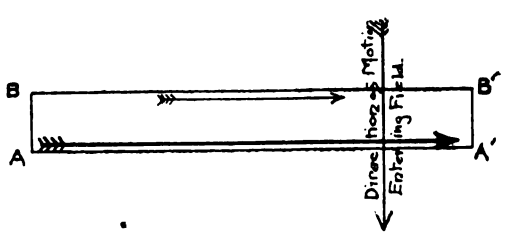

FIG. 2.

flows in the direction indicated by the longer arrow—*i.e.*, A A′ B′ B. The heat produced by this current is, as usual, C^2R, and although R is small, C is large, and C^2 much larger, so that evidently a very considerable amount of heat comes in question. And, as already mentioned, the heating is so great that it is practically impossible to build armatures with strips of greater width than about 0·2in. The evil may be mitigated by setting the pole-edges "skew" to the axis. Then the conductors enter the field more gradually.

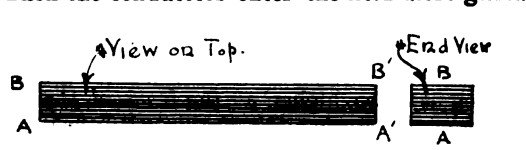

FIG. 3.

Or the field at the pole-tip may be "shaded off" by rounding the edges well and boring the magnets slightly oval, so that a greater air-gap comes where the field ends. But these are only makeshifts, and the solution of the problem is to use several thin conductors in parallel—*i.e.*, to laminate the bar, making the laminations as shown in Fig. 3. The insulation need not be high, because the E.M.F. in question is so small; but the number of laminations should be as large as possible, consistent with avoiding waste of space through insulation. The laminations are insulated from one another, generally with paper, throughout their length, except for a space at each end, where the end connections and commutator joints come. Here they are all sweated

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together, and make a solid end. If the bar were used thus, the amount of current would be much less than before, owing to the very much increased length of the paths as well as the diminished cross-section. Note, however, that eddy currents would still exist, because the old paths are open through the ends, and each lamination has still a different E.M.F. from every other. Hence the evil is still there, but it may be got rid of practically altogether in the following manner: before sweating the ends together, the whole bar, built up into its proper size, is twisted at the middle through 180deg., as shown in Fig. 4.

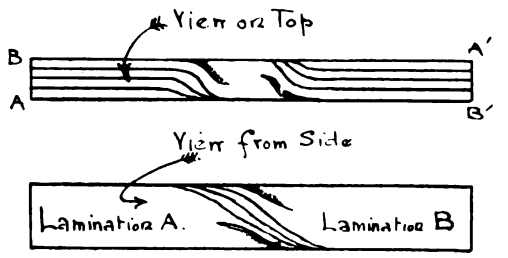

FIG. 4.

It is evident that one half of A has a high voltage induced in it at the same time that its other end has a low voltage. These two add themselves together simply, as A A' is too thin to allow any appreciable eddy current to be set up within itself. But similarly the two halves of B B' have different E.M.F.'s, which, however, add together to the same total as the total in A A'. Hence the old circuit, A A' B' B, has two equal E.M.F.'s in it opposing one another and no current flows. Similar considerations show that every lamination has practically the same E.M.F. in it, and as all are in the same direction no eddy current exists at all, but all the E.M.F. can be put to useful purpose.

Figures are asked for; but it is no use giving comparative numbers. These depend, like so many other things, on circumstances present at the time—*e.g.*, the total thickness of conductor compared with lamination, the peripheral of speed, and so on. But it has already been said that the use of laminations is simply that machines can be built which otherwise could not be built. And the twist, which eliminates the last traces of eddy current, increases the output of the machine by several per cent. for the same temperature rise.

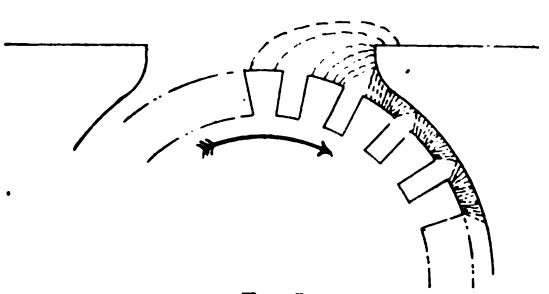

FIG. 5.

The consideration has been for the case of an excited machine on open circuit. But the same loss of efficiency occurs when a current is flowing, for then, although no actual circulation of current takes place, the current distribution is much higher at the front of the bar than at the back on entering the field; and hence the front becomes much hotter than it should, and this heat gradually spreads to the whole bar. It may be pointed out that the conditions are reversed on leaving the field. But the result is exactly the same—namely, unnecessary heat is produced. The avoidance of eddy currents has been accomplished in other ways, as, for instance, where the conductor consists of stranded copper pressed to the required shape. This is practically identical in principle with the above, the twist extending all along the bar instead of falling only in the middle. It may be added here that the twist as described is, after being made, pressed together to the same size as the rest of the bar. The ends are sweated together, and the whole is insulated, appearing just like a piece of solid rectangular copper. The twist takes up very little extra room.

It is interesting to pass to the second part of the question—concerning slot-wound armatures. In this case the distribution of lines in the air-gap may be taken probably somewhat as shown in Fig. 5. Practically no lines go through the long air-gap in the slot, as the magnetic resistance is so large. Imagine the armature moved a little forward. The lines of force still seek the shortest way—magnetically shortest—and consequently they follow the teeth and are "bent," to use a somewhat unphilosophical and illogical term as applied to lines of force. This "bending" goes on until the air-gap they are cutting is greater than the air-gap in the slot. Then they cross over to the next tooth. It is at this point that the possibility of eddy currents comes in, but it is a fact that no eddy currents result; and the reason is said to be that the lines of force jump across so quickly that the time of action of any differential E.M.F. which may be induced is so small as to be equivalent to zero. An illustration may help to make this clear. One must imagine that one is travelling in a railway carriage in one of whose window-panes is one of those slight imperfections called "diamonds" (?) of the nature of a small lens. If the train is passing a paling with vertical wood battens close together, then what one sees is something like Fig. 6. The palings must pass the "diamond," but one never sees them do it, because they jump across so quickly. The application is clear: the palings are like the lines of force, while the "diamond" is the conductor, and the cases are completely analogous.

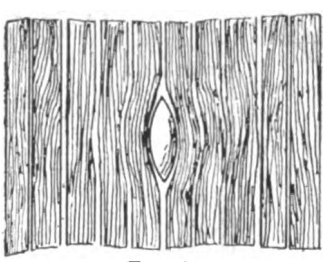

FIG. 6.

It may be mentioned, though it does not come directly into the question, that though no armature conductor eddy currents exist in a slotted armature machine, very serious eddy currents do exist in the pole-pieces, especially on the pole-tips. This is because of the "shaking" of the field, which takes place as has been described. This is most marked at the pole-tips where the stray field exists. The lines are carried with the teeth for a much greater distance than in the more saturated air-space inside the pole air-gap, and the effect is most marked at the "trailing" pole-tip when there is current in the armature, because then the armature reaction crowds the lines round to that pole. To avoid these eddy currents in the pole-pieces the air-space in the slot should be as nearly equal to the machine's air-gap as possible, and if the size of conductor does not allow this, then the slots may be either drilled right through the armature under the external surface, or the whole ordinary slotted armature may be enveloped in a winding of soft-iron wire in the direction of the armature plates, or the slots may be made not rectangular, but with the outer ends almost brought close together, which is practically equivalent to the first-mentioned method with enclosed conductors.

To sum up, for smooth-core large-current armatures the conductors must be laminated, and should also have some sort of twist, otherwise they become unbearably hot. For slotted armatures the conductors may be solid, but the eddy currents are transferred to the pole-pieces, which get hot, and in this case special constructional contrivances are employed also, a description of which in full does not, however, concern the present question.—T. C.

Answer to No. 236 (*awarded* 5*s.*).—Armature bars are laminated solely for the purpose of reducing the eddy-current loss in them, and the consequent heating and waste. These eddy currents occur only when the bar is passing through the fringe of magnetic lines spreading out from each pole-tip. Whilst in the fringe the two sides of the bar are passing through magnetic fields of different density, and therefore generate E.M.F.'s of different amount. These E.M.F.'s both act in one direction, but since one exceeds

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the other there is a net E.M.F. equal to their difference, acting up one side of the bar and down the other. This action, though chiefly confined to the outer edges (which have the largest difference in flux density), occurs in a gradually decreasing degree towards the centre of the bar as well (see Fig. 1). If the armature is supplying little or no current to the external circuit, this differential E.M.F. will cause an alternating current (in one direction whilst approaching, and in the reverse direction whilst leaving a pole-piece) to circulate in the body of the bar, whilst if the armature is supplying a considerable current to the circuit, the only effect may be to increase the current density at one side of the bar and reduce it at the other, in any case causing a waste of energy. That such an action takes place can be readily proved by fixing a single loop of wire (with the two sides of the loop separated by, say, ½in.) on any smooth-cored armature, and connecting the ends of the loop to an ordinary D'Arsonval galvanometer. If the field of the machine is then fully excited, and the armature is slowly turned round by hand, the galvanometer will be found to give a decided throw each time the loop enters or leaves a magnet pole, whilst at intermediate points no current will flow in the loop.

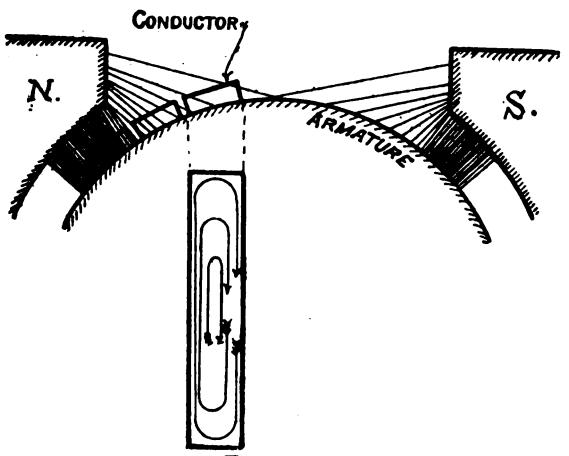

FIG. 1.

The maximum allowable width of a solid (unlaminated) conductor on a smooth-cored armature depends on the shape of the fringe and on the flux density in the air-gap. With ordinary conditions as to flux density, peripheral speed, etc., as found in practice, experience has shown that it becomes necessary to laminate the conductors in some way when their peripheral width exceeds about ¼in. or ⅜in. Various methods of laminations are in use. The bars may be split up into a number of parallel strips arranged edgeways to the core and separated from one another by thin paper or other insulation. Sometimes a number of ordinary cotton-covered wires in parallel are used in place of a single solid bar. Both these arrangements do good, but since the several parallels must be connected together at the ends of the conductors (where they are soldered into the end connectors or into the commutator) the eddy currents can still circulate to a certain extent. A much better arrangement, and the one most common in practice, consists in making the conductors of ordinary twisted stranded cable pressed to the required shape. It is found that the resistance of the oxidised surfaces of the separate wires is quite sufficient to prevent eddy currents passing across the bar (even when considerable pressure has been used in shaping it), and at the same time the twist of the cable causes a given wire to lie first on one side and then on the opposite side of the conductor, and thus wholly destroy the tendency for eddy currents to circulate through the soldered joints, as is the case with the other methods. The actnal eddy-current loss due to the use of solid conductors cannot be calculated with any accuracy, nor can it be experimentally measured because of the difficulty in distinguishing between eddy currents in the bars and eddy currents in the pole-faces or elsewhere. The fact that laminated conductors, in spite of their considerably greater cost, are invariably used on modern smooth-core dynamos having bars ¼in. or more in width points, however, clearly to the necessity for some such arrangement. In the case of slotted armatures this particular eddy-current trouble is considerably reduced, for the flux density inside the slot (even when parallel-sided open slots are used, but especially with partly-closed slots) is so low that slight differences in it can only give rise to exceedingly small and harmless volt differences between the two edges of a bar, even if the bar be very wide. Thus solid copper conductors as much as 1in. square are sometimes used successfully on heavy-current slotted armatures. Of course, if the teeth are worked at a very high flux density (20,000 to 23,000 C.G.S. lines per square centimetre) the density in the slots may approximate to that occurring in smooth-cored armatures, and correspondingly thin conductors must then be used. Slotted armatures wound with conductors of wide strip (1½in. to 2in. wide) set on edge sometimes give trouble due to eddy currents induced in the flat faces of the conductors by the action of the armature cross ampere-turns. These cross ampere-turns distort the main field so as to cause some of it to pass across the slots more or less at right angles to the direction of the teeth, instead of allowing all to pass radially down the teeth. This distorting action is zero at the surface of the armature and a maximum at the bottom of the slots, so that naturally the density of the distorted field varies at different points in the slot, and so gives rise to eddy currents in the strip conductors in much the same way as explained above for smooth-cored armatures. The strip conductors are therefore sometimes made up of plaited oxidised wires pressed to the required shape, and sometimes the solid strip is retained, but one or two longitudinal slots are cut in it from end to end, thus increasing the length and resistance of the eddy-current path.—Q.

FORTHCOMING EVENTS.

FRIDAY, FEB. 2.

Royal Institution.—At 9 p.m., discourse on "Wireless Telegraphy," by Signor G. Marconi.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel, paper on "Arc Lamps and Arc Lighting," by Mr. H. G. Cotsworth.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the electrical works of the London United Tramways, Limited. Assemble at works, 88, High-road, Chiswick; train from Westminster Bridge to Turnham Green at 1.52 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., at Newcastle, discussion on paper on "Receiver Drop in Multiple-Expansion Engines," by Prof. R. L. Weighton, and paper on "The Distribution of Materials in the Upper Works of Large Steamers," by Mr. S. J. P. Thearle.

MONDAY, FEB. 5.

Society of Arts.—At 8 p.m., Cantor lecture, "The Nature and Yield of Metalliferous Deposits," by Mr. Bennett H. Brough.

Society of Engineers.—At 7.30 p.m., at Royal United Service Institution, ordinary meeting.

TUESDAY, FEB. 6.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Papers on "Moving Loads on Railway Underbridges," by Mr. W. B. Farr; and "Note on the Floor System of Girder Bridges," by Mr. C. F. Findlay, M.A.

WEDNESDAY, FEB. 7.

Society of Arts.—At 8 p.m., ordinary meeting. Paper on "The Housing of the Poor," by Mr. Edmund Wilson.

THURSDAY, FEB. 8.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper on "The Standardisation of Electrical Engineering Plant," by Mr. R. P. Sellon.

Society of Arts.—At 4.30 p.m., at the Imperial Institute, paper on "The Projects of Railway Communication with India," by Mr. J. M. Maclean, M.P.

FRIDAY, FEB. 9.

Physical Society.—At 5 p.m., annual general meeting. Presidential address by Prof. Oliver J. Lodge, D.Sc., F.R.S.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Underground Sources of Water Supply," by Mr. D. E. Lloyd-Davies.

SATURDAY, FEB. 10.

Institution of Electrical Engineers.—Students' visit to Messrs. Siemens Bros. and Co.'s works, Woolwich. Train leaves Charing Cross for Charlton at 9.20 a.m.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "The Bacteriological Treatment of Sewage," by Mr. W. Shanks.

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TO CORRESPONDENTS.

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IN COURT.

No doubt a lawyer would prefer a trip to the Engadine as a change from his normal work, but a layman whose physical constitution can stand the atmosphere of the law courts and whose mental equipment is fairly perfect as regards a knowledge of technics may find considerable amusement, if not edification, in listening to a big case. Such a one has been in progress during the past few days. We are not entitled to consider the merits or demerits of the case, as the matter is still *sub judice*, and whatever may be the verdict in this court will probably be carried still higher. The educated layman must sit and listen with feelings of admiration akin to awe at the matter and methods of counsel. These gentlemen get up their case with wonderful acumen, each side trying to make such points as will tell for their particular view of the case, all the while educating the judge as far as possible to see the technical matter in the same light as they individually see it. The *rôle* of the judge, however, is the most complex and arduous of all. He perhaps has to learn all about this particular phase of technics whilst hearing the conflicting evidence and opinions, and though trained in the best school his task is about as difficult as that of any human being. Vast interests depend upon his decision, hence his responsibility is great. Long ago we suggested in an article that met with extended approval both with lawyers and laymen, that an unbiassed expert might with advantage be called upon to assist the judge in matters requiring special technical knowledge. We are bound to say, however, that even without such aid the judges manage generally to grasp the salient facts of each case, and to give decisions that generally meet with approval—that is, meet with the approval of disinterested parties; though the approval of those on the losing side is seldom given, at any rate till time has had a chance of assuaging chagrin or loss. Listening to the case of Rucker *v.* the London Electric Supply Corporation makes us desirous of offering another suggestion, involving no expert, yet, we think, if adopted tending to help the judge. This particular case is in relation to an electrical patent, and involves the use of electrical terms. Now such has been the progress of applied electricity during the last quarter of a century, that its terminology over that period has undergone constant change. A judge hears one witness speak of pressure, another of tension, another of E.M.F., then he hears of things in parallel, in multiple arc, a straddling the wires, in derivation; he hears of quantity, of current, of intensity, and so on through the whole gamut of electrical terminology. Surely it must require some mental strain to grasp that various terms are synonymous, and to group the synonyms. At the commencement of such cases would it not be possible to print lists of synonyms, so that the constant explanation is not required to drive home the fact that tension is the same as pressure or E.M.F., and that intensity and current mean one and the same thing. Surely it is no part of a case

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to have to show that terminals on mains in parallel are merely the terminals of the machine extended, and that connections with the opposite terminals on mains in parallel are merely equivalent to connections across the terminals of the machine. All these little things so familiar to the expert tend to complicate the matter in the mind of the inexpert, and even in the highest-trained legal mind must tend to fog rather than make clear essentials. Books and papers of this period published a few years apart use a different terminology, which to the listener for the first time must be very confusing. It is bad enough to the expert to find books and papers using the different terms indiscriminately, and to find in common formulæ a variety of symbols referring to the same thing. It is perhaps a little rude and impertinent to point out that the time of lawyers is a valuable commodity, and that whatever tends to curtail the time spent on a case tends to curtail the expenses also. We do not imagine, however, that the majority of lawyers would be against some minor improvements of the kind.

ELECTRIC RAILWAYS.

The Metropolitan Railway Company has allowed another general meeting to go by without coming to a practical decision on the use of electric traction on their lines. The Chairman, at the meeting last week, expressed his regret that the experimental train on the Earl's Court to Kensington High-street section had not been fully tested. He added that "the shareholders might rest assured that the question of the adoption of electrical traction was one which was exercising the Board's very careful attention, and he might state that they had tried other experiments on a piece of line at Wembley Park, which, so far as they had gone, had given the directors and officials an amount of valuable information, which would assist materially in solving the difficulties in the way of applying electrical traction to the working of the railway." The cost of the experiment is to be borne by the reserve fund. The chief encouraging feature in the company's report is the reference to the Bill to be brought before Parliament for powers to build a large generating station on the Thames near Chelsea Creek. In our opinion there was absolutely no need for the present experiment, as there is ample information to hand to enable engineers to design an equipment for the complete Inner Circle, giving a quicker and more efficient service. The directors may not feel assured as to the financial results, but here again they can obtain figures which should settle the matter once and for all. We trust that they will tackle the question boldly, and that the necessary steps towards the electrical equipment of this important, and, at present, most unhealthy, line may be taken this year.

Junior Engineers.—At the meeting of the Institution of Junior Engineers this evening at the Westminster Palace Hotel, at 8 p.m., Mr. H. G. Cotsworth will read a paper entitled "Arc Lamps and Arc Lighting."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TYNESIDE ELECTRIC POWER COMPANY.

SIR,—Referring to your paragraph with the above heading in your current issue, I should like to be allowed to point out that the prices per unit mentioned in our Bill should only be taken as maximum prices, and that we quite realise that considerably lower prices than those mentioned will have to be charged to large power consumers if we are to compete with steam-engines.

As a matter of fact, we have already offered a scale as low as 3d. per unit for the first 100 hours per quarter, and 0·9d. per unit for subsequent hours, for the supply of power in localities where the consumers are likely to be large and numerous.—Yours, etc., A. A. C. SWINTON.

London, S.W., Jan. 27, 1900.

REVIEWS.

The Steam Engine and Gas and Oil Engines. A Book for the Use of Students who have time to make Experiments and Calculations. By Prof. JOHN PERRY, D.Sc., F.R.S., etc. Macmillan and Co Price 7s. 6d.

It is rather late, but not too late, to notice this good book. There is a hearty breeziness about everything Prof. Perry writes that is good whether you agree with all the statements or decide to differ. Is this the book about which Prof. Perry tells the tale of a student saying to him that the said student took a technical book away to read during a holiday? "What! take a heavy scientific book to read," said the Professor; "why I should go to sleep." "That is just what I do," said the student. It is hardly conceivable that anyone interested in steam could go to sleep over this book whether upon a holiday or not. Indeed, we rather commend the plan of taking at least one heavy book when upon a holiday, as one soon gets tired of the utter inanities of fiction and gladly turns for rest to the heavier book when a shower or some other untoward event stops outdoor proceedings. At any rate, what is read under such circumstances is often thought out better than when read under the stress of ordinary work. This book has a twofold object. It discusses and illustrates simply and clearly the detailed parts of the machine, and it puts forward the theory which determines the construction and action of these parts. There are 34 chapters, but to examine and comment upon each of these in turn, attempting to appraise their relative value to each other or to similar writings in other books, would be too great a task. Thus we shall follow the example of the bee, and touch lightly here and there. Might we venture to suggest a fault in the many interpolations—too many for teachers and often a little unsuitable for students. It is extremely interesting to glean some hints as to Prof. Perry's own methods, but in turning aside to indicate these the writer is apt to imagine the student reader to know a little more of the subject than he usually does. The late Prof. Todhunter we always thought erred in this direction of assuming a little too much knowledge or brain capacity. It will probably be held that this fault—if fault it is—errs in the right direction, and far too many writers forget the essential work of the teacher, which is to make the pupil think, and not only to cultivate the memory and teach a long string of facts. Unless the reader of this book is prepared to exercise his brain, he had better put the book upon the shelf and buy a novel. A great difficulty in a work of this kind is to get illustration and descriptive text together. Prof. Perry has not solved this problem. Comparison with works on heat and steam a century old will show the immense advances made during that period, but a careful examination of this book will also show what great room there is for future workers. Here are dozens of suggestions for experimental research, dozens of acknowledgments that knowledge is defective and calculations approximate, which should prove an incentive to the ambitious young student. Let us take one such subject for comment. On p. 2 the

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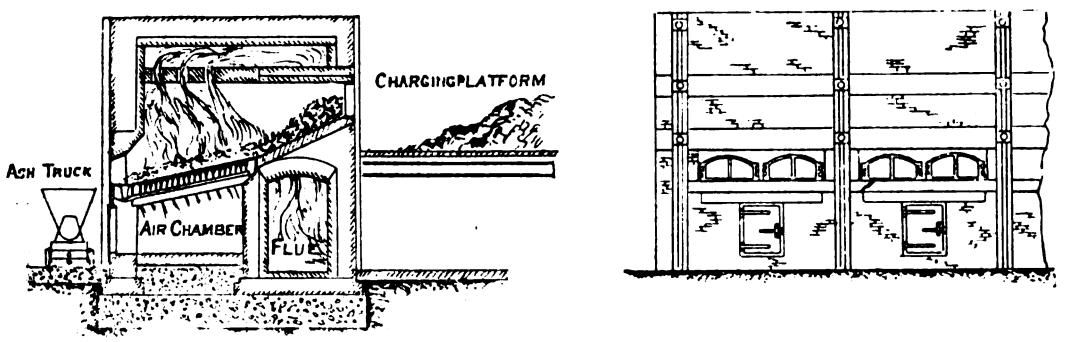
author calls attention to the waste energy when a bath of hot water is run away. On p. 155 he says: "But the above figures will teach an important lesson—important in all heat-engine work—namely, that we take away and waste in the exhaust nearly as much heat as we give to the stuff, so that only a small portion is utilised and converted into useful work." In connection with this subject we would suggest that every student makes himself thoroughly acquainted with a report to the Royal Agricultural Society issued, if we remember rightly, after their exhibition some few years ago at Newcastle. This report deals exhaustively with the query, Where does the heat energy of the coal go to? But to return to the exhaust. We have reason to believe that a good deal of attention is just now being given to this subject, and claims are made as to successful utilisation. It may even prove that Prof. Perry himself has to consider these claims. Be that as it may, he indicates a field for the student to examine and experiment. Throughout the book the author has clearly set forth accepted theories, in many instances adding surmises as to the trend of future developments as they exist in his own mind, and with these theories giving, as we have said, the latest practical details. We had marked a large number of paragraphs for detailed comment, yet refrain—because Prof. Perry thinks so little of the knowledge of the subject "possessed by a newspaper writer" (*vide* p. 112), while the student will gain more advantage by thoroughly studying the book itself. There is not a single chapter in it which does not deserve close and careful attention.



FIGS 17 and 18.—Cross-Section and Front Elevation of the Horsfall Patent Refuse Destructor.

THE ECONOMICAL GENERATION OF STEAM POWER.

BY BENJN. A. TAPP.

(Continued from page 122.)

The Horsfall furnace is constructed similarly to the foregoing, as will be seen from Figs. 17 and 18, forced draught being employed and obtained by means of a steam jet. Each cell consists of a drying hearth, down which the refuse moves to the furnace grate. Beneath the grate is a closed ashpit, into which the steam blast is led, thus increasing the air pressure and forcing the fire. The products of combustion escape through holes in the front part of the arched top, passing over to the back of arch, and then down the sides of the brickwork surrounding the drying hearth, and into the flue. Many circumstances affect the quantity of refuse and cost per day of burning, the most important perhaps being the kind of refuse and amount of moisture it contains. The frequency of clinkering has a marked effect on the rapidity of destruction and cost. Thus the Horsfall furnace, which will burn 10·2 tons at a cost of 8·82d. per ton in wages when the clinkering is done at intervals of two hours, will burn 14·8 tons when clinkered every hour, but the cost will be increased to 12·2d. per ton, and when the clinkering is done every half-hour, the refuse consumed may amount to 26·75 tons, but at a cost per ton of 13·46d.

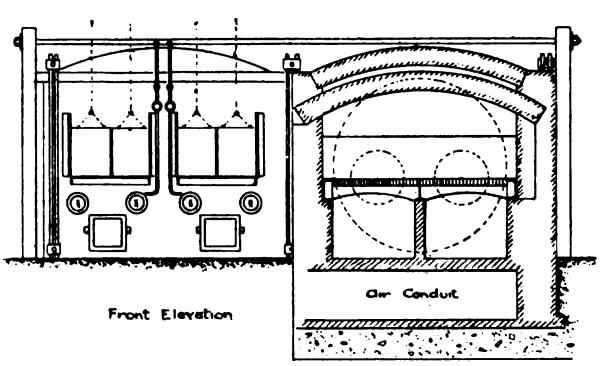


FIG. 19.—Cross-Section of the Meldrum Simplex Destructor.

One of the most recent refuse furnaces is Messrs. Meldrum's Simplex destructor (Figs. 19 and 20). This is a further development of their "forced draught" furnace, The arrangement is such as to ensure the efficient destruction of refuse from dust-bins, markets, etc., and may be used to consume pressed sludge if necessary. The furnace under consideration is built on to the end of a Lancashire boiler, and measures 7ft. by 6ft., with suitable dead-plates to prevent clinker from adhering to the walls. Each furnace has a grate area of 35 square feet, the grate being divided in halves by a brick division wall in the ashpit. Each ashpit is provided with two steam-jet blowers

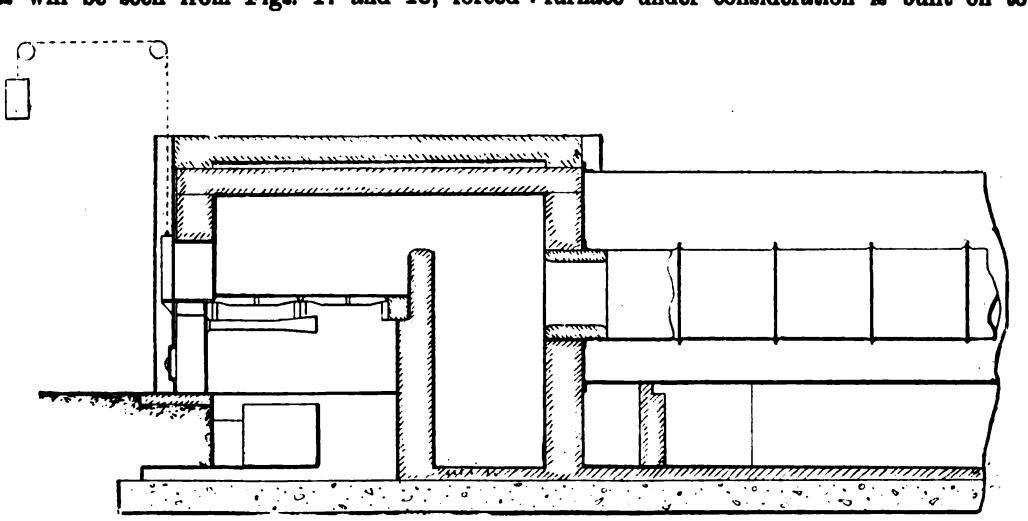


FIG. 20.—Longitudinal Section of the Meldrum Simplex Destructor.

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which enable a high temperature to be maintained by suitable firing, one portion of the grate being charged while the other is in an incandescent state. The patent steam-jet blowers are fixed in vertical uptakes in the furnace front, and draw air from the conduit under the ashpit. The furnace is provided with a combustion chamber at the back of the bridge, from which the gases pass into the boiler flues. These furnaces consume an average of 15cwt. of refuse per hour, firing being done by hand and a temperature of 1,800deg. F. to 2,000deg. F. is produced in the cell. The appended tests were made on a Meldrum destructor at Rochdale Manure Works. The tests were made as far as possible with one boiler and two furnaces; material burned, unscreened ashpit refuse only; Lancashire boiler, 30ft. by 8ft.; approximate grate area = 90 square feet.

Date of test, 1895	Nov. 14	Nov. 15
Duration ditto	6½ hours	6½ hours
Temperature of feed water	52deg. F.	52deg. F.
Water evaporated in one boiler	3,900 galls.	4,320 galls.
Water evaporated in stand-by boiler*	390 galls.	420 galls.
Water evaporated in one boiler per hour	600 galls.	664·6 galls.
Water evaporated in stand-by boiler per hour*	60 galls.	64·6 galls.
Total water evaporated	4,290 galls.	4,740 galls.
Total water evaporated per hour.	660 galls.	729 2 galls.
Average steam pressure	113·2lb.	114·3lb.
Total refuse weighed	14 tons 2cwt.	14 tons 13¾cwt.
Total bricks, stones, etc., not burned	7cwt.	6¾cwt.
Total refuse burned	13 tons 15cwt.	14 tons 7cwt.
Total refuse burned per hour	4,738lb.	4,945lb.
Total refuse burned per hour per square foot of grate	52·6lb.	54·9lb.
Water evaporated per pound of refuse burnt	1·39lb.	1·47lb.
Water evaporated per pound of refuse from and at 212deg. F...	1·68lb.	1·78lb.

* This being heat from the working furnaces, leaking past dampers into the stand-by boiler, the water evaporated is added in.

Our descriptions have so far dealt with improved means of combustion as a source of economy, but the question of cheaply and efficiently handling fuel and ashes for distribution through a boiler-house or yard claims some attention as an additional source of economy. The appliances for this purpose take the form of elevators and conveyors. The elevators should work at a speed of 100ft. to 180ft. per minute, at which latter speed they are usually constructed in sizes to carry from 3 to 50 tons slack per hour, the buckets' widths varying from 6in. to 15in. The buckets may be attached to ordinary "elevator" belting or to chain belting (of malleable cast iron), which offers greater facility for working in heat and water. Inclined elevators are usually the most satisfactory in work; they give a free discharge. Where possible elevators should be driven from the top, and a tightening arrangement for taking up slack is necessary, absolutely so in the vertical type. Vertical chain elevators are constructed with two chains, the buckets being centrally hung, and an arrangement of dump wheels provided for giving a free discharge. Conveyors are of great use for moving material in a horizontal direction, and are made of various designs, such as band, tray, scraper, bucket, worm, and many others. The forms most usually met with are the band, bucket, and worm types. Band conveyors are made of special belting of 6in. to 36in. in width, and average 10 to 15 tons carrying capacity per hour per foot in width, with a speed of 30ft. to 50ft. per minute. Tray or pan conveyors, entirely constructed in metal, are sometimes essential; a conveyor with trays 12in. by 3½in. will handle 40 tons of small coal per hour at a speed of 150ft. to 200ft. per minute. Scraper conveyors are useful where it is desired to deliver material at various points along the route of travel, which is done by removing segments of the bottom of the trough in which the scraper works. Special dumping carriages are provided for belt and bucket conveyors, enabling them to discharge at any

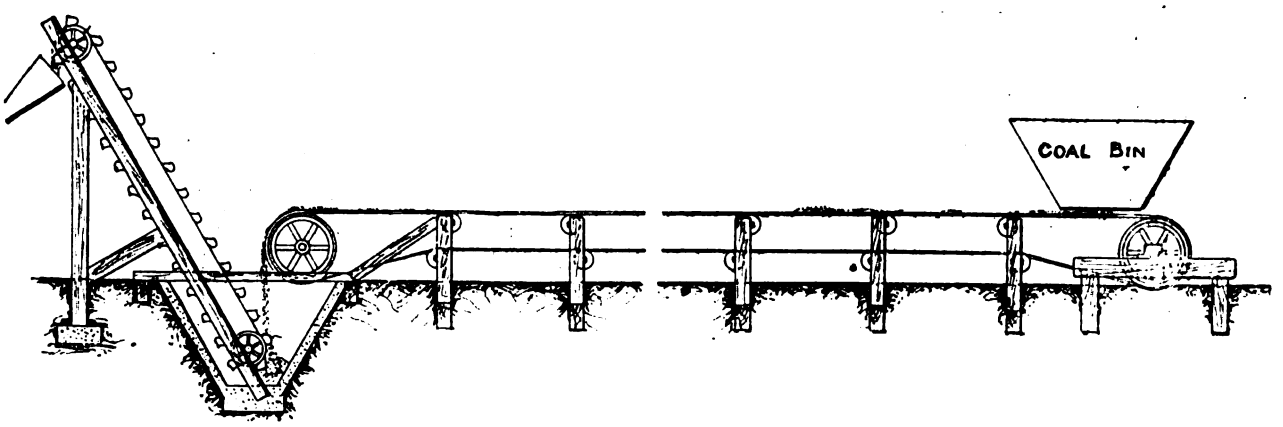
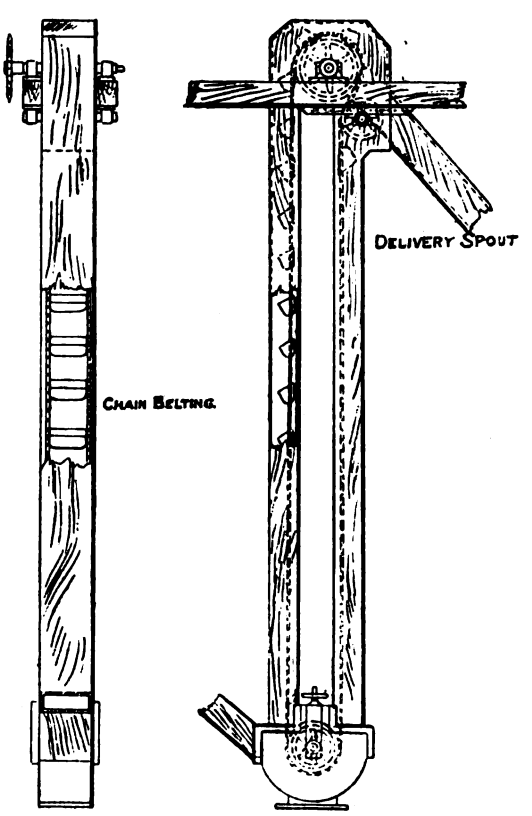
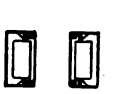


FIG. 21.—Elevation of a Band Conveyor and Elevator.

desired point. Worm conveyors are made of various patterns, the most common being a cast-iron helix, surrounding a spindle, which revolves in the centre of a trough containing the material. By its screw-like action the helix forces the material along the trough. These



PERFECT DISCHARGE ELEVATION



CROSS SECTION THRO' CASING

FIGS. 22 AND 23.—Details of a Bucket Elevator.

conveyors tend to grind up their contents by their action, and several special forms have been devised to overcome this defect. They will work in an inclined and even vertical position, but are most efficient horizontal. Several diagrams (Figs. 21, 22, and 23) illustrative of elevator and conveyor types are given, which will prove self-explanatory.

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Before leaving this section, the author would draw attention to the advantages to be derived from the adoption of aerial ropeways, etc., for conveying fuel from canal or siding to the bunkers as compared with the use of horse and cart or tramroad, over moderate distances. This form of conveying is largely in use in America, and gradually gaining favour in this country.

(To be continued.)

ELECTRIC LOCOMOTIVES.

At the last meeting of the Verein deutscher Maschinen-ingenieure, Herr Tischbein, of the Allgemeine Elektrizitäts-gesellschaft, read a paper entitled "Moderne elektrische Lokomotiven." In the course of his address Herr Tischbein remarked that the favourable results which had attended the introduction of electricity as a motive power for street tramways had led one to the idea of employing electricity also for railway work. But the conditions pertaining to railway work were vastly different to those holding for street tramways. This was consequent upon the circumstance that a considerable portion of a railway's work consisted in the transportation of goods. The difference in the trains employed for this purpose, coupled with the limited control of such, made it appear impossible to conceive of a general introduction of motorcars for the transport of goods. Hence it was that we were obliged to fall back upon the equivalent of the steam locomotive—that is to say, the electrically-propelled locomotive—to help us out of the difficulty. Electric locomotives might be divided into two classes: those for standard and those for narrow-gauge lines. But they might also be distinguished according to the manner of conveying their driving current to them, since in some cases this current was collected from a conductor laid along the track, while in others the necessary power was obtained from accumulators, and, finally, some lines were equipped for mixed working. It appeared as if the last-mentioned system was destined to obtain the preference for standard gauge lines. Herr Tischbein summed up as follows: For the working of electrically-propelled locomotives over standard-gauge railways, an overhead trolley system of conductors would be suitable when a frequent service of cars over long or short stretches had to be provided for. In the case of locomotives, however, required principally for shunting purposes over a complicated system of points and cross-overs confined in a comparatively small space, it would prove advantageous to increase the mobility of the locomotive, and at the same time simplify the system of overhead conductors by supplementing the latter by an accumulator trailer-car, to be attached to the locomotive when it was required for shunting work. Should, on the other hand, a slow service of cars over a line of considerable length be in question, and should there exist a convenient generating station having spare power, or, at least, a natural source of motive power for driving generators for charging purposes, then it would be of advantage to adopt accumulator-driven locomotives.

A comparison between the steam locomotive and the electric locomotive from an economical standpoint resulted entirely in favour of the latter. In the first place, economy was effected in the construction of the electric locomotive, and to this must be added the considerable economy rendered possible in the construction of the permanent way of a railway designed for electric traction, not to mention the attendant saving in cost of administration. These three items of economy amply compensated for the extra cost entailed by an overhead system of trolley wires. It had further to be considered that the electric locomotive required one driver only, and that the provision of waterworks, pumps, fire, and cleaning trenches became unnecessary. Finally, electric traction was more economical because it enabled greater uniformity of speed than was the case with regard to steam working. We should like to see figures supporting Mr. Tischbein's proposal to use accumulators for supplying the current for shunting purposes. In the States the electric locomotive with overhead trolley has been found of great service in shunting yards.

INAUGURATION OF THE ELECTRICITY SUPPLY AT INGLETON.

We gather from the *Lancaster Guardian* that the supply of electricity to consumers was successfully inaugurated at Ingleton on Wednesday, the 24th ult. The growth of the West Riding village as a health resort had made the inconvenience arising from insufficient lighting very keenly felt, and matters reached a climax last winter, when complaints were rife against the quality and quantity of the gas. Two or three breezy meetings were held, and on Feb. 4, at a public meeting, 12 ratepayers were selected to canvass the town and ascertain the wishes of the property owners and occupiers as to whether they preferred improved gas or electric light. Fully 75 per cent. decided in favour of the up-to-date light, and a company was formed and registered, with Mr. William Metcalfe as chairman; Mr. John Brookes, secretary; and Mr. Brotherton, manager. The directors, acting on the advice of engineering experts, decided on a capital of £4,000, in £1 shares, and over £3,500 of these shares have already been allotted. The effect of the floating of the company has been beneficial to the ratepayers in this sense: it has been an incentive to the gas company to replace some obsolete plant, which was responsible for the defective lighting, with a new retort and purifier. The price charged per 1,000 cubic feet of gas—an important point—was also reduced from the proverbial lawyer's fee, 6s. 8d., down to a simple crown. It remains to be seen what the effect of the competition will be. The electric lighting company are charging 6d. per unit, and as a consequence of the public lighting, there will be a lighting rate levied by the Parish Council to bring in £70. To return to the scheme, it may be stated that contracts were let, amounting to about £3,300, for the supply and erection of generating, storage, and distributing plant. The contractors were as follows: turbine plant, Messrs. G. Gilkes and Co., Kendal; dynamos, Messrs. Drake and Gorham; sub-contractors for the street wiring and cables, Messrs. Callenders, London; local contractors for the building of the power-house, Messrs. Thistlethwaite and Kettlewell, Ingleton; local sub-contractor for the battery-house, Mr. Mackay, Ingleton; local contractors for street trenching, Messrs. Thistlethwaite and Kettlewell; engineers for the whole, Messrs. G. Gilkes and Co., Kendal. Water power is obtained from the River Greta, the weir being 40ft. wide. The water is conveyed to the house, erected on ground leased from the Craven Lime Company, through wrought-iron pipes 30in. in diameter, laid as far as the course lies in the bed of the stream, forward in a wooden launder, and the water is strained at a pen trough fixed just outside the power-house. Inside the latter building there are placed two vortex turbines, each being capable of developing 15 h.p. to 20 h.p., with an effective head of 25ft., and run at a speed of 320 revolutions per minute. Each turbine drives a dynamo which has a maximum output of 35 amperes 330 volts. The current is transmitted from the switchboard by means of insulated cables across the river to an accumulator-house in the centre of the town, where a large storage battery is erected capable of supplying current to 400 16-c.p. lamps for six hours in ordinary working, or, in case of emergency, double this quantity for a short period. Three feeders are run from this accumulator-house to a corresponding number of feeding points situated in various parts of the distributing network of mains. These feeders are triple-concentric armoured cables. The general plan of lighting has been designed with the ultimate view of supplying about 1,000 lights in the town.

A three-wire system of distribution has been adopted in the principal streets, with 220 volts across the outers, but the outlying parts of the town are supplied with current at a pressure of 200 volts in the consumers' houses. The whole of the street lights are electric, the Parish Council having entered into an agreement with the electric light company to supply current for three years. In addition to this, numerous premises have been connected up to the mains, including the police court and the Wheatsheaf Hotel. Current will also be supplied for power purposes. The work has been supervised throughout by Mr. W. M. Harris, A.M.I.E., of Kendal (on behalf of Messrs. Gilkes and Co.), while Mr. Mildred (of Messrs. Callender, London) has superintended the laying of the cables, and Mr. Baggley (of Messrs. Drake and Gorham) the installation of the dynamos and switchboard. Subsequent to the opening ceremony a dinner was served in the Wheatsheaf Assemby Rooms, about 50 guests being present.

Pacific Cable.—The British Empire League, on the 30th ult., unanimously resolved to urge Canada to promptly ask the Imperial and New South Wales Governments to refuse to assent to any agreement granting concessions to the Eastern Telegraph Company unless provisions were made for its cancellation, if the public interests demanded. The meeting declared its emphatic opinion that the Pacific cable scheme was of vital strategic importance to the Empire, and that the concession might prove its death-blow.—*Reuter.*

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PHYSICAL SOCIETY.

At the ordinary meeting on Jan. 26, Prof. Lodge, F.R.S., president, in the chair,

A paper by **Prof. Ayrton** and **Mr. Mather** on "**Some Developments in the Use of Price's Guard Wire in Insulation Tests**" was read by Prof. Ayrton. For insulation tests made by the direct deflection method the guard wire properly applied affords complete protection against surface leakage when the ends of the cable tested are near the galvanometer, so that it is possible to have the wire connecting the conductor of the cable with the galvanometer terminal "air insulated." A difficulty, however, arises when the ends of the cable are at a considerable distance from the testing instrument; this may render air insulation impossible. The authors have overcome this difficulty by applying a guard wire along the entire length of the lead. This is done by using a concentric wire to connect the cable and galvanometer, the inner of the concentric being used as the lead and the outer as the guard wire. The principle can also be applied to determine whether a defective piece of cable is bad throughout or bad owing to one or more isolated faults. In this case the cable is placed in two water-tanks, one of which is earthed and the other fairly well insulated. By a suitable arrangement of the guard wire it is then easy to determine the resistance of the wire in the earth tank, so that by altering the length of this wire the character of the insulation can be determined throughout the whole length of the cable. In referring to some of the earliest experiments with the guard wire made by Mr. Appleyard in 1895, Prof. Ayrton pointed out that the principle had not been applied completely, and that at one point there was a chance of leakage.

Mr. Campbell said that the necessity of having a concentric wire could be obviated by simply hanging the lead from the guard wire by short lengths of material of fair insulation.

Mr. Appleyard said that he quite agreed with Prof. Ayrton that the guard wire ought, in general, to be applied at both ends of all leads, provided that both ends could be got at. The reason it was used at one end only in the experiments on dielectrics made in 1895 was that the far end of the lead was carried into the condenser box, which was submerged in water in the temperature tank. Special precautions were taken to ensure good insulation of the submerged end of the lead, and tests showed that the leakage there was nil. As the end of the wire could not be got at, no guard wire could be applied. Mr. Appleyard congratulated the authors upon the use of a concentric cable for a lead, and pointed out that such a lead was sufficient for all the routine tests on core; the inner and outer conductors could be used for the purpose of taking the "copper" resistance.

Mr. Price expressed his interest in the developments of his principle which had been made by the authors.

Mr. Appleyard then read a paper on "**A Fault-Test for Braided and other Cable Core.**" This method enables the fault to be found without the removal of braiding or tape. The core is wound on two insulated drums or tanks, the intermediate piece of cable being about 10ft. long. One end of the core is left free, the other is connected to earth through a galvanometer and a battery. A guard wire is connected from some point between the galvanometer and the battery to some point of the braiding on the wire between the drums. A wet cloth, connected to an earth-wire, is laid on one or other of the drums, over the braiding. The galvanometer deflection is noted. The earth-wire is then changed over to the second drum, and the corresponding deflection is observed. A comparison of these deflections at once indicates upon which drum the fault lies. With the galvanometer still deflected the core may be run through a suitable contact brush or sponge attached to the guard wire. The instant the fault passes under the guard-wire contact, the deflection falls and the fault is located. The paper gives the theory of the method, and indicates how to apply it (1) to localising "distributed" faults, (2) to several faults in a single cable, and (3) to the case of a single fault. One advantage of the method is that at the critical moment when the fault passes under the guard wire the galvanometer is short-circuited through the fault, and thus completely protected.

A paper on "**Reflection and Transmission of Electric Waves along Wires**," by **Dr. E. Barton** and **Mr. L. Lownds**, was read by Dr. Barton. The waves used were produced by means of an induction coil and an oscillator, and travelled along wires ·15cm. diameter, 8cm. apart, and 166m. long. The ends of the wires were connected by graphite markings on ground glass, so that any wave trains which reached the ends were at once absorbed. Three circular parallel-plate condensers were used of 15cm., 9cm., and 5cm. radius respectively. The plates were in all cases separated by air, and were placed 1cm. apart. The needle of the electrometer connecting the wires was uncharged, so that it was always attracted by the charged plates. The positions of the condenser and electrometer could be varied so as to study either the reflected or the transmitted waves. The electrometer produced a negligible disturbance, as it reflected only 0·04 per cent. of the energy incident upon it. The authors have attacked the problem mathematically, using the relations of Heaviside, and have obtained expressions for the reflected and transmitted systems. These expressions consist of two terms, one of which is comparatively unimportant. From the other term certain values have been calculated. A superior limit has then been given to the other term, and the values already obtained have been subjected to a correction on this account. By a suitable arrangement of the condenser and electrometer these calculated values have been experimentally determined and are in close agreement with the theoretical numbers, falling in many cases between the results derived from the approximate and the corrected theories. The authors have also investigated the stationary wave system produced by interference when the electrometer is placed close to the condenser, and between the condenser and the oscillator.

The **Chairman** said that the experiments afforded a satisfactory verification of Heaviside's theory.

A paper on "**The Frequency of Transverse Vibrations of a Stretched Indiarubber Cord**," by **Mr. T. J. Baker**, was taken as read. In this paper Mr. Baker has investigated the frequency of the note given out by an indiarubber cord of square section when subjected to different tensions. The relation between length and tension is linear over a considerable range. The curve connecting length with frequency shows that while the cord was doubling its length the pitch was rising rapidly, but that further extension was practically without effect, since the relation between length and tension is linear, while the sectional area is decreasing, it follows that the value of Young's modulus must be changing. The author has shown that the value of Young's modulus is proportional to the square of the stretched length of the cord. Using this fact, the frequency of the note given out by a stretched indiarubber cord is shown to be proportional to a quantity which varies very slightly with increase in length of the cord, and hence the variation in elasticity is given as the cause of the constancy of the note.

Mr. Appleyard exhibited some mirrors produced inside incandescent electric lamps by the application of voltages much above those for which the lamps were designed, and the consequent deflagration of the filaments.

The meeting then adjourned until Feb. 9.

LEGAL INTELLIGENCE.

RUCKER v. THE LONDON ELECTRIC SUPPLY CORPORATION.

(Continued from page 135.)

THURSDAY.

Mr. Jas. Swinburne was further re-examined by Mr. Bousfield as to the effect of resistance on the regulating power of transformers. He explained that the Gaulard and Gibbs transformers were frequently used to transform up. He then explained the action of a transformer in choking back the current when the secondary was open. He did not think that the article in the *Times* describing Fuller's invention was complete without the specification, and he thought the details given in the specification would not enable a transformer to be made. With respect to the Brush patent, he thought that the object of the inventor was to keep a continuous circuit even though one lamp went out. He did not think that Mr. Brush had any idea of the choking action of a transformer. He had read the article published in Vienna about the plaintiffs' system, and did not think sufficient information was given to enable the invention to be followed. Mr. Rankin Kennedy's article would lead one to suppose that it was impracticable to work transformers in parallel. These articles showed that Mr. Rankin Kennedy had a qualitative knowledge of transformer work, but did not understand the subject quantitatively.

Mr. Jas. Mackenzie, examined by Mr. Bousfield, said that in 1882 he was engineer to the Metropolitan Brush Electric Lighting Company. Shortly afterwards he met Messrs. Gaulard and Gibbs and had had to do with the installation of their system at the Royal Aquarium. With respect to the *Electrical Review* article of April 21, 1883, the four transformers were connected with their primaries in series, certain transformers supplying groups of lamps. The Grosvenor Gallery installation was started as a private plant in 1884, and it was quite the latter part of 1885 before outside consumers were taken on.

Cross-examined by Mr. Moulton, Mr. Mackenzie said that in February, 1885, the temporary direct-current plant at Grosvenor Gallery was started. It was quite the end of that year before Wallery's premises were lighted. With the Gaulard and Gibbs system the incandescent lamps were sometimes connected in parallel on the secondaries. The Metropolitan Railway installation was started in September, 1883, and used a primary current of about 11 amperes.

Re-examined by Mr. Bousfield, Mr. Mackenzie said that the primaries of the transformers were in series at the Aquarium. Five railway stations on the Metropolitan Railway were lighted from machinery in Edgware-road, but no alternating current was used on the Grosvenor Gallery before the date of the plaintiffs' patent.

Mr. W. M. Mordey, examined by Mr. Bousfield, said his first practical work in connection with transformers for alternate-current working was in 1886, but he was familiar with the history of transformers before that time. It was generally known in 1885 that high-voltage currents were economical for distribution. Thus the Colchester system, started in 1884, used high-tension direct currents to charge accumulators. The difficulty was that the high-tension wires in the consumers' houses were objectionable. At that time the work of Gaulard and Gibbs was not considered practicable, and alternate currents were little understood. With a Ruhmkorff coil used with a contact maker the ratio between the volts on the battery and the volts on the secondary was not dependent on the ratio of turns in the two windings. It depended more on the current interrupter. In a transformer, however, supplied

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with alternating currents the ratio between the voltages was proportional to the number of coils. He considered that the plaintiffs' specification disclosed this fact, and explained how a constant voltage could be obtained by keeping the resistance of the two circuits low. He considered that the mistake in the drawing of the plaintiffs' specification was obviously a draughtsman's error.

Cross-examined by Mr. Moulton, Mr. Mordey would not agree that it was common knowledge in 1885 that alternating currents could be transformed down from one pressure to another, and certainly it was not common practice. The law of transforming ratios was only true for a Ruhmkorff coil if alternating currents were used. It was not true if an interrupted curren by means of a make and break were employed. With respect to Fig. 9 of the Brush specification, he considered this represented a system of alternating currents with transformers in parallel and with arc lights on the secondary. He could see nothing in the plaintiffs' specification to support the view that transformers would be burned up if connected in this way unless certain precautions were taken. He considered, however, that there was information given as to how transformers should be made, as, for instance, in the statement that transformers must be so made with their internal resistance relative to the voltage they had to work on and the current they had to take or give must be relatively below. He thought that Gaulard and Gibbs's transformers connected up according to the plaintiffs' method would have converted a failure into a success. He thought an electrician would know how to design transformers to prevent them being burnt up, and also that the first Zipernowsky and Déri transformers were a success. He considered it novel to connect transformers in parallel in 1885. With respect to the Edison system with commutators for converting direct into alternating current, serious resistance would be introduced with the commutators, which also gave great trouble from sparking. Otherwise the system was one of parallel connections at constant potential. He thought that the subsidiary apparatus would affect the regulation. While the plaintiffs' specification did not give exact details as to the construction of transformers, he thought it gave indication as to how they should be made. In this respect the plaintiffs gave more information than Brush. He did not think that the description of the plaintiffs' invention published in Vienna was sufficiently clear to enable the arrangement to be understood. The defendants' transformation from 10,000 volts to 2,400 with single transformers naturally would be similar to that described by Marcel Deprez.

Mr. Bousfield here explained that he did not rely on that part of the system.

In further answer to Mr. Moulton, **Mr. Mordey** reiterated his opinion that with some experimenting an electrician would be able to arrange transformers to meet particular requirements from the information given in the plaintiffs' specification.

Re examined by Mr. Bousfield, the question of the transforming ratio was again gone into, and Mr. Mordey described a test he had made of a Gaulard and Gibbs transformer in which the drop of pressure from no load to 27 amperes was about 25 per cent. This was due to the high internal resistance of the transformer. He was surprised to find that the transformer only took 30 watts on open circuit, so that it was suitable for connecting in parallel. It was a 1 to 1 transformer, and was tested at 40 volts. He considered that Mr. Fuller was transforming up on the consumer's premises to get a high potential for a certain type of lamp. There were no indications given in the Brush specification respecting transformers either up or down. He did not see in the original specification as it stood any want of good faith, and he thought it showed great skill and knowledge on the part of the inventor.

This closed the case for the plaintiff, and the Court adjourned till

FRIDAY.

Mr. Fletcher Moulton opened the case for the defence by a complaint that the plaintiffs' counsel had hinted that litigation brought had been successful, and had brought absolutely no evidence on the point. He explained that the difference in this case was that one had to go back from the adult stage of a great industry to what might be called its infant stage. His Lordship had stated that one did not commence an industry of this kind until there was an accumulative knowledge, premising so much that one could step from the individual sporadic use of the means at your disposal to large schemes of combined action. He held that new results might be derived from this knowledge without entailing invention. After a brief *résumé* of the history of electrical engineering, Mr. Moulton described the systems of arc lighting in 1877, which were followed in the early eighties by the incandescent lamps lighted on the Edison system with the lamps in parallel. He argued that when one was used to connect lamps in parallel in one's own house there was no invention in expanding the system so that several consumers could be supplied in parallel by the same means. For instance, say the Brotherhood engine had been used to drive a certain machine, one could not patent the use of the Belliss engine for driving the same machine. The Electric Lighting Act of 1882 arranged for the distribution of electrical energy, and placed no restriction on the use to which electrical energy should be put. Thus if a man were supplied at constant potential with alternating currents, there was nothing to prevent him from placing a transformer across the mains to vary the voltage on his lamps. The connecting of lamps in parallel on the secondary of a transformer certainly was not new. They were then reduced to the plaintiffs' claim for the position in which he placed the transformer, but this was practically common knowledge, as was shown by the Electric Lighting Act of 1882. They were told that there was novelty in making a transformer which could be connected in parallel without burning out, but he saw no information in the patent specification of the plaintiff which would justify a royalty for its use. Gaulard and Gibbs showed how to use lamps on the secondary of a transformer, and the Brush specification gave diagrammatically the plaintiffs' system. He also held that the article in the *Times* by Fuller described a similar system to the plaintiffs'. With respect to Edison's specification, he held that Edison did all that the patentee did, and more, and that all the criticisms which had been made upon Edison's invention related to the more—in other words, if they took away the part which had defects, it then left the plaintiffs' system. He held that Edison's arrangement was successful. He knew that Mr. Swinburne had condemned the type of transformer shown in the Edison specification, but Edison said distinctly that it could be used with any form of transformer. Mr. Moulton then treated of the description of the Zipernowsky and Déri apparatus published in Vienna, which, he held, enabled the arrangements to be thoroughly understood. He held that the plaintiffs really invented a system by which they made the regulation of the voltage in the primary mains very accurate. He thought that the explanation, "The tension as constant as possible," in the amended specification, really referred to the apparatus for regulating this voltage, which had been cut out by the amendment. If this was so, the inventors did not presume to claim generally what was now read into the claim by the plaintiffs' counsel and experts. The evidence in the patent itself showed that Zipernowsky and Déri recognised that the laws of transformer design were well known. The sentence, "Now the electromotive forces of the two coils of a transformer bear a constant ratio to one another," was spoken of by the inventors as a matter of common knowledge on which to base their conclusions as to the effect of internal resistance of the constancy of the secondary pressure. The expression that the internal resistance must be kept very low was not sufficiently clear to give to an engineer when making transformers. The choking action in a transformer was well known before the date of the patent, as was shown by Mr. Rankin Kennedy's articles. He thought that the "substantially as described" in the claim referred to the apparatus for making the tension as constant as possible, which was now disclaimed. In conclusion, he reiterated his opinion that the claim was one for connecting transformers in parallel on the mains, and that Brush and Fuller, as well as Zipernowsky's own paper, proved that this was old. Hence the validity of the patent could not be maintained, and he held that the patent was also upset by the common practice of connecting consumers in parallel, as evidenced by the Electric Lighting Acts of 1882, which would invalidate the patent quite apart from any specific anticipations.

Lord Kelvin was then examined by Mr. Moulton. He said the distribution from alternating-current machines to lamps in parallel had been used in 1882 at the Health Exhibition, and also at his college at Cambridge. The invention of the induction coil was due to either Henry or Faraday somewhere about 1848. The improvement in laminating the cores was discovered before 1870, and he thought that at the date of the patent information necessary for transforming up an alternating current was known. The high-tension distribution saved copper. He had seen Edison's specification, and agreed that Edison did what the patentee did, and more besides. The defect in Edison's system was in those parts outside the plaintiffs' system. He gathered from Mr. Rankin Kennedy's article that he understood the self-governing system of distribution obtained by connecting transformers in parallel, but that Mr. Rankin Kennedy had not thoroughly thought out the effects of parallel connection on the conductors. He found nothing novel in the plaintiffs' specification beyond what was contained in the inventions of Brush, Fuller, and Edison. It was quite customary at the date of the patent to study to increase efficiency by keeping the resistance of electrical circuits low.

Cross-examined by Mr. Bousfield, Lord Kelvin described the distribution system of charging accumulators at high potential and then connecting them in parallel for discharging purposes. He had taken out a patent himself for a means of ensuring that the high voltage used in charging should not go on to the consumers' wires. This system was provided for in the Act of 1882. There was no provision in this Act, however, for alternating currents of higher pressure than 100 volts. The storage battery system was too costly to be successful, and hence electrical engineers were in 1883 4-5 endeavouring to find a better means of distributing electricity at high tension and utilising it at low. The Gaulard and Gibbs's was one such system which was partially successful. He explained that the reason why electrical engineers with prior knowledge of Edison's and Fuller's devices did not perfect the same before the plaintiff was because they preferred to work with continuous currents. He supposed that while the system was known no one had thought to apply it to town lighting. The Fuller system of transforming up would not save copper in the line. He thought from the plaintiffs' specification with the common knowledge in 1885 an electrician would be able to carry out the system in practice.

He was then cross-examined as to the effect of resistances of the transformers, and contended that in this respect the plaintiffs' specification was not sufficiently explicit. He also stated that the impedance of the transformer, as well as the resistance of the circuits, had to be considered.

The Court then adjourned until Monday.

MONDAY.

Lord Kelvin, further cross-examined by Mr. Bousfield, said that the plaintiffs' system was described in Edison's specification. The plaintiffs' system of putting the primaries in parallel was one of the elements which changed the failure of the Gaulard and Gibbs system into a success. He thought that others might have solved the problem, as the means for doing it were fully published before

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the date of the specification. He had read Prof. George Forbes's article of Feb. 26, 1886, which showed that the author did not agree with the plaintiffs' system. The question of the design of transformers was then taken up, and Lord Kelvin stated that the information given as to the resistance of the coils was quite insufficient to enable a practical transformer to be made. There was other information on the subject at the time, and makers of Ruhmkorff coils knew how to proportion the number of coils in primary and secondary. He could not give any directions from Clark Maxwell's writings on the general design on transformers to maintain constant potential. Dr. Hopkinson's specification provided automatic means for regulating the voltage on the secondary, and he thought such a regulator was useful to-day. Ruhmkorff coils had been used as transformers with the contact breaker screwed down. In the Edison specification he could find no hint that the resistance of the transformers should be kept low to give a practical system. With the Gaulard and Gibbs system the resistance in the transformer coil did not affect the working of the apparatus.

Re-examined by Mr. Moulton, Lord Kelvin said that in his opinion the specification of the plaintiffs' did not add anything to the then knowledge of the world as to the effect of such an arrangement or the mode of carrying it out. Hopkinson's device could be, and was, used to counterbalance the irregularities of public supply. Since the date of the patent, practical experience had been acquired respecting transformers, but he considered that no new principles for their calculation had been discovered. The transformer shown in the Edison specification was modified by the description in the text. If the coils were wound over each other, the transformer would work better than if these coils were placed in different parts of the core.

Mr. E. Fesquet, examined by Mr. Moulton, said he knew Mr. Gaulard in 1882, and was with the Jablochkoff Company at the Aquarium Exhibition in 1883. The Gaulard transformers used there were provided with primary circuits of thin wire. The secondary coils were formed on four separate bobbins connected either in series or parallel according to the voltage required. The connections were made on terminals at the top, and the arrangements were frequently changed. He knew at that date how to vary the voltage by altering the number of turns. He had met Mr. Mackenzie at the exhibition.

Cross examined by Mr. Bousfield, Mr. Fesquet said that Mr. Mackenzie had as much opportunity of seeing what was none as he had. He did not make transformers for Gaulard and Gibbs until 1884. With constant potential on the primary of a transformer, the voltage on the secondary did not vary with the number of lamps in use. After considerable questioning, Mr. Fesquet admitted that with the resistance of the Gaulard and Gibbs transformers the secondary would vary with the number of lamps. Working on the series system, the resistance of the transformer was not so important. In those days the practical way of maintaining the voltage constant on lamps supplied in parallel from a dynamo was to vary the speed, and hence it was not so important to keep the internal resistance of the dynamos low. The witness was then referred to an issue of the *Electrical News* describing the installation of electric light at the Aquarium in 1883. The switches shown at the base of the four transformer columns affected only the primary circuits. These transformers were experimented with to see which way they would give the best lighting effect. Mr. Fesquet contended that they were tried both with their primaries in series and in parallel, and that the drawings and description in the *Electrical News* were incorrect. The dynamo supplied at 400 volts; he thought the transformers could stand this pressure, although when connected in series they would only get 100 volts each. He made a drawing of the connections which he believed were used.

Re-examined by Mr. Moulton, Mr. Fesquet said he had coupled the primaries of the Aquarium transformers both in series and parallel. Mr. Gaulard preferred the series connections, because he could keep the current constant, and then knew that there was constant voltage on the secondary of the transformers.

Mr. S. Z. de Ferranti, examined by Mr. Cripps, said he found nothing novel in the specification of the plaintiffs', either as to the system used or as to the instruments used with the system. The constant ratio of transformation in a transformer was well known by himself and others before the specification was published. It was also known that the secondary circuits should have a low resistance. With the Brush specification and the connections shown in Fig. 9 there would be no invention in replacing an arc lamp by a group of incandescent lamps. This had been done at Brighton and elsewhere in 1882 or 1883.

The Court then adjourned.

Tuesday.

Mr. S. Z de Ferranti, further cross-examined by Mr. Cripps, agreed with what Lord Kelvin had said respecting the Edison specification. Edison's description of a transformer, taken with the diagrams, would refer to an up-to-date transformer. He considered that the article on the Zipernowsky and Déri system published in Vienna gave quite as clear a description of this system as the specification.

Cross-examined by Mr. Bousfield, Mr. Ferranti said that the Gaulard and Gibbs installation, as used on the underground railway, was bad because of its want of regulation, and because it was not easy to design a series system in order to meet required extensions. He considered that in 1883 the importance of having low internal resistances in electrical machinery was well understood. His own dynamos, as supplied to the First Avenue Hotel in 1883, had been replaced by continuous-current machines because of the inductive action in the wiring making the regulation bad. He would not admit that these machines had too high an internal resistance. In the Zipernowsky and Déri article the statement that "switching off 199 lamps out of 200 would not affect the economy of distribution in the slightest degree" was wrong, because it would mean absolute perfection. He had read Mr. Rankin Kennedy's article, and gathered from that that he quite understood the choking action with transformers. The article showed that he was quite clear as to this action, but that he had not fully considered the question of parallel distribution. Evidently he had written the article against time, and had not afterwards gone further into the subject. The transformer described in the Fuller specification was quite consistent with a successful transformer with two closed magnetic circuits. He did not consider Edison's system of obtaining alternating currents from continuous impossible, as he had had considerable success in designing rectifiers. All of the knowledge required to design transformers was known to him and others before the date of the patent specification. At that date alternators might have a drop of 25 per cent. at full load, but it would not be more than that. In fact, some machines supplied in 1883 had wonderful regulating properties. The Brush specification might be wrong with respect to Fig. 8, but the description of Fig. 9 was quite correct. Although engineers might not fully understand the effect of magnetic leakage at that date, they might still be able to design by trial and error a successful apparatus. In the patent he had taken out on Dec. 11, 1885, he had shown a similar system to the plaintiffs' with provision for connecting and disconnecting transformers in order to avoid magnetising loss.

Re-examined by Mr. Moulton, Mr. Ferranti said this patent referred to banking transformers, and gave improved economy. He considered that Edison's description of his transformers more clearly showed what should be done than did the plaintiffs'. He also found in the extract quoted from the Brush specification that Mr. Brush understood the choking action in a transformer. The large Siemens alternators exhibited at the Health Exhibition in 1883 fed 1,000 lamps, and regulated very closely.

Mr. Eli Collins, examined by Mr. Moulton, said he was employed in the Patent Office library. He then gave the dates at which the various books referred to had been received and placed on the table. The *Zeitschrift fuer Elektrotechnik* in which the article of Zipernowsky appeared was deposited in the library on March 14, 1885.

Mr. Fletcher Moulton then commenced to sum up the case on behalf of the defendants. His first proposition was that at the date of the plaintiffs' specifications the parallel system of distribution, giving each consumer a supply of electrical energy at constant potential, was perfectly well known both for continuous and alternating currents. It was also recognised that the two poles in the consumers' houses were a substitute for a machine producing electricity at constant potential. The second proposition which he established by the evidence was that the transformer was as that date known as a machine which multiplied up or down the potential across the primary, He then reviewed the evidence as to the knowledge of transformer design, and argued that unless the knowledge was assumed, the plaintiffs' patent fell through, as it did not contain sufficient information to teach people what transformers would not burn up and what transformers would. He held that the bulk of the evidence showed that the constant transforming ratio of a transformer supplying in parallel was known to electrical engineers at the date of the patent. His third proposition was that it was known that transformers could be connected across the terminals of such machines. His fourth proposition was that it was old to use an induction coil with its primary excited and the lamps in parallel on the secondary. This, he argued, was proved by the Brush, Fuller, and Edison systems, and also by the article referred to as the Zipernowsky and Déri article. This article, he claimed, gave a more clear description of the plaintiffs' invention than the specification. There was also more information in the article than in the specification. He contended that Mr. Fesquet's evidence on the connections at the Aquarium exhibition transformers had not been upset in cross-examination. As regards Edison's system he quoted clauses to prove that the faulty section of a patented system would render invalid a subsequent patent for successful details which were described in that patent. As Edison had done all that the plaintiffs had claimed, any defects in the addition would not prevent the remainder invalidating the plaintiffs' specification.

Wednesday.

Mr. Moulton, resuming his summing up of the case for the defence, proceeded to deal with the plaintiffs' specification. Taking the claim first he pointed out that this read as follows: "In the application of induction coils or transformers for alternating electric currents the arrangement of several stations of second order as branch circuits of the main line—*i.e.*, connecting up the local centres with the main line in multiple, or to which main line is supplied, an alternating electric current of a tension as constant as possible substantially as described and shown in the drawing." The drawing showed arrangement only, and hence he argued that the claim was practically one for connecting transformers in parallel, exactly as was done in Fig. 9 of the Brush patent. The words "substantially as described and shown in the drawing" might refer to the other devices for keeping the tension as constant as possible which had been struck out of the amended specification. He argued that the claim was invalidated by its broadness, and that the plaintiffs tried to save it by introducing limits which were not considered necessary by the original patentees. The ratio of the E.M.F.'s of the two coils of a transformer, the influence of the internal resistance, although pointed out, were nullified by the statement that any form of transformer

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could be used without departing from the principle of the invention. Also the attempt to read high tension and low tension into the patent was not supported by anything in the claim, while the advantages of using high tension in distributing and low tension on the consumers' premises were well known before the date of the patent. Mr. Moulton proceeded to argue that the low resistance spoken of in the body of the specification only referred to the secondary coils. It had been pointed out by his witnesses that the resistance of the primary coils was some 500 to 600 times greater than that of the secondary, and this resistance could not be called low. In fact, the whole question simply depended on the working of the well-known Ohm's law. He argued that because Mr. Ferranti and Dr. Hopkinson had patented improvements to the plaintiffs' system, it could not be held that they did not recognise how good the system was. The Hopkinson three-wire patent was not a parallel one to this, because it described what was really a novel arrangement. Mr. Moulton proceeded to quote from past decisions of the House of Lords to prove that the combination of two well-known pieces of apparatus could not form the subject of a valid patent. He stated his final opinion that the arrangement claimed was old, and that the plaintiffs had attempted to read limits into it which no one could get from the document. Their object was to limit the claim, which was fatally broad. He submitted that the patent must be held to be invalid.

Mr. Bousfield proceeded to sum up the case for the plaintiff, his speech being continued on Thursday. At the close of this, his **Lordship** said he would take time to consider the evidence, and give his judgment at a later date.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED, v. SOUTH AMERICAN CABLE COMPANY, LIMITED.

In the Commercial Court on the 30th ult., before Mr. Justice Kennedy, the plaintiffs obtained judgment for their full claim of £475 and costs. The point of contention was the construction of an agreement as to the proportion of receipts payable for messages or exchange traffic between the two companies.

COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq., Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq., 96, Ashley-gardens, Westminster; Edwin Tate, Esq., 21, Mincing-lane, London, E.C.

Report of the directors, with abstract of accounts, for the half-year ending Dec. 31, 1899, to be submitted to the half-yearly ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on Monday, Feb. 5, at 12 noon:

The receipts from all sources for the past half-year have amounted to £27,506. 1s. 3d., and the cost of working has been £15,968. 4s. 6d., leaving a profit of £11,537. 16s. 9d. Inclusive of the balance brought forward from June 30 last, the net revenue account shows an aggregate total of £15,538. 4s. 8d. After making provision for the debenture stock interest, a balance remains available for dividend of £11,429. 19s. 6d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 1¼ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,267. 9s. 6d. to be carried forward to the next account. Your directors regret the diminution in the dividend, arising from the increased cost of materials and from the fact that the ordinary stock, ranking for dividend, has been increased by £225,000, expended on lines not yet open for traffic. The following table shows the number of passengers, exclusive of season-ticket holders, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders).	Receipts (including season tickets).
Dec. 31, 1890 (11 days)	165,000	£1,568 3 9
June 30, 1891	2,412,343	19,403 6 9
Dec. 31, 1891	2,749,055	19,798 16 6
June 30, 1892	2 813,162	20,931 4 2
Dec. 31, 1892	3,117.602	22,002 17 5
June 30, 1893	3.146,656	22,458 6 9
Dec. 31, 1893	3,093,351	22,067 14 10
June 30, 1894	3.383,154	23 564 10 6
Dec. 31, 1894	3.275,649	23,540 12 4
June 30, 1895	3 113,199	23,711 5 8
Dec. 31, 1895	3,172,438	23,780 3 7
June 30, 1896	3 192,672	24 021 13 0
Dec. 31, 1896	3,368,480	25.456 6 9
June 30, 1897	3,437,810	26,403 3 6
Dec. 31. 1897	3,337,861	25,472 12 10
June 30, 1898	3 478 977	26,356 16 4
Dec. 31, 1898	3,462,814	26,319 14 10
June 30, 1899	3,540,098	26,749 3 0
Dec. 31, 1899	3,442,942	26,197 14 10
Total since the opening of the line	57,703,263	£429,804 7 4

Your directors regret that owing to the delay on the part of the several contractors, it was found impossible to open the Moorgate-street extension line at the date anticipated in the last report. Every possible pressure has been put upon the contractors, and the works are now so far completed that it is hoped the sanction of the Board of Trade for opening for public traffic will be obtained within the next two or three weeks. The delay has been a source of great disappointment, as the capital expended on the construction and equipment of the extension has consequently been unproductive in place of earning an adequate return. The works on the Clapham extension are rapidly approaching completion; the surface stations are well advanced, and there is every prospect of its being ready for public traffic within the next three months. The sites for the stations on the Islington extension have been acquired, and are in the hands of the contractors; good progress has been made with the tunnelling; 579 yards on the up line and 550 yards on the down line have been driven. The subway at London Bridge to connect this Company's station at the corner of Denman-street with that of the London, Brighton, and South Coast Railway, will be commenced as soon as some preliminary boring operations have been completed. Of the 10 locomotives referred to in the last report as under contract, eight have been delivered and are giving satisfaction. The principal works for the generation of the current necessary for running the trains to Moorgate-street are now completed, and the further power required for the extension to Clapham is expected to be ready early in March. A large new carriage shed is in course of erection. The Bill which will be submitted for approval at the conclusion of the ordinary general meeting is to obtain the sanction of Parliament to substitute a tunnel of 30ft in diameter for two of 21½ft. at the station at the Islington terminus, whereby greater convenience will result in the working of the traffic and a saving in the cost of construction. Negotiations are in progress with the Great Northern and City Railway Company for the construction of a joint station at the corner of Old-street for the exchange of traffic between the two companies; and a Bill has been deposited in Parliament by the Baker-street and Waterloo Electric Railway Company, now in course of construction, for the extension of that line from Waterloo to join this Company's railway at the Elephant and Castle station. In accordance with the powers conferred on the Company by the City and South London Railway Act of 1898, the half-year's dividend on the 5 per cent. perpetual preference shares issued in 1896 will be charged to capital. The warrants for this and the other dividends will be posted on the 12th prox. The directors who retire by rotation on this occasion are Mr. Sampson Hanbury and Mr. S. Barclay Heward, both of whom are eligible for re-election. Mr. James Lorimer Oliver is the retiring auditor, and is eligible for re-election.

Dr. REVENUE ACCOUNT.	£	s.	d.
Maintenance of way, works, and stations	675	17	10
Locomotive and generating power	5,899	7	7
Carriage repairs	488	1	0
Traffic expenses	6,136	7	10
General expenses	1,876	10	10
Law charges	4	4	0
Rates and taxes	834	18	6
Passenger duty	52	16	11
	15,968	4	6
Balance carried to net revenue account	11,537	16	9
	£27,506	1	3

Cr.	£	s.	d.
By passengers (3,442,942)	25,199	13	3
Season tickets (459)	998	1	7
Parcels, etc.	152	9	1
	26,350	3	11
Transfer fees	19	2	6
Rent of property	1,023	1	1
Sundry receipts	113	13	9
	£27,506	1	3

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Balance from net revenue account	11,429	19	6
Unclaimed dividends and interest	63	11	3
Interest payable or accruing and provided for	1,393	1	9
Contractors' retention fund	48,980	0	0
Sundry outstanding accounts	21,385	4	3
Loan account	219,200	0	0
Reserve fund	1,000	0	0
	£303,451	16	9

Cr.	£	s.	d.
Cash at bankers, current accounts	8,447	15	0
On hand	310	3	11
	8,757	18	11
General stores	5 595	19	11
Sundry outstanding accounts	5,899	13	6
Investments: balance June 30, 1899, £117,239. 5s. 6d.; less proportion of interest received applied in reduction of premiums, £239. 5s. 6d.	117,000	0	0
Debenture stock issued against loans	30,680	0	0
Balance from capital account	135,518	4	5
	£303,451	16	9

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LIVERPOOL OVERHEAD RAILWAY.

Report of the directors to be presented to the twenty-third ordinary half-yearly general meeting of the shareholders, to be held at the Law Association Rooms, 14, Cook-street, Liverpool, on Tuesday, Feb. 13, at 3 p.m. :

In presenting the half-yearly statement of capital and revenue accounts to Dec. 31, 1899, the directors have to report that the gross revenue receipts amount to £42,928. 11s. 9d., and the working expenses to £25,007. 5s. 5d. The number of passengers carried during the last two years is as follows :

	Half-year ending June 30, 1898.	Half-year ending Dec. 31, 1898.	Half-year ending June 30, 1899.	Half-year ending Dec. 31, 1899.
First-class	637,547	663,177	594,669	676,768
Second-class	2,686,651	2,962,827	2,445,572	2,941,392
Workmen (special return tickets).	1,148,743	1,268,917	1,435,038	1,596,797
Total	4,472,941	4,894,921	4,475,279	5,214,957

There has been an increase in the number of passengers carried of 320,036, and in receipts of £1,940. The works of the Waterloo and Great Crosby tramways are proceeding, and it is hoped they will be opened for traffic during the half-year. The directors are promoting a Bill in Parliament for a short extension northwards, to join the Seaforth Station of the Lancashire and Yorkshire Railway, and southwards for a short line beyond the Herculaneum Station, and for widening the line at Pierhead Station.

Revenue Account.

Receipts from passenger traffic amount to	£42,011	7	8
Miscellaneous receipts and interest	917	4	1
	42,928	11	9
Less working expenses	25,007	5	5
	17,921	6	4
Deduct interest on mortgage debentures	3,400	0	0
	14,521	6	4
Add balance brought forward, June 30, 1899	4,320	8	3
Leaving available for dividend	£18,841	14	7

Out of this balance your directors recommend the declaration of dividends at the following rates (less income tax), payable on and after Feb. 16 next: 5 per cent. per annum on preference shares, £3,000; 5 per cent. per annum on ordinary shares, £11,250; leaving a balance of £4,591. 14s. 7d. to be carried forward to next half-year. The directors retiring by rotation at this meeting are Mr. Richard Hobson and Mr. James Barrow, who, being eligible, offer themselves for re-election. The auditor retiring by rotation is Mr. George Nicholson, who is also eligible for re-election.

REVENUE ACCOUNT.

Expenditure.	£	s.	d.
Maintenance of way, works, and stations	4,168	1	4
Locomotive power	6,995	16	4
Repairs and renewals of carriages	446	2	4
Traffic expenses	9,071	2	2
General charges	2,155	1	2
Law charges	66	17	0
Compensation	10	7	0
Rents, rates, and taxes	2,009	17	7
Government duty	84	0	6
	25,007	5	5
Balance carried to net revenue account	17,654	19	4
	£42,662	4	9

Receipts.	£	s.	d.
Passenger traffic	42,011	7	8
Parcels, etc.	49	12	2
Rents	587	15	5
Transfer fees	13	9	6
	£42,662	4	9

SMITHFIELD MARKETS ELECTRIC SUPPLY.

The report of the directors for the 15 months ended Dec. 31, 1899, to be presented to the shareholders at the general meeting to be held at Winchester House, E.C., on Feb. 9, at noon, states that the gross revenue amounts to £12,083. 6s. against £6,501. 5s. 2d. for the year ending Sept. 30, 1898, while the gross profit on trading had been £3,435. 0s. 9d., against £759. 3s. 1d. for the same period. That result would have been even better but for the difficulty which the Company had experienced, in common with all other electric lighting companies, in obtaining the best quality of steam coal, and the consequent largely increased consumption. Nevertheless, further reductions had been effected in the costs per unit generated and sold. The net profit for the 15 months, after paying debenture interest and other charges, was £564. 18s. 2d., thus reducing the deficit existing at Sept. 30, 1898, to £210. 2s. 8d. That amount would it was anticipated have been more than wiped off by the end of January, 1900. The conviction expressed by the directors in their last report that the use of electricity in the Central Markets was likely to become more popular had been borne out by results. During the period covered by the accounts 78 new installations had been obtained and the increase in the number of lamps connected had been 7,237, or 74 per cent. As about one-half of those lamps were connected during the last three months of the year the full effect on the revenue would only be apparent in the current year's accounts, which would show a further substantial increase. New customers were constantly being obtained and several were at present waiting to be connected. The plant and machinery had been worked satisfactorily throughout, no interruption of any kind having occurred in the supply. The storage battery had been in use since October last with economical results. The value of that battery in the saving of coal and wages would be considerably enhanced during the summer months, as it would enable the plant to be shut down for several hours per day, as well as ensuring against failure in the supply at all times. The directors regretted that their application for a provisional order to enable them to supply current in the City of London had been unsuccessful. The cost of the application will be spread over a period of five years. Mr. H. S. Leon had been appointed a director to fill the vacancy caused by the retirement of Mr. G. H. Brougham Glasier. The director retiring under the articles of association was Mr. Ernest Schenk, who, being eligible, offered himself for re-election. The auditors, Messrs. Ford, Rhodes, and Ford, also retire, and offer themselves for re-election.

TRADING ACCOUNT, 15 MONTHS ENDED DEC. 31, 1899.

Dr.				£	s.	d.
Generation of Electricity.						
Coal, cartage of ashes, etc.	£2,600	8	8			
Oil, water, and engine-room stores	428	5	5			
Wages at generating station	1,280	7	5			
Repairs and maintenance: (*a*) plant and machinery, £686. 13s. 5d.; (*b*) buildings, £78. 2s. 7d.	764	16	0			
				5,073	17	6
Distribution of Electricity and Maintenance.						
Repairs and maintenance of mains, meters, etc.	17	5	9			
Maintenance of installations	924	4	4			
Lamp renewals	521	11	9			
				1,463	1	10
Rent, Rates, and Taxes.						
Rents payable	660	0	0			
Rates and taxes	289	15	11			
				949	15	11
Management Expenses.						
Salaries of secretary, chief engineer (proportion), clerks, and collector	699	16	1			
Stationery and printing	64	19	2			
General charges and office expenses	147	19	4			
				912	14	7
Legal Charges and Insurance.						
Legal charges	56	2	0			
Insurance	95	18	5			
				152	0	5
Compensation				70	10	0
Audit fee				26	5	0
Total expenditure				8,648	5	3
Balance to profit and loss account				3,435	0	9
				£12,083	6	0

Cr.	£	s.	d.
Sale of current	9,605	2	8
Meter rents	121	8	6
Installation charges	423	17	9
Sundry receipts, discounts, etc.	50	12	1
Transfer fees	7	5	0
Rent of cold-air store	1,875	0	0
	£12,083	6	0

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Interest on 4 per cent. debenture stock, paid and accrued	2,500	0	0
Interest on 5 per cent. second mortgage debentures accrued	47	15	7
Proportion of preliminary expenses	137	15	4
Proportion of provisional order expenses	233	15	9
Trustees' fees	62	10	0
Balance to general balance-sheet	564	18	2
	£3,546	14	10

Cr.	£	s.	d.
Balance from trading account	3,435	0	9
Interest on deposits	111	14	1
	£3,546	14	10

EASTERN TELEGRAPH.

The half-yearly general meeting was held Thursday last week. The report, published in our last issue, was adopted.

The **Marquis of Tweeddale**, who presided, said they had asked the Government to reconsider their late decision, by which all war news was to be sent by the West Coast route only. He denied that they were deriving enormous receipts from the effects of the war, saying that the additional traffic would be barely sufficient to recoup them for the loss which they might sustain from the subsequent disturbance of business.

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BIRKDALE AND SOUTHPORT TRAMWAYS.

At the half-yearly meeting on Tuesday Mr. N. Yates presided, and proposed the adoption of the report and the declaration of a dividend of 7½ per cent. The British Electric Traction Company had forfeited a deposit of £500 under an agreement for option of purchase. At a subsequent extraordinary meeting the sale of the Southport portion of the line (being five-eighths of the whole) to the Corporation for the sum of £12,500 was confirmed. The purchase price is equal to £3,430 per mile of single track.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS.

The fourth annual meeting of the shareholders was held on the 26th ult. in the Accountants' Hall, Manchester, Mr. T. J. Huchinson presiding. The directors' report stated that the last season consisted of 133 days, during which 37,593 miles were run, the total number of passengers was 100,769, and the gross traffic receipts £4,444. Deducting £740 for tolls to the Douglas Head Marine Drive. Limited, and adding £16 for sundry receipts, a total of £3,720, against £3,458, represented the net receipts. The profit for the season's working was £1,455, which, added to the profit balance brought down from the last balance-sheet, made a disposable balance of £1,806. The directors recommended that a dividend of 6 per cent. per annum be declared on the 7 per cent. preference shares, and the balance, £272, carried forward. The report was adopted.

Mr. Huchinson, the chairman of the Company, was re-elected a director.

WATERLOO AND CITY RAILWAY.

The report for the half-year ended Dec. 31, to be submitted on 8th inst., states that the expenditure on capital account was £573,656. The further estimated expenditure of £40,000 is amply provided for by the capital powers of the Company. The gross receipts amounted to £13,349. Out of this amount £4,824 has been retained by the L. and S.W. Railway for working expenses, leaving £8,525 for a dividend at the rate of 3 per cent. per annum. The number of passengers carried is given at 1,769,731, exclusive of 776 season-ticket holders.

GREENOCK AND PORT-GLASGOW TRAMWAYS.

The ordinary meeting will be held on the 5th inst., when the half-yearly report by the directors will be submitted. The directors recommend a dividend at the rate of 5 per cent. per annum. The report states that on the 9th ult. a fresh offer was made to the Police Board of £1,200 per annum rent for the Greenock tramway lines, but, so far, no answer had been received. Mr. John MacOnie and Mr. D. M. Erskine are the retiring directors, and they are eligible for re-election.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Salford.—The Electric Light Committee invite tenders for supplying and fixing iron and steel work required at the electricity station. Tenders by 12th inst.

Rochdale.—The Corporation invite tenders for the supply and delivery of electricity meters. Tenders by 28th inst. Full particulars in our advertising columns.

Belfast.—The Electric Committee invite tenders for the supply and erection of 400-kw. steam dynamos. Tenders by Feb. 8. Particulars in our advertising columns.

Tunbridge Wells.—The Corporation invite tenders for two Lancashire boilers for their electricity works. Tenders by Feb. 5. Full particulars in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply and erection of two overhead electric travelling cranes. Tenders by Feb. 5. Full particulars in our advertising columns.

Chingford.—The Walthamstow Urban District Council invite tenders for the supply and erection of electric and Dowson gas plant at their isolation hospital. Tenders by Feb. 17.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for 130 car bodies, trucks, and electric equipment. Tenders by March 2. Details in our advertising columns.

Dudley.—The Electric Lighting Committee invite tenders for the supply and erection of pump, feed-water heaters, and pipe work. Tenders by Feb. 8. Details in our advertisement columns.

Stoke-upon-Trent.—The Guardians invite tenders for the proposed electric lighting of a portion of the workhouse premises. Tenders by Feb. 15. Full particulars in our advertisement columns.

York.—The Corporation invite tenders for the conversion of the wiring of the Courts of Justice to suit the higher voltage of the supply mains. Tenders by Feb. 15. Details in our advertisement columns.

York.—The Corporation invite tenders for the conversion of the wiring of the public library to suit the higher voltage of the supply mains. Tenders by Feb. 15. Details in our advertisement columns.

Beetle.—The Corporation invite tenders for the supply and laying, within the borough, of certain underground electric cables. Tenders by Feb. 17. Details in our advertisement columns.

Wood Green.—The Urban District Council invite tenders for the construction of refuse destructor cells or furnaces. Tenders by Feb. 8.

Bath.—The Corporation invite tenders for the supply, etc., of cables (high and low tension), arc lamps, posts, and accessories, transformers, sub-station switchboards, and main works switchboards. Tenders by Feb. 12.

Burnley.—The Urban District Council invite tenders for the construction of refuse destructor works. Particulars may be obtained from Mr. John Gregson, surveyor, Council-chambers, Padiham. Tenders by Feb. 10.

Kingston-upon-Hull.—The Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked, to seat about 51 passengers). Tenders by Feb. 19. Details in our advertising columns.

Hastings.—The Corporation invite tenders for the supply and delivery of 12 20-kw. alternating-current transformers and high and low tension sub-station switch gear. Tenders by Feb. 12. Details in our advertisement columns.

Bedford.—The Electric Light Committee invite tenders for the supply, delivery, and erection of one surface condenser, with air and circulating pumps, and engine for driving same. Tenders by Feb. 6. Details in our advertisement columns.

Great Yarmouth.—The Corporation invite tenders for the supply and erection of two water-tube boilers (Section A); three 200-kw. continuous-current steam dynamos (B) Tenders by Feb. 15. Full particulars in our advertisement columns.

Glasgow.—The Corporation invite offers for the supply of 200-300 motorcar trucks; 200-300 motors and equipments; the supply, delivery, and erection complete of the overhead trolley. Tenders by Feb. 17. Details in our advertisement columns.

Portsmouth.—The Corporation invite tenders for 12 months supply of electrical goods, etc., from April 1 next. Tender are to be endorsed "Stores Tender," and to be forwarded to the Superintendent, Electric Light Station, Gunwharf-road, Portsmouth, not later than Feb. 10.

Hull.—The Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked, to seat about 51 passengers). Specifications, etc. (£1), may be obtained of Mr. A. E. White, city engineer, Town Hall, Hull. Tenders by Feb. 19.

Keighley.—The Corporation invite tenders for the supply and erection of two Lancashire boilers, with mechanical stokers, economisers, feed pumps, etc.; and 120-kw. and 200-kw. high-speed direct coupled steam dynamos for continuous current. Tenders by Feb. 13. Full particulars in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of tramways switchboard. Specifications and forms of tender can be obtained of Mr. J. F. C. Snell, borough electrical engineer, at his office, Dunning-street, Sunderland, on payment of two guineas. Tenders to Mr. Fras. M. Bowey, town clerk, by 12 noon on 26th inst. Details in advertisement columns.

West Ham.—The Guardians of West Ham Union invite tenders for (1) supply and erection of the plant, etc., for the electric lighting of the workhouse and school premises at Union-road, Leytonstone, Essex, (2) erection of the engine and battery house for same. Plans and specifications may be inspected at the Clerk's Office. Tenders by 4 p.m. on Feb. 7.

Middleton (Lancs.).—The Corporation invite tenders for the building of electricity works, in accordance with plans and specifications prepared by Messrs. Lacey, Clirehugh, and Sillar, electrical engineers to the Corporation, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Plans, etc., may be obtained from Mr. Frederick Entwistle, town clerk, Town Hall, Middleton. Tenders by Feb. 14.

Horsham.—The Urban District Council invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, &c., pipework, etc., in engine and boiler house, two steam dynamos (vertical enclosed high-speed engines), and motor boosters, storage batteries, main switchboard and connections, six-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed type) and posts, station lighting. Tenders by March 1. Full particulars in our advertising columns.

Inverness.—The Town Council invite tenders for the supply and erection of two steam dynamos, each of 200 kw. output; one fuel economiser; one motor balancer and booster; one 1,500 ampere-hour storage battery; three water-tube boilers, each to evaporate 6,000lb. of water per hour, with automatic stokers of approved make; overhead travelling crane; a complete system of switchboards; station lighting; street arc lamps, with accessories, as per schedule; feeders and distributors, as per schedule; joint and service boxes and service cables, as per schedule; meters, tools, and usual accessories. Tenders by Feb. 8. Details in our advertisement columns.

Melbourne (Victoria).—The Corporation invite tenders for the supply and delivery of the necessary plant, and the superintendence of its erection, and of the carrying out of the work in connection with the electric lighting of the city, to specifications as follows: (1) boilers (dry-back or water-tube type, with superheaters) and economiser; (2) steam-engines, dynamos, equaliser, booster, and switchboard; (3) feeders, mains, and arc light leads, with all bitumen or insulating material; (4) accumulators. Specifications, etc., can be obtained from the Agent-General for Victoria, 15, Victoria-street, Westminster, London, S.W., on and after the

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28th instant, on payment of £1. 1s. for each specification, to be returned on receipt by the Corporation of a bona fide tender. The specifications and drawings may be seen at (but not obtained from) the office of Dr. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders by March 1. Full particulars appear in our advertising columns.

RESULTS OF TENDERS.

Croydon.—The Electricity Committee have accepted a tender for the supply of a Green's patent fuel economiser, the price for the same being £375.

Middlesbrough.—The Council have accepted an offer of the Klein's Water-Cooling Patents (E. F. Jarvis) for the condensing plant at the electricity station.

Hackney.—The Vestry have accepted the tender of Messrs. Hughes and Stirling, of Clock House, Arundel-street, Strand, for the refuse destructor, at £24,495.

Manchester.—The tenders of the Brush Electrical Engineering Company for 220 double-decked cars, and of Messrs. Milnes, of Birkenhead, for 160 cars of the same pattern and 50 single-decked, have been accepted.

Bedford.—The Electric Light Committee have accepted the following tenders: W. H. Allen, Son, and Co., one 420-b.h.p. inverted compound double-acting engine, £1,600; Rosling and Appleby, one 250-kw. alternator, £1,200.

Newcastle.—The tenders of the British Westinghouse Motor Company for generators have been accepted as follows: A 2,000-h.p. generator, £16,000, the Wallsend Slipway Company to supply the engine; two smaller generators, £16,450, Colt's engine to be used.

West Bromwich.—The following tenders have been accepted; Messrs. E. Danks and Co., Limited, boilers; Messrs. C. A. Parsons and Co., steam dynamos, condenser, feed-water heater, and travelling crane; Messrs. Cowans, Limited, switchboard; British Insulated Wire Company, Limited, cables; Tudor Accumulator Company, Limited, storage battery and connections.

Bradford.—The Tramways Committee have accepted the following tenders: Brush Electrical Engineering Company, Limited, for supply of 75 additional car bodies on the same specification and general conditions as applied to the 25 cars already ordered from them; Messrs. Blackwell and Co., Limited, for supply of 75 additional trucks and trolleys for electric tramcars on the same conditions as the 25 already ordered.

BUSINESS NOTES.

TRACTION.

Renfrew.—The County Council intend to petition against the Glasgow District Tramways Dill.

Great Grimsby.—Standing Order proofs relating to this Bill will be considered on the 12th inst.

Birkenhead.—An unopposed enquiry has been held into a loan of £3,500 for Higher Tranmere supply mains.

Hove.—At a special meeting of the Town Council on Thursday week, it was definitely decided to oppose the Brighton Tramways Bill.

Potteries Electric Traction Co.—The preference share transfer books and register of members will be closed until the 15th inst., inclusive.

British Electric Traction Co.—The preference share transfer books and register of members will be closed until the 15th inst., inclusive.

Rawmarsh.—The memorial against the Urban District Council Tramways Bill has been withdrawn, and the Bill passed by the examiner.

Blackpool.—The borough surveyor has been instructed to prepare estimates for the laying of a tramway in Central Drive from Cow Gap-lane to Great Marton-road.

Holborn.—The Board of Works will oppose the Bills promoted by the London County Council for the construction of tramways in Rosebery-avenue and in St. John-street.

Christchurch.—The Town Council have formally assented to the construction of the proposed Christchurch, Bournemouth, and Winton tramways by the Poole and District Electric Traction Company, Limited.

Farnborough.—The Urban District Council are asking the promoters of the proposed Aldershot and Farnborough light railway to give a written undertaking not to carry goods traffic beyond their own coal for working.

Leeds Suburban Railway Project.—When the Leeds City and Suburban Railway Bill was called before the examiners last week there was no appearance on behalf of the promoters, and it was accordingly struck out of the list.

South Lancashire Tramway.—On Friday last a conference of local authorities was held at Wigan to consider the South Lancashire Tramways Bill. Among those represented were the Newton, Golborne, and Haydock District Councils.

Dover.—At the last meeting of the Rural District Council the Clerk reported that the engineers of the Cinque Ports light railway had stated that they should get over the difficulty of the narrowness of the road near Martin Mill by purchasing land to widen the road.

City of Buenos Ayres Tramways Co.—The directors on Wednesday decided to issue at once 20,000 new shares, as authorised by the general meeting held on Oct. 17 last. Circular letters offering the above to existing proprietors will be dispatched on 14th inst.

Bradford.—The City Council has been recommended by the Tramway Committee to purchase the unexpired portion (three years) of the lease of the Bradford and Shelf Tramway Company at three years' purchase—the rolling-stock to be valued by arbitration.

Darlington.—The differences between the Corporation and the Imperial Tramway Company are likely to be arranged, having been narrowed down to comparatively minor points. The Corporation are to supply the necessary power from their new electricity supply works now being constructed.

Vale of Rheidol Light Railway.—The object of the Bill, which has passed the examiner, is to extend the time for the purchase of lands, and for the construction of the authorised light railway between Aberystwyth and Devil's Bridge, and to work the traffic thereon by electrical or other motive power.

Manchester.—The Tramways Committee have confirmed the appointment of Mr. Wood, late of the town clerk's department, to the position of chief clerk at a salary of £150 per annum, and that of Mr. Schofield, late of the city treasurer's department, to the position of chief accountant at a salary of £200.

Brompton and Piccadilly-circus Railway.—As will be remembered, powers were granted last year to this company to construct an extension railway to connect with the Metropolitan District Railway at South Kensington Station. In the present Bill extension of time is sought until August, 1904, for the completion of the line.

Musselburgh.—The Edinburgh Town Council has approved of the application of the Drake and Gorham Electric Power and Traction Company, Limited, for a provisional order for the construction of tramways in Musselburgh, on condition that the company do not come within the city boundary excepting with consent of the Corporation.

Charing Cross, Euston, and Hampstead Railway.—By their Bill the Company seeks an extension of time for three years from Aug. 9, 1899, within which to acquire the lands necessary for the construction of this railway. An extension of time for five years from Aug. 9, 1899, is also required for the construction and completion of the authorised railways.

Herts.—The County Council have approved of the application to be made to the Light Railway Commissioners in the name of the Hertfordshire County Council and the Metropolitan Tramways and Omnibus Company, Limited, for an order authorising the County Council and the company to construct light railways (with the exception of that part referring to Chipping Barnet).

Durham.—The County Council have given their support and assent to the proposals of the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, who are promoting a provisional order under the Tramways Act, 1870, for the construction of tramways on the overhead electric trolley system for various districts of which the Durham County Council is the road authority.

Cheshunt.—The Highways Committee of the Hertfordshire County Council have resolved to recommend the County Council only to run the tramways as far as the extent of the Cheshunt boundary. The Cheshunt Urban District Council insist on the 50ft. roadway passed by the Council, and have declared that they will oppose the order unless the County Council guarantee them an indemnity from any expenses except the county rate.

London United Tramways.—The London United Tramways Company's Bill practically covers the ground gone over at the light railway enquiry last year, the Commissioners having decided that the scheme should go before Parliament. The principal extensions are from Hanwell to Chiswick, and from Twickenham *vid* Teddington, Hampton, Hampton Court, and Hampton Wick to Twickenham again. The estimate is about £340,000.

Kidderminster.—After a long discussion on Wednesday the Town Council passed a resolution to the effect that they would allow the British Electric Traction Company to lay a line through the Bull Ring to pass their cars over, but not for traffic purposes, and that they would assent to a clause in the tramway order enabling the Council, if they saw fit at a later period, to give the company power for a limited traffic through the Bull Ring.

Cleckheaton.—At the Council's last meeting it was stated that the British Electric Traction Company appeared to repudiate the undertaking of their agent, Mr. Paris, to the effect that the company would take electrical energy from the Council, and they were also seeking to withdraw from other promises. It was decided that steps be taken for the purpose of procuring the performance by the Traction Company of their agent's undertaking to the Council.

Middlesex.—The County Council on Thursday last approved of the principle of the construction of light railway tracks by the Council, and of leasing the same afterwards to a company or companies to equip and work. Apart from the cost of equipment, the 11 lines now being promoted by the County Council and the Metropolitan Tramway and Omnibus Company will entail an expenditure of £336,000, and that of the five lines by the County Council is estimated at £263,000.

Bolton.—The *Bolton Journal and Guardian* learns from unofficial sources that the Tramways Committee now unanimously favour the bogie car, and the question for consideration is how best to

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make arrangements to secure the change. Pending a settlement, it is understood that for the present only two cars of the type now in use will be delivered, bringing the number up to 34. Several small accidents occurred on the 26th ult. owing to cars jumping the rails. Fortunately no personal injury resulted in any case.

Plymouth, Stonehouse, and Devonport Tramways.—The General Tolls Company, Limited, has presented a memorial in opposition to the Plymouth, Stonehouse, and Devonport Tramways Company's Bill. The memorialists maintain that the power sought to use electrical power upon the company's system is tantamount in this instance to the making of tramways in the place of the existing tramways of the company, and that, therefore, the Standing Orders applicable to new tramways ought to have been complied with.

Greenock.—At a special meeting of the Police Board on Thursday last week, offers for the leasing of the tramways were considered from the Greenock and Port-Glasgow Tramways Company, Mr. W. Murphy, the Drake and Gorham Electric Power and Traction Company, London, and the English Industrials, Limited, Manchester. A committee was appointed to consider the offers and confer with the applicants. It was also agreed to engage the services of an expert to advise as to which offer would be financially the best for the town to accept.

Bangor (Ireland).—We learn that the Drake and Gorham Electric Traction Company, the promoters of the line from Bangor to Donaghadee, have been negotiating with a London syndicate with a view to selling their interest in the undertaking. Some months ago the order for the construction of the line was passed by the Privy Council, but the necessary authority to proceed has not yet been completed, and before this authority can be received a guarantee of £5,000 will require to be deposited, or in other words, 5 per cent. of the estimated cost of £100,000.

Blackburn.—The Tramways and Electricity Committee have decided to sanction the construction of an electric tramway in the Audley district. A local paper says the scheme suggested by Mr. Giles (the electrical engineer) is that the line shall commence in Mincing-lane, through Darwen-street, up Lower Audley-street, to Queen's Park, and this was considered favourably. However, as Mr. Giles will be engaged in the spring converting the Darwen, Cemetery, and Accrington sections into electric traction, it may be some time before the Audley scheme can be carried out.

Hoddesdon.—The following resolution which was carried at a recent public meeting, came before the Urban District Council last week—viz., "That this meeting heartily approves of the scheme of an electric tramway on the lines suggested by the County Council, and further hopes that the County Council will carry on the tramway to the northern boundary of Hoddesdon and to Rye House Station." The opinion of the Urban District Council appeared to be equally divided on the matter, so nothing was done beyond forwarding the resolution to the County Council.

Lewisham.—At the last meeting of the District Board of Works the following report was adopted: "The Tramways Committee have considered a letter from the vestry clerk of Penge, forwarding a copy of the resolution passed by the Vestry, as follows: 'That in the opinion of this Vestry the construction of tramways in Croydon, Anerley, and Crystal Palace roads is undesirable, as it would be detrimental to the residential property in such roads.' The committee recommend that the Vestry be informed of the action proposed to be taken by this Board—which is to oppose the scheme."

Newcastle.—At the last meeting of the New Tramways Committee it was decided to have built-up crossings instead of the ordinary crossings and junctions, as in the past. The plans were adopted on the understanding that any slight alterations might be made afterwards, on the suggestion of Mr. Hopkinson, the electrical engineer. The plans of Messrs. Oliver Leeson and Co., the architects for the car-shed and workshops at Walker, were also adopted. Mr. Wood was instructed to submit them to the Walker Urban Council, and to advertise for tenders for putting in the foundation.

Nottingham.—The contract has been let for the erection of the new depôt for the electric cars at Sherwood, and it is expected that the work will be commenced without delay. The contract for the new buildings, which will be situated near to the laundry, has been secured by a local tradesman. The new rails will be of a very much heavier description than those at present laid, in order to carry cars of greater weight and at a higher speed. The track will be a double one right away to Sherwood, and when this route has been completed the Basford line will be taken in hand, the Trent Bridge and station routes being deferred until later on account of the heavy traffic there.

Paisley.—Details of the latest tramway scheme for Paisley and district, promoted by the Glasgow District Tramways Company, are now available. The capital of the company is £360,000, one-half of which would be expended on the Paisley and district tramways system, and the remainder on that part of the system situated on the other side of the Clyde. The motive power is to be electricity, conveyed on the overhead system, and would be purchased from the Paisley Corporation. In consequence of the extension of time granted by the Examiner of Bills for lodging, the promoters of the Glasgow district tramway scheme are making offers to the various local authorities who have not yet given their consent to the measure.

London County Council Tramways.—A conference of delegates representing the vestries and district boards interested in the London County Council's Tramway Bill (1900) was held on Tuesday at the Clerkenwell Town Hall for the purpose of considering the London County Council's Tramway Bill in so far as it affects the various local road authorities of the Metropolis. A resolution was passed to the effect that in the event of electrical traction being used a surface or underground system should be adopted, and an additional clause was adopted authorising local authorities to use all lines owned by the London County Council, between the hours of 12 a.m. and 6 a.m., free from toll, for the conveyance of sanitary refuse, road material, and so forth.

Portsmouth.—The Tramways Committee have decided on a scheme for the settlement of the deadlock with the company, and this will be presented to the representatives of the company by a deputation. The chief of the proposals are, according to the *Daily Chronicle*, that the company shall retain the omnibuses, carriages, hearses, etc., and that no claim is to be made on the Corporation for unexpired profits; that the Corporation grant running powers to the light railway company from Cosham to North End, and that the light railway company grant similar powers for the Corporation to run their cars as far as the enclosed land on Portsdown Hill; the arbitration between the tramway company and the Corporation to be proceeded with as soon as can be arranged, but the stock to be taken at a valuation to be made at the time possession is given up; no claim to be made by the company in consequence of delay, and when the tramways are taken over no legal differences to be raised.

Hayling Island.—An important scheme, says the *Hampshire Telegraph*, designed with the object of making Hayling Island still more popular as a seaside resort, was explained at two meetings held at the Victoria Hall, Hayling, on Monday, the 22nd ult. The proposal, which has aroused much local interest, is to introduce an electric tram service, to run from the Hayling Ferry to the coastguard station, and, in addition, to supersede the existing ferry across Langstone Harbour by an aerial bridge, across which passengers will be conveyed by means of a car having electricity for its motive power. Special interest is attached to this bridge, inasmuch as a structure of the description proposed has never before been erected in England, although it is stated more than one is likely to be built in the near future. The bridge, a model of which was on exhibition at the meetings, will consist of two huge uprights planted on either side of the entrance to Langstone Harbour, while at the height of some 120ft. above high-water mark the connecting span will stand. Attached to this span by means of long metal rods will be the car, and, by means of electricity, the vehicle will travel backwards and forwards across the water. Mr. J. Hewitt, of Manchester, is the engineer connected with the scheme.

Proposed Manchester-Liverpool Railway.—The parliamentary estimates for the construction of the proposed Manchester and Liverpool Electric Express Railway places the total cost of the scheme at £1,750,000. The estimates give the length of the railway from Deansgate, Manchester, to its termination at the Bluecoat Hospital, Liverpool, as 34 miles 4 furlongs 2 chains. The railway will throughout its whole length be constructed as a double line in accordance with the system known as the monorail system, with such modifications as may be found necessary. The principal items in the estimates are: stations, £67,600; land and buildings required to be taken (310 acres), £451,600; the permanent way, estimated at £18,000 per mile, £621,450; viaducts, £175,300; and contingencies, £117,940. This scheme is proposed to be carried out by a company with a share capital of £2,000,000 and a loan capital of £666,000. A deputation of gentlemen interested in the promotion of the proposed railway waited last week on the Parliamentary Sub-Committee of the Manchester City Council to submit the plans of their undertaking so far as they may affect scheduled property within the city boundary. The committee were informed that the Manchester station will be near to the top of Quay-street, Deansgate, and the line will run in a westerly direction on the south side of Atkinson-street. The whole of the property, as well as the streets and passages, lying between Deansgate, Quay-street, Byrom-street, and Atkinson-street is scheduled. The railway line will cross Byrom street at a height of 33ft. above the road level, Gartside-street at a height of 38ft., and Water-street at a height of 47ft. After passing through Salford and Eccles the line will go through the Manchester Corporation's estate at Chat Moss, as a result of which certain roads will have to be diverted. The committee appointed the Lord Mayor and Mr. Alderman Southern to treat in future with the company's representatives. The same course was followed in the case of the proposed new city of Manchester railway, plans and details of which were before the meeting.—*Manchester Guardian.*

Lancashire.—The Lancashire County Council have issued a report on the different schemes of light railways and tramways, which is of the greatest importance to the rural authorities in the vicinity of Southport. The Council lay down a general policy of non-opposition provided the local authority is making the application, or is supporting some other body, but cases in which the proposed railways would inconvenience and endanger general traffic on the road and increase the cost of maintenance they reserve the right to report to the Board of Trade. With regard to the width of the roads the report states that, in consideration of the special user of the main roads given to the promoters without payment for the easement, a condition should be imposed upon them, where necessary, to bear the cost of providing such additional space for the ordinary traffic as will at any rate minimise the inconvenience, delay, and danger caused by the working of the undertaking. As a general rule, no light railway or tramway should be authorised along a main road unless there is a width sufficient to allow at the very least 9ft. 6in. on each side of the road between the kerb and the nearest rail, and where practicable

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a space of 12ft. 6in. should be left on one side so as to allow loads of hay, straw, and cotton bales and other wide loads to pass safely and without having to stop at a passing-place to wait for a car to pass. Should the main road be not wide enough to allow even 9ft. 6in. to be left on each side, and if it has buildings on both sides of it, then if a widening were forced upon the promoters the probable cost might prevent the undertaking from being proceeded with. In such a case it would be unreasonable to insist on the widening, but in order to give space on one side of the road for vehicles to pass a tramcar or railway carriage in safety it is pointed out that for the purposes of the general traffic it would be better in that instance to require the promoters to lay a double line of rails. Where, however, the road can be widened by setting back a fence on one side or the other it does not seem unreasonable to require the widening to be carried out at the expense of the promoters before the railway or tramway is allowed to be constructed, and this should be done without narrowing the footpaths to less than 6ft. In cases where a widening of an existing main road would be advisable for the convenience of the ordinary traffic, irrespective of the obstruction caused by any tramway or light railway, the sub-committee think that the County Council should consider the desirability of bearing a portion of the expense, but each case would have to be considered on its merits. With regard to county and hundred bridges, the general principle they proposed to be applied to main roads should also be made applicable to these bridges, and, where necessary, the bridges should be strengthened at the expense of the promoters.

LIGHTING AND GENERAL.

Arbroath. — The telephone is to be introduced into the infirmary.

Oban.—The electric light is, we understand, to be introduced into the Great Western Hotel.

Smithfield Markets Electric Supply Co.—The transfer registers will be closed until 9th inst. inclusive.

Leicester.—The Town Council intend to take steps to obtain another £40,000 for lighting extensions.

Leeds.—It has been decided to erect at the Whitehall-road station a two-phase plant for power supply.

Edinburgh.—The chief electrical engineer recommends the provision of additional machinery at a cost of £17,295.

Newington. — The public street-lighting, both arc and incandescent lamps, is to be taken over by the Vestry from March 25 next.

Appointments Vacant.—Details of various small vacancies appear in another column. Some of the appointments referred to last week are still open.

Cape Electric Tramways, Limited.—An extraordinary meeting of the shareholders will be held at 55 and 56, Bishopsgate-street Within, E.C., on the 14th inst.

Glasgow.—The Special Telephone Committee of the Corporation yesterday recommended that a Government license should be obtained for the establishment of a telephone exchange.

Darlington.—The Corporation are arranging to light the main thoroughfares of the town by means of electric light. It is proposed to erect 40 lamps in positions suggested by the surveyor.

Harrow.—The Urban District Council have agreed that if the other local authorities wished to oppose the North Metropolitan Electric Power Supply Bill the Harrow Council would join them

Brighouse.—The Brighouse Corporation are negotiating with the Halifax Corporation with a view to obtaining a supply of electricity in preference to that from the existing plant at Brighouse.

Wandsworth.—The Wandsworth and Clapham Guardians have resolved to obtain the opinion of an expert, at a cost not exceeding £50, with regard to the possibility of lighting the Tooting Home by electricity.

Leicester.—The electric lighting output continues to increase very satisfactorily, the 437,943 Board of Trade units sent out for the half-year ending Dec. 31 being a 40 per cent. increase over the corresponding half-year.

Sevenoaks.—The District Council have decided to withdraw their opposition to the local provisional order sought by the Electrical Power Distribution Company on the undertaking that a purchase clause be accepted.

Personal.—Mr. E. S. Saunders has been appointed departmental engineer at the Bradford electricity works in succession to Mr. A. H. Roe, who has taken the position of borough electrical engineer at Bury St. Edmunds.

Epsom.—Application has been made to two or three companies, inviting them to submit terms on which they are prepared to grant a loan of £16,100 on mortgage of the rates to meet the cost of the installation of the electric light.

Redruth.—The Urban District Council have passed a formal resolution authorising the Urban Electric Supply Company, Limited, to apply to the Board of Trade for a provisional order for supplying the district with electricity.

Bridgwater.—A public meeting of the ratepayers was held last week to consider the advisability or otherwise of the Corporation proceeding with the electric lighting scheme, when a resolution in favour of abandoning the scheme for the present was carried.

Shannon Water and Electric Power Syndicate.—The Inspectors of Irish Fisheries on Tuesday held an enquiry into the scheme of the Shannon Water and Electric Power Syndicate, which proposes to utilise the River Shannon, near Doonas, for the purpose of supplying an electric supply.

Shipley.—The District Council have decided to apply to the Local Government Board for sanction to borrow £22,000 for electricity works. The erection of a dust destructor is contemplated. Mr. R. C. Quin, electrical engineer to the Blackpool Corporation, has been appointed to act in a similar capacity to the Shipley District Council.

Greenock.—Bank-street is soon to be illuminated by two incandescent electric lights of a pattern similar to the lamp outside the office entrance of the electrical works. We learn that if the experiment is successful, this light will be introduced to several other side streets.

Ross.—In consequence of a recent decision of a meeting of ratepayers of Ross urban and Ashfield district declining to entertain the advisability of the Council promoting an electric light scheme, the latter have consented to a company about to be formed for application for licenses and provisional orders under the Electric Lighting Acts, 1882 to 1890.

Dublin.—By the Bill to incorporate the Dublin Electric Lighting Company, power is sought to provide for the lighting by electricity and the supply of electricity in bulk in the city of Dublin and the urban districts of New Kilmainham, Drumcondra, Clonliffe, Glasnevin, and Clontarf. The capital is £500,000, with power to raise £160,000 on debentures.

Blackpool and Fleetwood Tramroad Co.—The report for the half-year ended 31st ult., to be submitted at the meeting on the 9th inst., states that the balance of profit is £10,028, and a dividend at the rate of 10 per cent. per annum is recommended. The number of passengers carried was 1,161,786, and the gross receipts amounted to £20,476.

Stock Exchange.—The committee have ordered to be quoted in the official list the Commercial Cable Company's further issue of £230,550 sterling 4 per cent. 500-year debenture stock. Application has been made to the committee to appoint a special settling day for the Hampstead Electric Supply Company's ordinary and 5 per cent. cumulative preference shares.

South Wales Electrical Power Distribution Co.—Under the Bill to incorporate the South Wales Electrical Power Distribution Company, powers are sought to supply electricity within the whole of the county of Glamorgan and a part of the county of Monmouth, including the whole of the boroughs of Cardiff, Swansea, and Newport. The capital required by the Company will be £750,000.

Keighley.—The new Queen's Theatre and Opera House is to be opened to-morrow. Both the auditorium and the stage are fitted with a large number of electric lights. The electric installation has been put in by Messrs. Grace and Sutcliffe, Keighley, the high-speed gas-engine being supplied by Messrs. Crossley Bros., Manchester, and the dynamo by the Electrical Engineering Company, Morley.

Redcar.—The Urban District Council have decided upon the districts to be supplied with electric light under the Electric Lighting Acts, 1882 and 1888, and the Electric Lighting (Clauses) Act, 1899, and within the next two weeks the Council will decide what lands will have to be leased and what sites already belonging to them shall be appropriated. The scheme is estimated to cost £10,000.

Aberdeen.—In consequence of the report by Mr. Bell, electrical engineer (already published), with respect to the probable demand in the immediate future for extension of the facilities for providing electric current for lighting and motor purposes, and in which the establishment of another station was recommended, it has been decided to ascertain the terms on which a site could be obtained at Dee Village.

Price-List.—We have received from Messrs. Halliday and Sons, of Huddersfield, their price-list of incandescent electric lamps. These lamps are guaranteed with fair use a life of 1,000 hours. The firm makes a speciality of high-voltage lamps. We gather that the sales of "Halliday" lamps from Sept. 1 to Dec. 31 totalled 11,420. We have also received a sheet illustrating their makes of dynamos and motors.

Cleckheaton.—At Tuesday's meeting of the District Council it was reported that the Bradford Corporation, the North Bierley Gas Company, and the British Electric Traction Company had lodged formal objection to the granting of the Council's electric lighting order, with the object of securing clauses for their protection. It was resolved that these clauses could not be accepted, and that steps be taken to resist the claims put forth.

Gravesend.—A letter was read at the last meeting of the Town Council from the Drake and Gorham Electric Power and Traction Company, Limited, the owners of the tramways, offering to take and work the Corporation's electric lighting order. After some discussion as to the desirability of the Corporation themselves carrying out an electric lighting scheme for the town, the letter was referred to the whole court in committee.

London Lighting.—A conference is to be held at the Municipal Buildings, Lavender-hill, S.W., on the 13th inst., where representatives from Battersea, Bermondsey, Islington, Lambeth, Shoreditch, and Whitechapel, together with other authorities affected by the Bill to be promoted by the County of London and Brush Provincial Electric Lighting Company, are to discuss the same with a view to united action in the matter.

Rhondda.—With regard to the Bill for incorporating and conferring powers on the South Wales Electrical Power Distribution Company, we learn that the District Council have appointed representatives to wait upon the promoters with a view of ascer-

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taining if they would insert a clause in the Bill to abandon the application for power to light the district by electricity. At the same time the District Council have resolved to enter opposition to the Bill.

Catalogues.—We have received from the American Blower Company, 70, Gracechurch-street, E.C., whose English works are at Bedford, a well-got-up catalogue illustrating their A.B.C. fan system of heating and ventilation. They also manufacture steel cars, trucks, etc., feed-water heaters, and steam specialities. These catalogues are printed in various languages, even Swedish and Norwegian, an example English manufacturers might well follow to their advantage.

Tudor Accumulators.—Referring to the notice we inserted in our issue of the 19th ult., that Mr. Edward Lomer, of 12, St. Mary-axe, E.C., had been appointed agent of the Accumulatoren-Fabrik in this country, Mr. Lomer now informs us that this announcement was due to a misunderstanding, and that the Tudor Accumulator Company, Limited, have the sole rights for the manufacture and sale in the United Kingdom of Tudor accumulators, which is the type of cell manufactured by the German company referred to above.

Bath.—During the recent debate on the report of the Electricity Committee, which was adopted, a comparison was made between the cost of the electric works in Bath and that of other corporations working the electric light with a view to showing how unfavourably Bath compared with other authorities. It was stated that the working of the electric light in Bath for 1898 resulted in a loss of £771, whereas last year there was a loss of about £1,500. The formation of a strong sub-committee from the Electric Light Committee was suggested in order to see what means could be taken to reduce expenditure.

New Companies.—Longstreth's, Limited, has been registered with a capital of £3,000, the object being to carry on the business of electricians, electrical instrument makers, etc.—Charles S. Madan and Co., Limited, has been registered with a capital of £12,000, the object being to acquire and carry on the business of mechanical and consulting engineers and contractors now carried on by Charles S. Madan and W. H. A. Ord Mackenzie at 34, Crowther-street, Salford, Lancashire, under the style of Charles S. Madan and Co., and to carry on the business of mechanical, electrical, consulting, and general engineers, etc.

St. Marylebone.—At a meeting of the Vestry yesterday a report was submitted by the Parliamentary Committee recommending with respect to communication from the Board of Trade forwarding amended description of the system to be adopted by the Metropolitan Electric Supply Company, that the Board of Trade be informed that the Vestry see no objection to the proposed system, subject to a penalty being provided for. The committee also recommended that a communication be forwarded to the electric light consumers in the parish asking them to give notice at the court house as to any failure in the supply of electric light.

Chichester.—The Town Council on Friday discussed the proposal for electric lighting. Nearly two years ago the Council obtained a provisional order, which becomes void in July next. Mr. J. Saunders, city surveyor, has prepared a scheme providing for a generating station and refuse destructor at St. James's, where sufficient power is to be developed to light the city and supply electric motors at the waterworks pumping station and the sewage works. The estimated cost is £25,000. The scheme has been favourably reported on by Mr. Price, electrical engineer, Portsmouth, and several times considered by the Council. After discussion it was agreed to postpone the question for six months.

South Staffordshire Tramways Co.—An extraordinary general meeting was held last Saturday at Cannon-street Hotel, E.C., Mr. Schuster in the chair. The meeting was called to confirm the Bill to be promoted this session in Parliament. The Bill has for its object the leasing of a portion of the Company's lines to local authorities, and especially the portion at Walsall. Mr. Dawson objected to the steam portion being leased, as this brought in a profit, which, he stated, the electrical lines did not. He handed a balance sheet which he had prepared to the Press, but we rather fancy that Mr. Dawson has mixed up his items considerably. Mr. Dawson's amendment that the steam lines should not be leased was not seconded, and the original resolution was carried.

London Gazette.—The first meeting of creditors in the estate of F. King, the Stone Bridge, Bristol, will take place on Feb. 7, 1900, at 12 o'clock at the offices of the official receiver, Baldwin-street, Bristol, and the public examination on Feb. 9, 1900, at 12 o'clock at Guildhall, Bristol.—The last day for receiving proofs *re* Rothwell, Wild, and Co., Atlas Works, 6B, Virginia-street, Southport, is Feb. 12, 1900; Nathan Yates, 4 and 6, Wood-street, Bolton, trustee.—The last day for receiving proofs *re* E. B. Pym, 29, Braham-gardens, South Kensington, is Feb. 10, 1900; A. H. Wildy, official receiver, Bankruptcy-buildings, Carey-street, W.C. The trustees have signed a release *re* D. W. Paine, 84, Glo'ster-road, Brighton, and F. Jones, 147, St. John's-hill, New Wandsworth.

Metropolitan Asylums Board.—At the last meeting of this Board the General Purposes Committee reported that Prof. Ayrton, the engineer employed by the Board to superintend the electric lighting of the new wards at the North-Western Hospital, had applied for an additional fee of 100 guineas for extra services. This work was carried out by Fowler, Lancaster, and Co., Limited, under contract dated Aug. 23, 1895, the contract sum being £859. 15s. The committee, after enquiring into the matter, were of opinion that the case had been one of altogether exceptional and unforeseen difficulty, and that Prof. Ayrton had quite made out his case for additional remuneration. They therefore recommended that an additional fee of 100 guineas should be paid. This was agreed to.

Chiswick.—A letter from Messrs. Kincaid, Waller, and Manville, engineers of the Aberystwyth and Chiswick Electricity Supply Corporation, Limited, making certain suggestions as to the lighting of the High-road by electricity, was read and considered at the last meeting of the District Council. The surveyor reported as to the cost compared with gas lighting as follows: "I have compared the cost of the proposed electric lighting with the present method of incandescent gas lighting, and the difference I estimate at £789 per annum. At present I cannot recommend the Council to accept the offer." It was agreed not to entertain the offer. A further letter was read from Messrs. Kincaid and Co., giving notice of the intention to lay electric cables in Fairfax-road, Addison-lane, Corney-lane, and Duke's-avenue.

British Westinghouse Manufacturing Co.—We have received from this Company copies of their circulars Nos. 1,013 and 1,014 which they have just published. Circular 1,013 deals extensively with switches for 1,100 and 2,200 volt alternating-current circuits, and are of the plunger type. Circular 1,014 deals with the round pattern of ammeters and voltmeters. In the first circular switches are illustrated showing back and front views of four-pole double-break switches for two-phase circuits, double-pole single break switches, and dynamo-charging switches. Considerable information is also given as to the breaking capacity, sizes, etc., of the switches. The advantages claimed for this type of switch are that it will break a 2,500-volt lagging current, the contacts are not burnt, they have a high efficiency, and low heating. The parts are interchangeable, and they are safe. In the meter catalogue information is given respecting the meters, and also a list of the styles and their different ranges. The meters listed are all of standard sizes, but the firm state that in addition to the list they can calibrate the instruments for any number of alternations or type of generator armature.

Rochdale.—We gather from a local contemporary that the electricity supply works which the Rochdale Corporation are erecting are now approaching completion, and the Corporation has issued a statement describing the conditions under which the light will be supplied to consumers. The generating plant has been designed to meet an output for the equivalent of about 15,000 8 c.p. lamps connected to the mains, but the generating station is large enough to accommodate double this capacity without further extensions. Mains have been laid in the following streets: Dane-street, the Esplanade, South-parade, Drake-street, Manchester-road (from Dane-street to Merefield-street), Yorkshire street (to Whitworth-road), Cheetham-street, Blackwater-street, and Lord-street. When the demand warrants it, the area of supply will be extended. Consumers will be connected free of charge, provided the premises to be lighted are not more than 60ft. from the mains. The charge for current for lighting purposes will be 6d. per Board of Trade unit. For power the price will be one-half that charged for lighting, or 3d. per unit though special terms will be conceded to large consumers.

A Large Engine for Russia.—We understand that Messrs. Alexander Shanks and Son, Limited, of Dens Ironworks, Arbroath, have just completed a fine specimen of their specially designed high-speed engine for the driving of electric plant. The engine is perhaps the largest of the high-speed direct-coupled type yet constructed on the East Coast for driving electric plant. It has been constructed to the order of a Russian manufacturing firm, and is of 1,000 i.h.p. The engine will drive the powerful dynamos in the works, which, in addition to supplying light to the establishment, will furnish the motive power for the auxiliary machinery. The engine is of the triple-expansion surface-condensing inverted cylinder or marine type. It is designed and constructed for a working steam pressure of 160lb. per square inch, developing the above power at a speed of 160 revolutions per minute. The high-pressure cylinder is fitted with piston valves, while the intermediate and low-pressure cylinders have double-ported slide valves. Admission of the steam to the high-pressure cylinder is regulated by an expansion valve under the control of a powerful governor. All three cylinders are steam-jacketed, the drains being led to steam traps conveniently arranged beneath the platform fronting the engine. The crank-shaft is of large dimensions, and with the view of providing for continuous running without risk of heating the bearings are very long, are lined with white metal, and are fitted with a system of forced lubrication—a small oil pump, driven by an eccentric on the shaft, drawing oil through a filter and delivering it under pressure to the bearings. The engine is fitted with complete splash-guards, while the crank-pits are closed in so as to collect all the waste oil, not only from the main bearings, but from the other bearings throughout the engine. This waste oil passes to a filter, and is used over and over again. The framework of the engine is of massive design. To provide against a breakdown of the main governor the engine is fitted with a supplementary governor, which will prevent the speed rising beyond a fixed limit. Couplings are arranged at each end of the shaft for direct connection with the dynamos, the half coupling at one end consisting of a barring disc flywheel. Additional flywheel effect will, of course, be obtained from the armatures of the dynamos. The engine is also fitted with steam starting gear.

West Bromwich.—At a special meeting of the Town Council held last week, the Electric Lighting Committee reported that they had now obtained, and had under consideration, tenders for the supply of boilers, steam dynamos, condensers, feed-water heater, travelling crane, switchboard, cables, and storage battery in connection with the electric light undertaking, and recom-

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mended that the tender of Messrs. E. Danks and Co., Limited, for boilers; Messrs. C. A. Parsons and Co. for steam dynamos, condenser, feed-water heater, and travelling crane; Messrs. Cowans, Limited, switchboard; the British Insulated Wire Company, Limited, for cables; Tudor Accumulator Company, Limited, for storage battery and connections, be accepted. The report was adopted.

Inquest.—Mr. Schroder held an enquiry at Paddington on Monday into the circumstances connected with the death of a man, named John Gardiner, killed on the Central London Railway. The deceased on the previous Friday started from Holland-park Station to go to work in the tunnel. There were a number of workmen and they were all riding on buggies, of which there were seven. They were propelled by an engine at the back. The deceased was on the bogie in front of witness, and was standing up, probably owing to the damp condition of the platform, and when between Queen's-road and Westbourne Stations he fell off. They were then proceeding at about five miles an hour, and the engine stopped within a few yards. There was only about a foot space on each side of the buggy, and the deceased rebounded from the wall under the wheels. A labourer who was on the same train considered that riding on the buggies was quite safe, and that there would have been no danger had the deceased sat down. The jury returned a verdict of accidental death.

St. Helens.—A successful preliminary run over the new line from Thatto Heath to Scholes-lane, St. Helens, was effected on the 26th ult. On the night previous some 80 employés of the St. Helens and District Tramway Company were entertained by the directorate at dinner at the Raven Hotel, the hour (11 o'clock) being fixed so as to allow the men to finish their work. Owing to the late hour there was little speechmaking, but Mr Henry Martin addressed a few remarks to the men anent their work, touching upon Mr. Cuttler's system of rewarding merit with premiums. Mr. A. P. Trotter has made his official inspection, and also held an enquiry into the application of the Corporation to borrow £25,000 for the purposes of extending the tramways system. Mr. G. W. Bailey (town clerk) explained that the money which they sought to borrow would be expended in the completion of the Haydock and Derbyshire-hill-road sections, the extension of the Peasley-cross route, and the making of the Rainford-street, Nutgrove, and North-road sections. It was estimated that this work would cost £17,138, which with £6,995 for extension of the generating station and the amount overspent on the original loan would bring the total nearly to the £25,000. No opposition was offered.

Sell's Directory.—Since its inception, 15 years ago, "Sell's Directory of Registered Telegraphic Addresses, National List of Large Commercial Houses and Buyers' Guide" (Henry Sell, 167, Fleet-street, E.C.), has reached enormous dimensions, and the alphabetical list of the work alone now requires 1,500 pages. The work is compiled from official lists supplied by authority of the Postmaster-General, and actually contains all the information received from the Post Office to Jan. 1, 1900. We are informed that a special staff is engaged to keep daily note of all alterations, corrections, additions, etc., for the quarterly supplements which are sent free to each subscriber, and are a special feature of the work. Amongst the subsidiary contents of the volume will be found special articles on British trade and foreign competition, and a digest of the main features for 1899 of the following great industries: iron and steel, engineering, shipbuilding and shipping, coal, petroleum, textiles, agriculture, tea, and sugar. Two unique maps of South Africa, in colours, are issued with the work, one of which, giving a comparison of South Africa with Europe, is of particular interest at the present moment, as it gives at a glance a thorough idea of the correct value of the vast distances separating the various scenes of the theatre of the war.

New Ships.—The following may be of interest to manufacturers of electrical machinery and of electric lighting apparatus: The dockyard authorities at Devonport have received orders to prepare for the building of a new third-class cruiser, which is estimated to cost £145,000. The keel will be laid down almost immediately. The cruiser will be 310ft. long, 36ft. 6in. in breadth, with a displacement of 2,200 tons, and her engines will develop 7,000 i.h.p., giving her a speed of 20 knots an hour. An important step at Portsmouth is the reconstruction and lengthening of No. 5 building slip to allow of the laying down of the new armoured cruiser "Kent," whose sister ship, the "Essex," has already been commenced at Pembroke. These vessels form a couple of four whose displacement is 9,800 tons, and which are to be ready for launching in the autumn of next year. In the meantime the "Albemarle" has been laid down at Chatham. The "Duncan" and "Cornwallis" are now being built by the Thames Ironworks Company, the "Exmouth" is building at Birkenhead, and the "Russell" at Jarrow. The "Implacable" is being hurried along at Devonport, and the "Ocean," a sister ship to the "Canopus," is to be completed in order to relieve the "Hood," which will, after an expenditure of £15,000, be transferred to the Reserve Squadron.

Nuneaton.—Plans for the erection of works for the British Thomson-Houston Company on the Glebe Farm were passed at the meeting of the Urban District Council on Thursday last week, and it is expected that the building will be commenced at an early date. Some idea of the magnitude of the works may be gained from the following measurements of the buildings it is intended to erect at once: machine-shop, 300ft. by 265ft.; stores and warehouse, 98ft. by 180ft.; power station, 100ft. by 120ft.; smithy and steel stores, 117ft. by 55ft.; annealing furnace and punching shop, 94ft. by 55ft.; pattern-shop, 55ft. by 74ft.; brassfoundry, 55ft. by 104ft.; pattern stores, 55ft. by 52ft.; ironfoundry, 110ft. by 277ft.—plus 45ft. by 105ft.; sand-shed, 25ft. by 95ft.; messroom, 48ft. by 74ft.; and offices, 141ft. by 48ft. The Urban District Council have adopted a report by the Electricity Committee recommending the approval of plans for building extensions in connection with the electric light works, and instructing Mr. Pickering to approach Mr. W. P. Evans with a view of ascertaining the price of the land adjoining the works; also recommending the Council to apply for sanction to borrow £16,000 for the purchase of the Nuneaton electric undertaking and carrying out the proposed works, instead of £10,000, as resolved at the meeting of the Council held on Nov. 15, 1899.

Canterbury.—"The electric lighting undertaking in Canterbury continues to flourish," remarks the *Kentish Gazette*, "and the latest statement of the financial position should make the ratepayers more than ever thankful that the installation was kept in the hands of the Town Council, rather than being handed over to a private company. Canterbury is, we believe, the only town in England which has been able to show a profit within the first six months upon a municipal installation of the electric light, and its record for the past quarter is certainly exceptionally gratifying. Here are the figures: Accounts for Christmas quarter—private supply, £935. 19s.; public lighting, £235 5s.; meter rents, etc., £34. 15s. 1d.—total, £1,205. 19s. 1d.; less cost of production, £350. 11s. 11d.—total, £855. 7s. 1d.; less repayment of principal and interest, £459. 5s.; net profit, £396. 2s. 1d. The installation has only been in working for three-quarters of a year, and the net profit on the entire period amounts to just under £200. It would appear, therefore, that instead of the £1,500 allowed in the estimates to cover any possible deficiency being required, there will be a substantial sum of profits available at the end of the year's working in reduction of rates. This is a probability upon which we have insisted from the earliest initiation of the electric lighting scheme, and it is extremely gratifying to us, as it must also be to the Town Council to find that the citizens have so satisfactorily supported the undertaking of which they are the possessors and the beneficiaries."

Ipswich.—At the last meeting of the Town Council considerable information transpired with reference to the position of the Corporation's electric lighting scheme. The Public Health Committee reported in favour of the provision of a refuse destructor. It was believed that this could be erected to advantage in connection with the electric light generating station in Portman-road, and the committee asked that they might be empowered to obtain expert advice upon this point, and get detailed plans and specification and estimate for submission to the Council. Mr. F. Turner said the desirability of having such a destructor had been discussed on previous occasions. Hitherto they had made temporary arrangements for the disposal of the refuse, but something of a permanent nature must now be done. A good opportunity was about to arise to provide a destructor, as the Council was about to put down electric light plant, and if they utilised the heat that would be obtained from the destruction of the refuse for the electric light apparatus, they would save a great deal of fuel. Others also spoke against the present system of disposing of the house refuse, and added that a destructor was the most suitable and sanitary method, and not, on the whole, expensive, especially when combined with electric plant. Alderman Wrinch said he should like to know how the Council stood with regard to the electric light question. It was about two years since they assented to the proposition to have electric light in the borough. The Deputy-Mayor, in reply, said with regard to the electric light, Prof. Kennedy some time ago had instructions to prepare plans. Just at that time the question of electric trams came on, and it was felt to be impossible for him to complete the plans until it was known whether the plans for electric trams would be added. For that reason the plans stood over till last August. When the Corporation decided to take over the tramways, Prof. Kennedy had instructions to go on with plans both for electric light and trams, and the committee were waiting for the completion of the plans before placing them before the Corporation. After some further discussion the report was adopted.

Plymouth.—As important developments are about to take place at the electrical works at Prince Rock and still further developments will follow, a few details, gleaned from Mr. J. H. Rider, the borough electrical engineer, may be of interest, says the *Western Weekly News*. At the last meeting of the Plymouth Town Council a considerable extension of premises and plant was authorised, Mr. Rider having reported that within three months of starting the works the demands had outgrown the means of supply. The present machinery can supply 7,500 lamps of 8 c.p lighted at the same time, but as only about 60 per cent. of the lamps are lighted simultaneously, the department is at the present moment supplying power for a total of 12,200 lamps of 8 c.p. connected to the supply mains. A light of 8 c.p. is taken as the unit for purposes of calculation. Not only, therefore, are the works supplying a greater number of lamps than the plant would perhaps actually warrant, but the demand still increases. It is hoped that the additional machinery will be working before next winter. This includes a steam generator of 700 h.p., with two additional boilers for lighting. This is altogether exclusive of the 700-h p. generator and two boilers authorised some time ago for the Compton section of the tramways. There are at present facilities for only one set of the additional machinery, and to provide for the second the building is to be lengthened about 90ft. It is now 100ft. long. This will, however, make provision for the additional plant that will be necessary when other traction developments take place. There is, for example, the Mount Gould tram, which will probably be undertaken next year, and there is also the probable line for the Pounds estate. This building extension will make room for four 700-h.p. steam generators. As to private lighting, applica-

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tions have poured in from streets where there are no mains, and as the Act insists upon all being supplied, mains are to be laid in Mutley-plain, Tavistock-road, the higher end of Old Town-street, King-street, Russell-street, Frankfort-street, Treville-street, Whimple-street, Princess-square, Market-avenue, Drake-street, Courtenay-street, and Embankment-road. Applications have been received from almost everyone of these places. This addition to buildings, plant, and mains is to cost £48,000, which the Council has authorised, besides the £20,000 sanctioned two or three months ago, making a total of £68,000 since the opening of the works in September. The original works were estimated to cost £46,000, so that the capacity is practically being doubled within three months. A remark as to the unusual competition which electricity at Plymouth had to meet, with gas at 1s. 9d. per 1,000, led Mr. Rider to say that the competition was indeed remarkable, only one other town—Widnes—having a lower price. He is confident, however, that after March 31 they will be able to meet all working expenses and pay interest and sinking fund for that period. Already his forecast, given to the Town Council prior to the works being instituted, had been exceeded. He had anticipated 5,000 lamps of 8 c.p. at the end of the first winter, and at least 10,000 at the end of the first year. As a matter of fact, they had 12,000 lamps—not at the end of the winter, but practically at the beginning. This large increase of supply, it was explained, would mean only a slight increase of staff. Plymouth's price per unit for electricity is 4½d., while the average of the kingdom is 6d. Fourteen new tramcars have been ordered for the Compton section, which is waiting for the Tavistock-road improvement. These cars will have an extension of the roof over the dashboard, which will not only give four additional seats, but provide a safer and more convenient staircase, and afford shelter to the driver. A number of rails will have to be relaid, but Mr. Rider hopes that the cars will be running by the spring of next year.

Durham.—An exhaustive report which was presented by the county surveyor (Mr. Crozier) at last week's meeting of the Durham County Council in connection with the generation and supply of electric power in the county has been published in the *North-Eastern Daily Gazette*. Mr. Crozier stated that powers were being sought by the County of Durham Electric Supply Company to establish central stations to generate electric power and supply or use electrical energy throughout the poor-law unions of Gateshead, South Shields, Chester-le-Street, Sunderland, Houghton-le-Spring, Durham, Easington, and Hartlepools. The company incorporated in the Bill the section of the Electric Lighting (Clauses) Act, 1899, which empower the company to break open streets and bridges on notice. This would give the company power to open out about 71 miles of rural main roads under the control of the County Council, and about 33 miles of main road under the control of the urban district councils, and 56 county bridges or parts of county bridges. The Tyneside Electric Power Company seek power to take vacant lands within the districts of Hebburn and Whickham Urban Councils upon which to erect electrical stations, and also to break open the main roads. As the areas of supply in the two foregoing Bills overlap, if both become law two companies would have power to break up the same main roads and bridges. Under electric lighting provisional orders other companies were applying for similar powers. At Barnard Castle the Northern Counties Electricity Supply Company are the undertakers, and the area of supply is the Barnard Castle urban district. Mains are to be laid on the north approach of Barnard Castle Bridge within the time limit of two years from the commencement of the order. There is only about half a mile of main road besides and no other bridge within the urban district. At Bishop Auckland the Urban Electric Supply Company, Limited, are the undertakers, and the area of supply is the whole of Bishop Auckland urban district. Mains are to be laid on the Sunderland Bridge and Bowes main road from Cockerton Hill to the road leading to Gaunless Bridge (length about half a mile) within the time limit (two years after the commencement of the order) and two county bridges lie within the area of supply. At Seaham Harbour the area of supply did not affect main road or bridges. At Spennymoor the undertakers are the Northern Counties Electricity Supply Company, and the area of supply is the Spennymoor urban district. Mains are to be laid on the Bowes main road from Five Lane Ends to Spennymoor House (about 1½ miles in length) and on the Gibbons and Spennymoor county bridges within the time limit (two years after the commencement of the order). The remainder of the main roads (about two miles) and one other county bridge are included in the area. At Chester-le-Street the undertakers are the County of Durham Electrical Power Distribution Company, Limited. The area of supply is described in the order as the rural district of Chester-le-Street, but is shown on the map only as the parish of Chester-le-Street. Mains are to be laid on the Durham and Newcastle main road from Chester Town Bridge to the Catholic schools (about 1,023 yards), and on Chester Town Bridge approach within the time limit (two years after the commencement of the order) Included in the area of supply is about two miles of main road and four county bridges. With regard to the whole of these applications by companies seeking parliamentary powers, the surveyor pointed out that the Gasworks Clauses Act, 1847 (incorporated by the Electric Lighting Clauses Act, 1899), requires the promoters to keep in repair roads, etc., broken up by them for three months, and to make good subsidences for 12 months. These periods were not long enough to ensure the consolidation of the roadway, but having regard to the very recent date of the last-mentioned Act, he thought it improbable that the County Council would procure better terms by opposing the applications. In each case the promoters should be asked to insert clauses indemnifying the county from responsibility for damage to their works by steam rolling or other traffic.

PROVISIONAL PATENTS, 1900.

JAN. 23.

1407. **Improvements relating to electric traction.** Robert Brown, 18, Southampton-buildings, Chancery-lane, London.

1445. **Improvements in electric transformers** Arthur Henry Loring and Harry Lee Clark, 46, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 24, 1899, being date of application in United States.) (Complete specification.)

1449. **Improvements in or relating to electric glow lamps.** Denis Ripley Broadbent, 19, Southampton-buildings, Chancery-lane, London.

1450. **Push for electric bells or the like.** Theodore Holme, Raglan House, Dursley, Glos. (Julius Vilhelm Jacob Silfverberg, Denmark.)

1457. **Improvements in and relating to electrolytic apparatus.** Wilfrid Barnes, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1464. **Improvements in surface-contact electric railway systems.** John McLeod Murphy, 56, Ludgate-hill, London. (Complete specification.)

1475. **Improvements in electric igniters for explosion meters** Josepha Schiele and Jean Baptiste Boisselot, 18, Buckingham-street, Strand, London. (Complete specification.)

JAN. 24.

1512. **Improved method of holding magnet winding.** William Gibson Primrose, 301, Great Cheetham-street, Higher Broughton, Manchester.

1528. **Improvements in continuous-current dynamos and electrometers.** Johannes Schuil, 100, Clerkenwell-road, London.

1531. **Electric light dimmer.** James Robinson Hatmaker, 30, St. James's-square, London.

1537. **Improvements relating to the preparation and treatment of filaments for incandescent electric lamps.** Charles Garner, 6, Bream's-buildings, Chancery-lane, London.

1555. **Improvements in the method of transmitting electric energy through ether and devices for same.** Emile Guarini Foresio, 70, Chancery-lane, London.

1560. **Improvements in record cylinders for phonographs and method of producing the same.** Thomas Bennett Lambert, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1863, Sec. 103, Aug. 14, 1899, being date of application in United States.) (Complete specification.)

1561. **Improvements in record cylinders for phonographs.** Thomas Bennett Lambert, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Nov. 4, 1899, being date of application in United States.) (Complete specification.)

1566. **Improvements in or relating to accumulator plates.** Marcel Wuillot, 111, Hatton-garden, London.

1568. **Improvements in or relating to electrolytic electricity meters.** Charles Orme Bastian, 31, Southampton-buildings, Chancery-lane, London.

JAN. 25.

1573. **Improvements in or relating to rubber-insulated electric cables.** George Edward Heyl-Dia, 55, Market-street, Manchester.

1578. **Improvements in and in connection with trolley poles of electric tramcars.** William Gloinson, 9, Westland-row, Dublin.

1583. **Improvements in or relating to the manufacture of electric cables.** George Edward Heyl-Dia, 55, Market-street, Manchester.

1595. **New or improved electrical influence machine for transforming mechanical energy into electrical energy or electrical energy into mechanical energy.** William Edward Ayrton, William Fitzgerald Crawford, and Hedley Jeffreys Thomson, Central Technical College, South Kensington, London.

1617. **Improvements in or connected with carbon contacts for electrical switches and the like.** August Reichwald, 33, Chancery-lane, London. (The firm of Fried. Krupp, Germany.)

1618. **A new or improved method of and devices for regulating or controlling electrical switches.** William Kingsland, 33, Chancery-lane, London.

JAN. 26.

1653. **Method of boosting a direct current of electricity by means of an alternating current.** David Cook, 30, Lancaster-park, Richmond, Surrey.

1679. **A new and improved method of and process for insulating electrical wire.** Hartwell William Webb, 77, Queen Victoria-street, London.

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1690. **Improvements in picking up electric current sent from a generating station by a railway car and returning it.** Robert Cooke Sayer, 11, Clyde-road, Redland, Bristol. (Complete specification.)

1692. **Improvements in electric telephony.** Charles Adams-Randall, 98, Prince of Wales-mansions, London.

1694. **Improvements in the treatment of carbon electrodes for electric arc lights.** John Tilghmann Robinson and James Henry Ferguson, 6, Bream's-buildings, Chancery-lane, London. (Complete specification.)

1704. **An electric alarm.** Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Denis Pial, jun., France.)

1711. **Improvements in or relating to electrical condenser batteries.** Emil von Szvetics, 322, High Holborn, London.

JAN. 27.

1731. **An improved connector for electric conductors.** Albert Edgar Tanner, 579, Stretford-road, Old Trafford, Manchester.

1783. **Improvements in or relating to magneto-electric ignition devices.** John Ridley and John William Roebuck, 18, Hertford-street, Coventry.

COMPLETE SPECIFICATIONS ACCEPTED.

Published Jan. 27.

1899.

405. **Jacks used in combination with electrical annunciators or indicators for the replacement of the shutter or signal flag.** August Eckstein and Jane Eidsforth and Henry Wilkinson, executors of the late Richard Penteny Eidsforth.

416. **Electrical heaters or resistances.** Barman.

571. **Electric arc lamp clutch and feed mechanism.** James.

1862. **Transmission of electric telegraph signals without connecting wires.** Braun.

1863. **Wireless electric transmission of signals over surfaces.** Braun.

1960. **Electric railways of the sectional conductor type.** Lorrain. (Esmond.)

2131. **Means or apparatus for reducing or extinguishing the electric arc formed on breaking electrical circuits.** Acock.

3005. **Electrical switches.** Lane.

3594. **Arc lamps.** Baggett.

3784. **Electric safety appliances.** Badger and Plews.

3909. **Electric traction for tramcars and the like with accumulators.** Milnes.

4219. **Electrical traction on a sectional conductor system.** Kingsland.

4776. **Electric therapeutic apparatus.** Wilkinson and Titherley.

4788. **Electric arc lamps.** Davy.

5090. **Storage plates for accumulators and process for the manufacture of the same.** Goller.

5374. **Electro-therapeutic baths and the like.** Stanger.

8399. **Electricity meters.** Abel. (Soc. Anon. Continentale pour la Fabrication des Compteurs à Gaz et autres Appareils.)

20124. **Means for electrically controlling gascocks and lighting gas burners.** Haddan. (Soc. Anon. "Lux Nova.")

20986. **Machines for and the method of making electrodes for storage batteries.** Hanscom and Hough.

21429. **Incandescent electric lamps.** Wolffhardt.

21637. **Electrodes for arc lamps.** Bremer.

21886. **Connecting plugs for electrical switchboards.** Thomson and Warnford-Davis.

23100. **Electric lamp supports.** Long.

23216. **Switches for permanent way and for conductors on electric railways.** Joedicke.

23289. **Controlling devices for electric motors.** British Thomson-Houston Company, Limited. (Potter.)

24085. **Terminals and connections for electric cables and like conductors.** Hall.

24200. **Anode or other electrode for use in electrolysis and process of making same.** Roberts.

To be published Feb. 3.

1898.

21633. **Electricity meters.** Hookham.

1899.

918. **Enclosed electric arc lamps.** Davy.

1106. **Facia for electrical instruments.** Max Byng and Jane Eidsforth and Harry Wilkinson, executors of the deceased Richard Pentney Eidsforth.

1758. **Improvements in portable hand dynamos, parts of which improvements are applicable to small-power dynamos and motors for other purposes.** Evershed and Vignoles, Limited, and Evershed.

2273. **Electro-therapeutics.** Day. (O'Neill and Rooney.)

2627. **Electric time and fire and like alarms.** Wendt and Krausse.

3865. **Method of and apparatus for controlling the operating gears of rudders, signals, and the like by means of heat, light, or electrical waves.** Orling and Braunerhjelm. (Date applied for under International Convention, Oct. 26, 1898.)

3130. **Electric lamps.** Brown.

4065. **Electrical switches.** Verity's, Limited, and Steele.

4088. **Lamp-holder for incandescent electric lamps.** Lynes.

4158. **Transformers for continuous electric currents.** Wydts and Weissman. (Date applied for under International Convention, Aug. 4, 1898.)

4496. **Electrical contact breakers.** Bowron.

4822. **Motor suspension for electric automotor vehicles.** Brookes. (Stort.)

5622. **Apparatus for the production of ozone by electricity.** Lamprey.

5468. **Electro-deposition of metals.** Zimmermann. (Courant.)

5781. **Electrolysis and electrolytical apparatus.** Le Verrier.

20062. **Electric motors.** Heyland.

21219. **Electric cut-outs and electric switch devices applicable to and serving as holders therefor.** Sachs.

22107. **Electric alarm water-level indicators for steam-boilers and the like.** Bush and Swain. (Date applied for under International Convention, April 8, 1899.)

22525. **Means for placing, removing, and cleaning incandescent electric lamps.** Haddan. (Simms.)

22679. **Electromagnets for use in relays, sounders, and other electromagnetic apparatus.** Cutler.

24226. **Electric railways on a road contact system.** Gunyon. (Privat.)

24458. **Supporting electrical contact rubbers or brushes below rail or tramway vehicles.** Ransford. (Compagnie Générale de Traction.)

24723. **Process of smelting ore and electric furnaces therefor.** Hatch.

To be published Feb. 10.

1899.

934. **Apparatus for electrically transmitting orders, signals, or indications from one place to another.** Alcock.

974. **Prepayment electricity meter for continuous or direct currents whose action depends on deposition of copper in a balance against silver coins.** Terrey and Phillips.

1047. **Construction of straight and curved underground conduits for enclosing electric conductors, haulage cables, and other means of communication, allowing connection of vehicles, sledges, and moving bodies to same, and allowing access below.** Sutcliffe.

1230. **Lighting trains by electricity.** Elieson and Naylor.

4416. **Direct-current systems of electrical distribution.** Lamme. (Date applied for under International Convention, Aug. 4, 1898.)

5548. **Devices for changing the frequency of alternating currents and systems of electrical distribution.** British Thomson-Houston Company, Limited. (Steinmetz.)

5549. **Systems of electrical distribution.** British Thomson-Houston Company, Limited. (Steinmetz.)

5887. **Apparatus for use in connection with electrical advertising signs and display boards.** Brown.

8641. **Apparatus for rectifying alternating electric currents.** British Thomson-Houston Company, Limited. (Thomson.)

8775. **Electric incandescent lamp fittings.** Lachman.

8840. **Incandescent electric lighting systems.** British Thomson-Houston Company, Limited. (Davis.)

9246. **Apparatus for measuring electric currents.** British Thomson-Houston Company, Limited. (Fish.)

12949. **Electric incandescent lamps.** Atherton.

23021. **Electric motor road vehicles.** Sefton-Jones. (Kölner Accumulatoren-Werke Gottfried Hagen.)

23047. **Radioconductor tubes or electric coherers.** Ducretet.

24196. **Thermostatic electric switches or pushes.** Harrison. (Auto-Protective Appliance Company.)

24208. **Electrically-controlled locking mechanism for collecting and other boxes.** Lake. (Williams.)

24307. **Electric incandescent lamp.** Van Deventer.

24431. **Electric demand indicator.** Harris.

24439. **Systems of electric distribution particularly applicable to electric railway systems.** British Thomson-Houston Company, Limited. (General Electric Company.)

27473. **Electric accumulator plates.** Majert.

24940. **Automotor trolleys for electrically-driven vehicles.** Lombard-Gerin.

To be published Feb. 17.

1899.

1294. **Ratchet gearing and locking for electric clocks and general registering or other like machines.** Stockall.

1438. **Electric mechanism for driving turret and other clocks.** Neill.

1765. **Surface-contact electric traction system.** Thompson and Walker.

2164. **Primary batteries.** Heffernan.

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2660. Electrical influence machines. Lemström.

4312. Electric welding and apparatus therefor. Imray. (Geo. L. Thompson Manufacturing Company.)

4632. Operation of electric motors at different speeds. Reed.

4633. Methods of and means for operating electric motors. Reed. (Date applied for under International Convention, Aug. 17, 1898.)

5416. Spring-break switches for electric currents. Walklate.

6052. Apparatus for working railway points and signals by electricity. Webb and Thompson.

6220. Electrical incandescence lamps. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

6593. Combination brake coupling for electrically connecting railway vehicles fitted with vacuum brake for communication or signalling purposes. Cunningham.

7427. Rotary converter or transformer for simple or polyphase alternating electric currents. Imray. (Soc. Anon. pour la Transmission de la force par l'electricité.)

8156. Electromagnets. d'Arlincourt.

8483. Electrical signalling apparatus. Lavens and Lavens.

10699. Street lamp posts, electric light standards, and the like. Jones.

10768. Electric arc lamps. British Thomson-Houston Company, Limited. (Fleming.)

13565. Method of and apparatus for controlling alternating electric current motors. British Thomson-Houston Company, Limited. (Armstrong.)

13566. Thermostatic electric circuit breakers. British Thomson-Houston Company, Limited. (Haskins.)

16132. Method of and means for inducing magnetism in magnetic circuits, applicable to alternating-current motors, transformers, and the like. British Thomson-Houston Company, Limited. (Steinmetz.)

16133. Alternating electric current motors. British Thomson-Houston Company, Limited. (Steinmetz.)

21651. Electric railways and controlling devices therefor. British Thomson-Houston Company, Limited. (Potter.)

21653. Regulation of electric motors and brakes for electric railway vehicles and the like. British Thomson-Houston Company, Limited. (Case.)

21654. Electric brakes and methods of operating the same. British Thomson-Houston Company, Limited. (Case.)

21657. Electric train control systems. British Thomson-Houston Company, Limited. (Barry.)

21658. Signal systems for electric railways. British Thomson-Houston Company, Limited. (Stewart.)

21661. Cut-outs and switches for high-potential electric circuits. British Thomson-Houston Company, Limited. (Hewlett.)

21667. Systems of electrical distribution and measurement. British Thomson-Houston Company, Limited. (Steinmetz.)

22016. Electrical switches for telephonic systems and other purposes. Byng and Bell.

23284. Systems of electrical distribution and cut-outs therefor. British Thomson-Houston Company, Limited. (Thomson.)

23737. Pneumatically-operated contact shoes for third-rail electric railway systems. British Thomson-Houston Company, Limited. (Libby.)

23740. Controlling alternating electric current motors. British Thomson-Houston Company, Limited. Steinmetz.)

24643. Magnet frames for dynamo-electric machines and motors. Burke.

24832. Method of making commutators for electrical machines. Kaeferle.

25019. Safety fuses for electrical circuits. Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Jan. 20	4,029	3,745	+ 284	11,943	11,351
Blackpool-Fleetwood	,, 27	149	154	- 5	573	564
Bradford City Trams	,, 26	339	247	+ 92	25,303c	—
Bristol Tramways Co.	,, 26	2,697	2,382	+ 315	—	—
City & South London	,, 28	1,092	1,134	- 42	4,470	4,516
Dover Tramways	,, 27	151	132	+ 19	606	586
Dublin U.T., elec. cars	,, 26	2,837	726	+2,111	—	—
Dublin S.D. Electric	,, 26	609	620	- 11	—	—
Halifax Corporation	,, 28	545	305	+ 240	25,494a	8,189b
Hull Corporat'n E.S.	,, 13	682	—	—	—	17,711e
Liverpool Corporat'n	,, 20d	6,622	5,907	+ 715	20,027	17,807
Liverpool Overhead	,, 28	1,571	1,258	+ 313	6,026	5,260
Sheffield Corporation	,, 28	1,918	—	—	—	—
South Staffordshire	,, 26	733	542	+ 191	2,349	2,308

a Since April 1, 1899. b Since June 29, 1898.
c Total receipts. d Partly electrical. e Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Tuesday.
Commercial and Industrial.—		
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¾-⅞
British Insulated Wire, Ord., 1-40,000	5 ..	13-14
—— 6 per cent. Cum. Pref., 1-27,500	5 ..	6-6½
—— 5 per cent. Mortgage Debentures	100 ..	98-103
British Electric Works, Ordinary, 50,001-95,000	1 ..	⅞-1
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	1-1⅛
—— 4½ per cent. First Mortgage Debentures	108 ..	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	8 ..	2⅞-3¼
Brush Electrical Engineering, Ordinary	2 ..	1⅞-2
—— Non. Cum., 6 per cent. Pref.	2 ..	2¼-2⅜
—— 4½ per cent. Debenture Stock	100 ..	110-115
—— 4½ per cent. 2nd Debenture Stock	100 ..	102-105
Callender's Cable, Debentures	100 ..	110-115
—— Ordinary	5 ..	13½-14½
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	8 ..	3½ 4
—— 5 per cent. Debentures	— ..	98-101
Edison and Swan United, Ordinary	3 ..	2-2¼
—— 5 per cent. Debentures	5 ..	3½-4¼
—— 4 per cent. Deb. Stock, Red.	100 ..	93-95
Electric Construction	2 ..	2-2¼ xd
—— 7 per cent. Cumulative Pref.	2 ..	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	103-106
Giffre Electro-Chemical and Power, Ordinary	1 ..	¾-1⅛
W. T. Henley's Telegraph Works, Ordinary	5 ..	13-14
—— 4½ per cent. Preference	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	111-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	100-104
Telegraph Construction and Maintenance	12 ..	36-40
—— 5 per cent. Bonds	100 ..	102-105
Telegraph Manufacturing, Ordinary	5 ..	9-10
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	7-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	104-106
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	10-11
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	8 ..	8½-9½
Charing Cross and Strand	5 ..	10-11
—— 30,001-50,000	5 ..	9½-10½
—— 4½ per cent. Cum. Pref.	5 ..	5½-6½
Chelsea Electricity Supply	5 ..	7½-8½
—— 4½ per cent. Debentures	100 ..	109-111
City of London, Ordinary	10 ..	10½-11½
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-127
County of London and Brush Provincial, Ordinary	10 ..	9½-10½
—— 6 per cent. Cum. Pref.	10 ..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	— ..	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	4⅞-5½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	8 ..	8-8½
London Electric, Ordinary	3 ..	2-2½
—— 6 per cent. Pref.	5 ..	5-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	101-103
Metropolitan, Ordinary	10 ..	14½-15½
—— 62,501-85,000	10 ..	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	115-117
—— 3½ per cent. Mortgage Debenture, Red	100 ..	95-97
Notting Hill Electric Lighting	10 ..	15½-16½
Oriental, 1879	1 ..	1½-1⅝
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	6¾-7¼
River Plate Electric Light and Traction, Deb.	100 ..	75-85
Royal Electrical Company of Montreal	½ ..	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
South London, Ordinary	3 ..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15½-16½
—— 40,081-52,080	5 ..	15½-16½
—— 7 per cent. Pref.	5 ..	9-9½
Westminster, Ordinary	5 ..	14½ 15½
Electric Railways.—		
Central London, Ordinary	10 ..	9½-10
—— Pref. Half-Shares	5 ..	4½-5
—— ,, ,, deferred	5 ..	4½-5
City and South London, Consolidated Ordinary	100 ..	58-61
—— ,, ,,	5½ ..	4½-5½
—— 4 per cent. Debenture Stock	100 ..	125-130
—— 5 per cent. Pref. Stock '91	100 ..	143-148
—— ,, ,, ,, '96	100 ..	135-140
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
Waterloo and City, Ordinary	100 ..	101-104
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10 ..	17½-18½
Brisbane Tramway	100 ..	104-106
British Electric Traction, Ordinary, 1-30,000	10 ..	16-17
—— 60,001-75,000	10 ..	15½-16½
—— 6 per cent. Cm. Pf. 30,001-60,000	10 ..	13½-13¾
—— 5 per cent. Perpetual Debenture Stock	100 ..	125-128
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4⅜-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4½-5
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
Costa Rica Electric Light and Traction, 5 per cent. First Deb., 1-1,000 of £100 and 1,001-1,600 of £50 each	— ..	75-85
Kidderminster and District Lighting and Traction, Pref.	8 ..	8-8½
New General Traction, Ordinary	5 ..	3½-4
—— 6 per cent. Cum. Pref.	5 ..	5-5½
North Staffordshire Trams	6 ..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	18-19
—— Preference	10 ..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
Telephones.—		
Consolidated Telephone Construction and Maintenance	½ ..	½-½
National Telephone, Ordinary	5 ..	5½-5¾
—— 6 per cent. Cum. First Pref.	10 ..	14-15
—— 6 per cent. Cum. Second Pref.	10 ..	14-15
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅜-5⅝
—— 3½ per cent. Deb. Stock, Red.	100 ..	98-100
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

Free Trade in Electricity.—The Niagara Falls Power Company has passed a resolution stating that the company is opposed to a duty upon electricity generated in Canada and transmitted to the United States; that the imposition of such a duty is not required for the protection of any American industry; and that it might invite retaliatory legislation by the Canadian Government.

Power Supply.—We are glad to note that the Leeds Electricity Committee has given careful attention to the question of the supply of power throughout the town. For this purpose a two-phase system is being adopted for extensions, so that light and power can be conveniently supplied from the same mains. The Corporation are charging only 2d. per unit for power, and the number of consumers is in consequence on the rapid increase.

Telegram Thieves.—It is reported from Berlin that two former messengers of Wolff's Agency have been sentenced by the Criminal Section of the Berlin Provincial Court to two months' and one month's imprisonment respectively for stealing telegraphic dispatches belonging to that agency at the instigation of a partner of another news agency known as Hirsch's Telegraphic Bureau. Mr. Kurt Hirsch, a partner of this latter agency, has been sentenced to three months' imprisonment for instigation to theft and the crime of receiving stolen property.

French Cables.—In the French Government Bill which has for its object various cable routes a number of lines are proposed. The first cable is proposed to be laid between Oran, Tangier, Teneriffe, and St. Louis; the second is a line from Hué to a point north of Hong Kong; the next, a line from Tamatave to Réunion. Submarine cables are also proposed between French Benin and the French Congo, and the extension and improvements of the land lines in West Africa, at an expense not exceeding £40,000. The total expenditure is estimated at about £6,000,000.

Royal Institution.—At a general monthly meeting of the Royal Institution on Monday last Sir James Crichton-Browne, treasurer and vice-president, presided. The special thanks of the members were returned to Mr. Charles Hawksley for his donation of £100, to Mr. Frank M'Clean for his donation of £25, and to Sir Andrew Noble for his donation of £100 to the fund for the promotion of experimental research at low temperatures. The chairman reported the death of Prof. Hughes, and said that the managers desired to express to Mrs. Hughes their heartfelt sympathy with her, and their deep regret at losing a most valued colleague.

Combined Opposition to Bills.—The Battersea Vestry has decided to convene a conference of the authorities who will be affected by the Bill which the County of London and Brush Provincial Electric Lighting Company are promoting in Parliament. This conference is to be held at the Municipal Buildings, Lavender-hill, on Tuesday, Feb. 13, at seven o'clock. The Battersea Vestry is asking the other vestries to appoint two delegates. The conference wishes to consider the question of a joint opposition to the Bill, instead of each authority appearing separately. From information to hand from other parts affected, we believe that almost all the vestries affected by the Bill will join the conference.

Trailing Cars.—It is stated by a local paper that the use of trailer cars on the electric tramways at Hull is likely to be discontinued to a certain extent, as some of these cars are being equipped with motors at the present time. The disadvantage of the cars is said to be that they disorganise the time-table owing to the shunting operations at the end of the line. We think, however, that the Tramway Committee will do well to hold a certain number of these trailer cars always in stock, as they are of great service when on special occasions extra traffic has to be provided for. At such times they enable the carrying capacity of the line to be doubled without altering the scheduled times.

Defence of Motorcars.—We are informed that under the title of the "Motor-Vehicle Users' Defence Association" a committee has been formed, in which the Automobile Club is largely interested, for the purpose of protecting motor-vehicle users in law actions, either civil or criminal, and, where necessary, of commencing legal proceedings. The interests of users of motorcars throughout the kingdom are also to be looked after. The officials of the association consist of three trustees, a chairman, a vice-chairman, and a managing committee of 10 members. The positions have now, says the *Financial News*, all been filled, Mr. R. W. Wallace, Q.C., being chairman, and Mr. F. R. Simms vice-chairman.

Glasgow Tramways.—The growth of the use of the tramways in Glasgow since the Corporation took them over some five years ago is evidenced by the following figures, which will in a few years' time be even more interesting to compare with the still further increase in the use of the tramways when they have been improved by the complete adoption of electric power. The first week that the Corporation ran the tramways the income was some £3,800, but the average receipts per week now amount to about £9,000, while the total number of people carried during last year was some 119,000,000, which corresponds to carrying three times the whole population of Glasgow for a single journey each week.

Personal.—On Friday last Mr. R. A. Dawbarn, the late superintending engineer of the Brush Electrical Engineering Company, Limited, met the officials of that company at their London offices, and was presented with a token of esteem and goodwill subscribed for jointly at Falcon Works and the London office, on the occasion of his leaving to join the ranks of the consulting engineers. The presentation, which took the form of a silver salver, a pair of silver candlesticks, and an illuminated volume containing the names of the subscribers, was of a very handsome character, and should be a pleasing memento to Mr. Dawbarn of his long association with the company. The presentation was made in happy terms by Mr. R. Percy Sellon, and suitably acknowledged by Mr. Dawbarn.

The Recent Snowstorm.—The heavy fall of snow which took place last Saturday and Sunday was a particularly destructive one to overhead wires, the telephone and telegraphic wires all over the kingdom, and more particularly in the Southern counties, being broken down and the telegraph and telephone services disarranged. The National Telephone Company, who were large sufferers in this respect, have naturally seized the opportunity to point out that they have been refused permission by a large number of local authorities to lay their wires underground, as they have wished to do for the last four years. They add that the London County Council has been the chief opponent of the placing of these wires underground, and that the interruptions in the telephone supply are thus indirectly due to this public body.

An Electric Submarine Boat.—The submarine boat "Holland," which uses electricity as its motive power when under water, has been experimented with considerably in the United States. We remarked recently on one of the trials, in which the boat seemed to be none too well under

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control. In the test in question it was supposed to steer a straight course under water, and from the chart given one could see that there was considerable deviation from this course. We now learn that the Naval Board, after tests and careful inspection, have reported unfavourably on this boat to the United States naval authorities. Of course, the report may be reconsidered later, but it seems to us to confirm the opinion held by our naval authorities of submarine boats. In the meantime, the French are incurring more expenditure for submarine vessels which may throw further light on their practicability.

Queensland Telegraph Department.—We have received from Mr. John Hesketh, the electrical engineer to the Post and Telegraph Department of Queensland, a copy of an interesting souvenir issued with Christmas and New Year's greetings from the heads of the departments. The souvenir consists of numerous reproductions of photographs, taken in different parts of Queensland, of post offices and means of transporting mails throughout the colony. The post offices range from important buildings in the main towns down to a small wooden hut by the wayside. The views of the coaches used to carry the mails give one the idea that an inspector's position in the department will be an exceedingly pleasant one in fine weather. At the end of the souvenir some interesting information is given as to the increase of the business done by the various post offices and telegraph and telephone departments.

Electrical Patents.—If the number of applications for patents sent in in a given year by any one firm gives a true indication of the original work done by its staff, we have every reason to be proud of two of the electric companies of this country. Thus we find that during 1898 the British Thomson-Houston Company took out no less than 88 patents. The subject matter of a large number of these was communicated from the United States, and hence is not due to original work carried out in this country. The next electric firm in order in the number of applications is Messrs. Siemens Bros. and Co., who have applied for 46 patents during the past year. Here the whole of the inventions are due to engineers residing in England, as the firm of Siemens and Halske, of Berlin, also appear in the Patent Office list as applying for some 37 patents. We trust that this large record for the year of new electric inventions will not mean a continuation of electrical lawsuits in the future.

Electric Street-Lighting.—It is curious to note how completely the arguments of our contemporaries devoted to gas lighting are being answered by actual work in hand. Thus, while we are informed that incandescent gas lighting for the streets is the cheapest, best, and only feasible system, great strides are being made with arc lighting in practically all the London districts. Thus, in the Strand area, arc lamp standards are now being erected which will be supplied by means of cables drawn into earthenware ducts, which were laid during the autumn. The London County Council's station for lighting the Thames-embankment is now well in hand, and it is hoped that during the present year the whole of the embankment will be electrically lighted. In the meanwhile in the whole of the outlying districts, such as St. Pancras, Shoreditch, and Hammersmith, the electric lighting of the streets is being extended. In this way the reproach which has been brought against the lighting of London streets is being gradually removed.

Middlesex Light Railways.—On the 1st inst., at the meeting of the Middlesex County Council, a definite decision as the policy of the County Council with respect to the provision of light railways was arrived at. This decision is to the effect that the railways should be constructed by the County Council and then leased to a company or companies to be equipped. It is said that with the schemes already proposed this will involve an expenditure of about £3,000,000 by the County Council, and it is expected that this capital expenditure will bring in sufficient return in rent for the lines to cover the annual capital charges. The cost of the 11 lines now being promoted jointly by the Middlesex County Council and the Metropolitan Tramways Company is estimated at £636,000, while the other five lines promoted by the Council itself are said to cost £263,000. These are, of course, only the first lines of an extensive system, which, when completed, will be of great service to the inhabitants of Middlesex. We believe that on practically all the lines electricity is to be used as a motive power.

Death by Electricity.—We give elsewhere in this issue a paper by Dr. Cunningham on some interesting researches he has made in order to determine what actually caused death after electric shock. His conclusions are that death is produced by the action of the heart being disorganised, and from the fact that the heart is not then able to resume its regular muscular action. His experiments were made to ascertain whether its renewed action cannot be stimulated so that the sufferer can be brought back to life. It is evident that if the doctor's conclusions are correct, artificial respiration is not of much use in restoring animation. It is curious that an additional electric shock should be suggested as giving the regular stimulations to induce the heart to resume its normal action. In addition to this, artificial circulation of warm defibrinated blood should also be maintained. As these means of restoration have to be applied very shortly after the shock has been received, it seems hardly probable that they can be used in time in the average case of an electric accident, when expert surgical advice is not to hand.

Tramways. — In the parliamentary return issued recently on the British tramways we notice a great development of tramways all over the kingdom. For instance, the capital authorised for tramway undertakings last year was £26,597,392, as against £6,586,111 in 1878. The total length of the lines open for traffic last year was 1,122, as against 1,064 in 1898, and 269 in 1878. At the present time it is becoming more and more the custom for tramways to be transferred from private enterprises to municipal authorities, and it is therefore of interest to note that out of 169 systems 61 are controlled by local governing bodies, and 108 by joint-stock companies, so that there is still a wide field open for those local governing bodies wishing to place the working of the tramroads under their own control. With regard to mechanical traction, we notice that it is authorised on 133 out of the total 169 lines in the United Kingdom, a very large proportion of this mechanical traction being electric. The majority of the tramways appear to yield a fair profit, the total gross receipts for the United Kingdom last year being £4,879,602, and the working expenses £3,675,559, this leaving a net profit of £1,204,043.

Railway Carriage Improvements. — At the fourth ordinary meeting of the Aberdeen Mechanical Society, Mr. Hornet, of the locomotive department of the Great Northern Railway Company, read an interesting paper on the "Construction of Railway Carriages." In this he went carefully into the improvements made in the length and weight of the coaches during the last 50 years, and the influence of these improvements on the durability of the carriages. The bogie system was now very largely used throughout the country. He then turned to questions of ventilation, lighting, and heating, and stated his opinion that in lighting, Stone's system of electric lighting was likely to supersede all other forms.

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We have described this system in past numbers of our journal, its strong point being that every coach is quite independent of the rest of the train. This enables the train to be divided and individual coaches to be connected on different trains, without in any way interfering with the system of supplying light. Another great feature of the system is that the required electrical energy is generated automatically by the running of the carriage. Mr. Hornet's lecture was illustrated by lantern slides, diagrams, and models.

Power Gas.—An interesting installation for town lighting by gas-engines which are supplied by power gas has recently been laid down at Saltburn-by-the-Sea. The plant consists of two Crossley high-speed electric lighting engines, which drive dynamos supplying current at 220 volts. From the engine-room lead-covered and steel-armoured cables are laid to the surrounding streets, about three miles of mains now being in the ground. To these mains some 1,300 lamps have been connected, while applications have been received for over 2,000 additional lamps. It is interesting to note that although the plant has only been running some three months, the income exceeds the cost of production. A gasholder of considerable dimensions is used with the gas plant, so that a reserve of gas is stored against all emergencies. Accumulators are also provided, which have practically the same effect on the constancy of supply. It is interesting to note that already the coal used per Board of Trade unit sold comes out at less than 3lb., in spite of the fact that the larger proportion of the current is supplied through accumulators, and hence has to be debited with the energy lost in charging the accumulators. We understand from Messrs. Cox-Walkers, of Darlington, who have been responsible for the laying down of this plant, that the mains are being extended, and that a third engine and dynamo will shortly be laid down.

Lightship Communication.—In the review which appeared in the issue of the *Times* for the 31st ult. on "Science in 1899," the Brethren of Trinity House were accused of moving slowly in the establishment of communication by wireless telegraphy between lightships and the shore. The Elder Brethren of Trinity House have instructed Mr. C. A. Kent to state that they were the first in this country to move in this matter of public interest, and that they gave the Wireless Telegraph Company every accommodation free of charge while conducting experiments with the system. The letter goes on to say that the Elder Brethren have, however, good grounds for stating that "the alleged facts as to the saving of property of the value of £52,000 by means of the connection between the East Goodwin lightships and South Foreland are incorrect; and, while they are of opinion that electrical communication with light-vessels might, in certain circumstances, be the means of saving both life and property, they do not consider that any property which would otherwise have been lost has been so far saved through the agency of electrical communication of any description with light-vessels on the coast of England. In considering the matter of the permanent adoption and extension of the wireless system, it is not only impossible to ignore the question of the expense involved, which would be considerable, but this question is not altogether within the control of the Board as the general lighthouse authority."

The Pacific Cable.—In the House of Commons on the 1st inst., Mr. Hogan asked the Secretary for the Colonies whether he was aware that the dilatory proceedings of the Pacific Cable Board had occasioned considerable disappointment and dissatisfaction in the colonies concerned, and whether he could state the position in which this important Imperial undertaking now stood. Mr. Chamberlain replied that the Pacific Cable Committee had held two meetings, and was making enquiries with a view to the settlement of a definite scheme. Those enquiries, relating as they did to technical questions, necessarily took time, but he had no doubt that there would be no avoidable delay. Mr. Hogan also asked whether certain concessions had recently been granted to the Eastern Telegraph Company as regards the opening of independent offices in the Australian capitals in connection with their proposed new cable from South Africa to Australia, and whether there was any ground for the apprehension that these concessions would seriously affect the financial success of the cable that was about to be laid from Canada to Australia under the auspices of the Imperial, Canadian, and Australian Governments. To this question the Colonial Secretary replied that the matter was under the consideration of the Australian Governments, but that he did not know whether a decision had been arrived at. In this connection we also understand that considerable reductions in tariff are offered by the Eastern Telegraph Company if the privilege of connecting direct by land lines with its customers in Australia is granted by the Australian Governments.

Refuse Destructors.—At a meeting of the Birmingham Association of Mechanical Engineers, held on the 3rd inst., Mr. R. B. Hodgson read a paper on the "Meldrum Furnace," with special reference to the "econometer" and the destruction of town refuse. Dealing with the subject of steam jet blowers, he pointed out that while the mechanical stokers with moving grates employed steam jets to keep certain parts of the apparatus cool, yet the fact was not brought prominently before the public, as steam users were rather apt to object to their employment. He contended that this objection was due to a want of knowledge of the advantages of forced draught, and he quoted results to show that by means of the steam jet the evaporation could be increased 50 per cent. without a loss of fuel efficiency. In some cases a considerable saving was also effected in fuel. The details of the Meldrum furnace were then described, after which the gas-weighing apparatus called the econometer was explained. This apparatus is used as a check on careless stokers, and enables a regulation of the air supply to boilers to be obtained. In the last part of his lecture Mr. Hodgson described the use of forced-draught furnaces for destroying town refuse, such as have been installed at Hereford and at the Darlington electricity works. He claimed that 1½lb. of water were evaporated per pound of refuse on trial, but he did not give average figures for a longer period. A curve of the steam pressure for a 24 hours' run was shown, which made it clear that the pressure was maintained fairly well up to 200lb. per square inch.

The Arnold Magnetic Clutch.—Some illustrations we have received from the manufacturers in Chicago of the Arnold magnetic clutch, form an interesting parallel to what was done in the early days at the City of London Electric Lighting Company's works. These Arnold clutches are being used by the electric lighting company in St. Louis to couple dynamos on to either end of the engines. We presume from the illustration that under ordinary conditions the generating machinery on each end of the engine shaft will be worked, but that at light loads the magnetic coupling between one or other of the dynamos will be released, so that the frictional losses of the same can be saved. The description forwarded to us is interesting, but it gives but a very hazy idea of the clutch itself. It seems that two discs of iron are keyed on to the ends of the shaft to be coupled, and that the electric circuit in one of these discs when energised causes the two discs to hold together. In starting up the dynamo the two opposite

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surfaces act as a friction clutch, the necessary force being maintained by the magnetic pull. The diameter of the clutch to transmit 3,000 h.p. at 150 revolutions is said to be 8ft. 4in., while only some 240 watts are required to energise the electric circuit. No information is given as to the disposition of the coils in the clutch. From the description, we gather that eddy currents are not relied upon when accelerating, as it is stated that the clutch drives by friction. A number of these clutches have also been used with synchronous motors in order to connect them to the load after they have been run up into step.

Illuminating Globes.—In the January number of the *Journal* of the Franklin Institute a paper by Messrs. R. B. Williams and J. H. Klinck on a "Photometric Comparison of Illuminating Globes" is given in full. The authors experimented with great care on a large number of globes and reflectors used in connection with the Welsbach gas-light. While, of course, in some respects these results are not applicable to incandescent electric lamps, and certainly not to arc lamps, the general effect of the globes on the light rays in a given direction will be the same. In order to ascertain what these actions were, the authors made photometric measurements at different angles in a vertical plane for the same light, with and without the globe or reflector. In this way polar curves were obtained by which the actual efficiency of the globes was calculated. As an example of the result when using a Holophane globe, the area of the curve above the horizontal line was decreased from 12·58 to 7·92, while the area of the curve representing candle-power below the horizontal line was increased from 11·15 to 12·72. The mean spherical candle-power of the light without the globe was 46·46, while it was decreased by the globe to 41·28. This gives the efficiency of the globe as 87 per cent. This efficiency must be considered together with the fact that the light given off below the horizontal line was actually increased, and that this light is the more useful. Similar curves are given for enclosing globes of different shapes, and for a large number of reflectors. The curves obtained are most valuable for reference, and make it clear how important it is to select the right globe for a given situation.

Cambridge Engineering Laboratory.—The new wing of the Cambridge University Engineering School was opened on Friday last by Lord Kelvin. The new wing, which has been presented to the university by the widow and family of the late Dr. John Hopkinson, comprises several handsome and commodious rooms and a fine lecture theatre. The Vice-Chancellor, Mr. Chawner, Master of Emmanuel, presided at the opening ceremony. Lord Kelvin said the opening of the John Hopkinson memorial wing of the engineering laboratory was an event of the deepest interest and of manifestly high importance in the history of the University of Cambridge. No one had done more to promote the application of science to the use of man than John Hopkinson, who devoted himself enthusiastically to the work of the civil engineer, and was twice president of the Institution of Electrical Engineers. It should not be forgotten at that moment that Dr. Hopkinson founded the Volunteer Corps of Electrical Engineers of which he (Lord Kelvin) was honorary colonel, and a large detachment of whom were under orders to proceed to South Africa. They wished success to the corps, he was certain, and it seemed a fitting moment to think of it when they were met to commemorate the opening of a memorial to John Hopkinson. In conclusion, Lord Kelvin announced that he had been delegated by the directors of the Linotype Company to offer for acceptance a bust of Dr. Hopkinson. The Master of Trinity having unveiled a portrait of Dr. Hopkinson, Mr. Bertram Hopkinson, on behalf of his mother, his sister, and himself, briefly thanked the donors of the portrait for their present.

Progress.—The *Elektrotechniker*, in a *résumé* of recent work accomplished in the electrical field, refers to the endeavours now being made to obtain a more efficient combination of the locomotive and car on railways, so as to avoid the necessity of carrying a large proportion of dead-weight over little-frequented stretches, and so lessen the cost of working, at the same time obtaining a more regular service of local trains without interfering with the express service. Mention is also made of an electrically-propelled ferry boat which has been established on the Seine at Neuilly. The electric motor is situated on board, and actuates two paddle wheels which propel the boat in the ordinary way, while current is conveyed to the motor by two wires stretched across the river. Another novelty which claims attention is a new method of ship haulage at present being experimented with on the ship canal between Stettin and Berlin. The method aims at substituting electrical haulage for the horse haulage hitherto in vogue on the canal. To this end, by way of experiment, a narrow-gauge railway has been constructed along the existing tow-path parallel with the canal between Eberswalde and the Ragoeser Lock. Over this railway small electric cars, propelled on the overhead trolley system, are run, and provide the means whereby the ships and barges using the canal are towed. In conclusion, the article refers to the discovery by the well-known Belgian chemists Hoho and Lagrange, whereby iron may be brought to a white heat by dipping it into cold water. A metal vessel is partly filled with water and connected up to a source of electricity supply giving 30 amperes of current. The other pole is attached to an iron rod provided with an insulated handle. The water offers great resistance to the passage of a current through the combination, a very high electrical potential being thus generated in the neighbourhood of the iron rod, whereby the water is rapidly decomposed, and a temperature of 1,200deg. to 1,500deg. set up within a period of 20 seconds.

Telegraphy in Mountainous Regions.—Experiments with wireless telegraphy upon Mont Blanc having failed to give satisfactory results, attempts have been made to obtain reliable connections between the various peaks of the mountain and the little town of Chamounix by other means. These attempts are not only interesting on account of the bearing which they have on telegraphy in mountainous regions, but also from a general point of view. Mr. Lespian undertook experiments with a view to ascertain whether the peaks abounding in the mountain, or, indeed, the glaciers themselves, could be used as supports for the telegraph wires, and whether they would afford sufficient insulation for practical purposes. It is well known that ordinary posts are useless for telegraph work in mountains owing to the difficulty of erecting them, in the first place, and their liability to be thrown over in the second. The question therefore presented itself whether, perhaps, telegraph poles might not be entirely dispensed with, and the wire simply laid over the glaciers and rocky peaks without further support. Improbable as this would at first sight appear, the experiment is reported, nevertheless, to have completely succeeded. Two wires each of 2,000 yards long were laid between two glaciers, at a distance of 16ft. apart, so that they actually rested upon the ice. The ends of the wire were then connected each to a transmitter, when messages were sent through the lines without the slightest difficulty. It was also proved, by means of a galvanometer, that no loss of energy over the lines was incurred. Neither was there the slightest

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disturbance through mutual induction between the wires. The glaciers proved themselves to be excellent insulators even when the ice on their surfaces was in a melting condition. But although these results are exceedingly interesting, the system suggested does not overcome all the difficulties pertaining to telegraph poles, since the wires are still exposed to the danger of breakage by avalanches and falls of snow.

The North-Western Electrical Association.—The eighth annual convention of the North-Western Electrical Association of America was held at Milwaukee on Jan. 17 and 18. The president this year is Mr. H. L. Doherty, and we gather from the descriptions of the meeting which have appeared in the American Press that it was most successful. The members present were, if anything, fewer than usual, owing to the great pressure of business. The rules of the association were amended in several respects, and alterations were made in the by-laws, which will have to be confirmed at a later date. At the close of the meeting the officers were elected for the following year, and included Mr. P. Norcross as president and Mr. J. G. Gille, of St. Paul, secretary and treasurer. The papers read at this meeting will be referred to in separate notes. Mr. Doherty's presidential address called attention to the remarkable activity and prosperity which had been generally distributed over the electrical industry during the past year. He considered that the rise in the price of materials would not prevent the placing of orders. He proceeded to refer to individual improvements which had been made in connection with various branches of electrical engineering, and particularly of the use of producer gas, which he thought was worthy of serious study by engineers Even now a unit of energy could be produced more cheaply as regards fuel by this means with gas-engines than by any other power producer. Added to this the producer-gas furnaces had the advantage that the gas could be stored, which was not the case with steam. Referring to the methods of charging for electrical energy, Mr. Doherty advocated the system which is known in this country as the Wright maximum demand system, although he did not approve of this system by name. He suggested that the reduction in rate should be made after the first hour's average consumption per day of the whole lights fixed in the installation.

Wireless Telegraphy.—Signor G. Marconi on Friday last delivered a lecture on "Wireless Telegraphy" at the Royal Institution. Alluding to the installation of the system between the South Foreland and the Goodwin Sands lightship, he said the experiments had shown that wireless telegraphy was reliable and certain in operation. He hoped before long that the necessary funds would be found to enable Trinity House to establish communication all round the coast with lightships and lighthouses, by means of which a vast amount of property and many lives might be saved. At the tardy request of the War Office he sent out one of his assistants, Mr. Bullock, and five others to South Africa, and on Dec. 11 these reached the camp at De Aar. When they arrived, however, they found that no arrangements had been made for the supply of poles, kites, and balloons, which were essentially part of the apparatus, and these had to be obtained on the spot. To get over the difficulty they manufactured some kites, and in that had the hearty assistance of Major Baden-Powell, brother of the gallant defender of Mafeking, and Captain Kennedy. The results obtained were not at first altogether satisfactory, but that was accounted for by the fact that the working was attempted without proper materials. It had been reported that the difficulty of getting through from one station to the other was due to the iron in the hills. If it had not been telegraphed from South Africa, it would hardly be credible that anyone should commit himself to such a statement. As a matter of fact, iron would have no more effect than any other metal on the "waves." During the naval manœuvres signals by means of wireless telegraphy went through a fleet of 30 ironclads and the apparatus was not affected thereby. However, on getting the kites up, communication was easily established between De Aar and the Orange River, over a distance of 70 miles. Poles had now been obtained, and although not quite high enough for conveying messages long distances, yet they were sufficiently high to be useful. Stations were now established at Modder River, Belmont, Orange River, and De Aar, and had worked well, and would be invaluable in case the field lines should be cut by the enemy. He was confident that the progress made this year in wireless telegraphy would greatly surpass what had been accomplished during the past 12 months, and he believed that by means of wireless telegraphy telegrams would become as common and as much in daily use on the sea as they were at present on land.

Indiarubber from Bolivia.—On the 31st ult. Sir Martin Conway read a most interesting paper before the Society of Arts on the "Undeveloped Resources of Bolivia." We note that the greater portion of the paper is devoted to the indiarubber industry in the country, which is being developed quickly. Thus, in 1893-94, the export of Mollendo rubber was only 37,587lb. For the last year in which statistics are available, 1897-98, no less than 491,087lb. of rubber were exported. The indiarubber collected in Bolivia is of exceedingly good quality, commanding almost as good a price in the market as Para rubber. The indiarubber trees are stated to be of the syphonia elastica species, which grow as large as the average English elm. These trees grow in clumps of from 100 to 150 together, and as they are higher than the other forest trees, their position can be easily located from an elevated point overlooking the forest. It is curious to note that in Bolivia the indiarubber trees are not in swamps, as in the Amazon River districts. Sir Martin Conway explains that the trees derive a large proportion of their moisture from the almost constant cloud which hangs over them, caused by the cold air continually pouring down from the adjacent snow-covered hills. A most interesting description of the difficulties in connection with the collection of the rubber is given by the author, and we find that scarcity of labour and cost of transport of food are the two chief obstacles which keep back the industry. The absence of roads makes the carriage of the food supply from the coast exceedingly expensive. The indiarubber, which has also to be brought to the coast, is unreliable if cheap. The average amount of rubber which one collector produces per day is considerably lower than in the Amazon district. The rubber is collected from April to July, and again from October to March, but if a tree has been tapped for three months in one year it needs a nine months' rest. The life of a tree which is annually tapped is said to be a long one, and is stated to exceed the 15 years which are required for the growth of a tree from the seed. Estimates are given from actual experience on the spot of the cost of production of 100lb. of rubber, which works out at 19·82d. per lb., delivered in London. An estimate by the author places the possible output of Mollendo rubber at 30 times the quantity collected at present. The author suggested that the roads required for opening up the country, while at first exceedingly valuable to the indiarubber merchants, would later on be of equal service in developing the valuable mineral products of the country.

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TROLLEY WIRES OVER MOVABLE BRIDGES.

Several unusual difficulties have had to be faced in the equipment of the electric tramway at Hull in consequence of the peculiar local conditions. Thus a number of level railway crossings occur in the routes of the cars. The greatest novelty consists, however, in the equipment of two bridges which are movable. These bridges over the dock and waterways of the town are of course unavoidable, and it is of the greatest importance that the electrical equipment shall be such that no time is lost in opening and closing them. The Corporation having decided to proceed with the Holderness-road route immediately on the completion of the Hessle and Anlaby roads, it followed as a matter of course that the works for the North Bridge over the River Hull would be favoured with earlier attention than those for the Monument Bridge, which will connect with a section to be taken last in order of rotation. Through the courtesy of Mr. A. E. White, the city engineer of Hull, we are able to give the following illustrations of the arrangements on the North Bridge. Thus Fig. 1 shows the bridge and approaches with the trolley wires and points of supporting the same. The next two drawings (Figs. 2 and 3) are respectively a plan and elevation of the bridge, from which the full details of the overhead construction can be seen. A cross-section of the bridge is given in Fig. 4. There are no special features about the permanent way, which will consist of the ordinary rails bolted to the cross girders of the bridge, packings being used as required to bring the rails to the contour of the roadway. The trolley wires on the west side of the bridge will terminate at a bracket carried by a pole on a pile in the river, the pole and bracket being stayed to the wall of an adjoining warehouse. The trolley wires on the east side will terminate at a bracket carried in the ordinary way by a pole at the kerb line immediately east of the opening span (Figs. 2 and 3). The wires on the movable part of the bridge will be carried by brackets on poles attached to the main girders. These wires will be connected to the wires on the east side by means of self-engaging switches, which will open and close as the bridge rises and falls. The switches will consist of tapered tongues slid into spring jaws. On the west side the wires on the bridge will terminate at a slightly higher level than the wires on the approach, and will not be electrically connected with them, but an inclined bar will be attached to the terminal bracket to guide the trolley

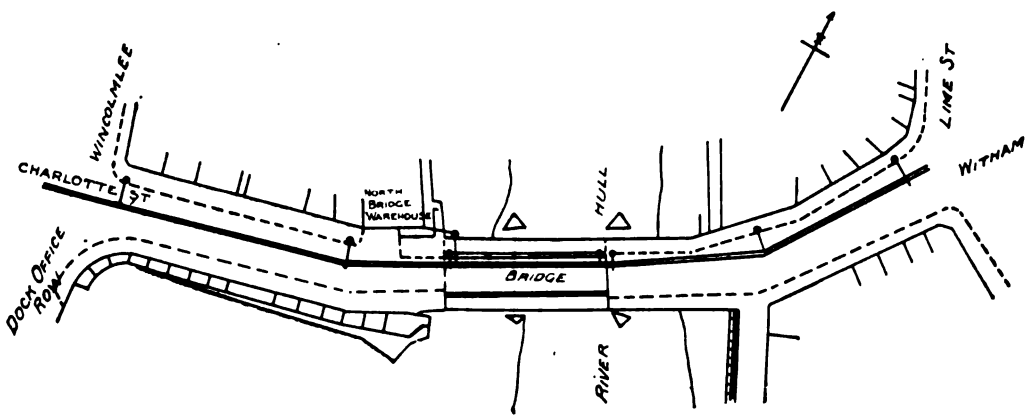
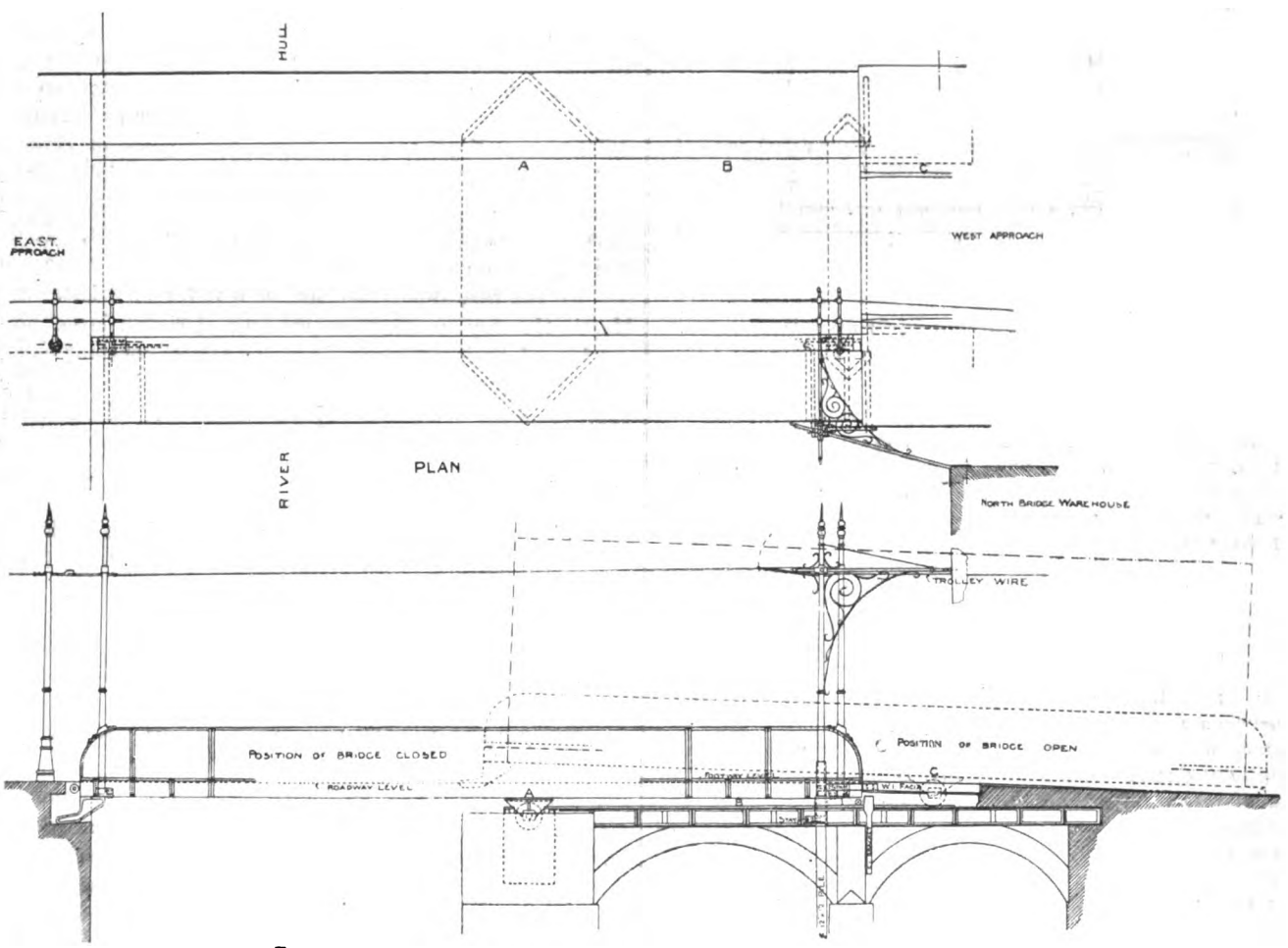


FIG. 1.—Plan of the North Bridge, Hull, and Approaches, showing Trolley Wires.



FIGS. 2 AND 3.—Plan and Elevation of the Bridge with Details of Trolley Wire Support

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from one wire to the other. When the movable part of the bridge lifts, the wires upon it will lift away from the west approach wires, and the lifting of the bridge will raise the wires upon it to such a height that they will be clear of the fixed wires when the bridge runs back to the dotted position shown in Fig. 3. When the bridge closes the wires will come back into line with the others, and the switches will automatically make the necessary electrical connection.

The trolley wires at Hull are divided into sections of about half a mile in length, insulated from each other. These sections are independently supplied with current. The feeders for the Holderness-road are carried under the bed of the River Hull, and the opening and closing of North Bridge will therefore not interfere with the supply of current to the lines on the east side. The return current from the rails on the east side will also be conveyed under the river by means of a cable connected to the rails on either side, and the return current from the rails on the bridge will be conveyed to the rails on the west approach by means of an automatic switch bridging over the break in the rails.

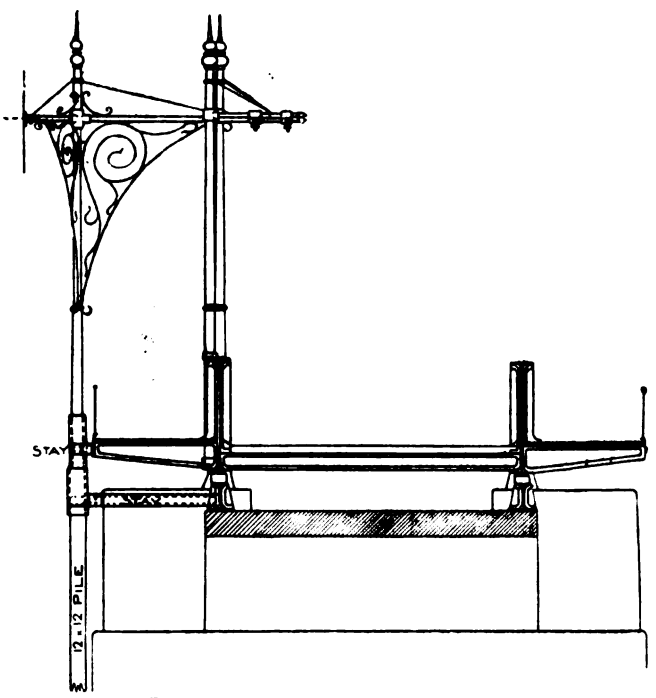

FIG. 4.—Section of the Bridge at one end.

The designs for the electrical equipment of this bridge were got out by Messrs. Siemens Bros. to meet suggestions by Mr. White, and were afterwards approved by him. These designs have now passed the Council, and the work on the bridge is now in hand.

DEATH BY ELECTRICITY.*

BY R. H. CUNNINGHAM, M.D.

As this subject is of such vital importance to all practical electricians, possibly many of your readers may be interested to read a brief description in non-medical language of how everyday electric currents induce death in the lower animals. Exactly how a man is killed by such currents is for the present, unfortunately not definitely answerable; but, as I have pointed out in a previous paper on this subject in the New York *Medical Journal* of Oct. 21 and Oct. 28, clinical evidence as well as the presumptive evidence from animal experimentation makes it quite probable that such currents kill men in essentially the same way that they kill a monkey or a dog. Thus my positive assertions in the above-mentioned paper, as well as in this article, relate to those phenomena that are exhibited by the various lower animals when they are subjected to the powerful electric currents of commerce.

For many years the question whether death from electricity results from that but slightly understood condition which the medical text-books describe as "shock," or whether it results from some indiscoverable molecular alteration of the tissues of certain organs necessary to life, or whether it is produced by the abnormal prolongation of some physiological effect of the current, has been the subject of much controversy among numerous scientists, and every kind of good, bad, or indifferent evidence has been brought forward to elucidate the problem. When I first investigated this subject five years ago by making a few experiments on dogs with arc light and other varieties of continuous currents at a thousand or more volts pressure, I passed them for various periods of time across the chest, through the brain, and from the brain to the thighs or to the belly; but from the lack of proper physiological registration apparatus I was able to determine definitely no more than had been determined definitely by Dr. Tatum in 1890—namely, that the chief lethal effect of currents, both continuous and alternating, seemed to be upon the heart.

What this cardiac effect was I recognised immediately; but owing to the fact that Dr. Porter's simple method of recovering the excised heart of the dog was not known to physiologists at that time, no way of definitely proving what I considered to be a fact occurred to me. Therefore, to solve definitely the question of how electricity kills an animal, I resumed last winter my previous experiments of five years ago, and followed my former plan of applying the currents in the three ways described above. In this instance, however, the upper surface of the brain and the upper portion of the spinal cord were exposed by removing the protective bony and soft parts, so that the electrodes could be applied directly to those parts. The E.M.F. of the continuous currents employed was from 112 to 124 volts. By making good broad contacts as much as 3·8 amperes could be passed through many of the animals. The duration of the shock varied from one-tenth second to one or more minutes. In every experiment the proper registration apparatus was employed to record graphically the most important phenomena manifested by the experimental animal.

Briefly summed up, my results with these currents were essentially the same as my former results obtained with currents of higher tension, which permitted a greater number of amperes to be passed through the animal. These results were as follows:

When the chest was traversed by a sufficient number of amperes, or fraction of an ampere, for a sufficient length of time, the most important effect produced was the immediate cessation of the co-ordinate beat of the heart. Consequently the circulation of the blood throughout the body ceased, and the various delicate nerve cells of the central nervous system died rapidly from the lack of indispensable blood. The action of the current upon the heart is clearly a physiological one, and the state produced in it is what physiologists term fibrillation. Roughly speaking, in this condition, the rhythmical synchronism of the contractions of the little muscle bundles of which the heart is composed is profoundly disturbed, and the contractions of the bundles fall out of phase. Thus the heart fails as a blood pump, and death quickly results unless the circulation is restored.

As the hearts of the higher mammalia practically never emerge spontaneously and permanently from this condition, it is evident that unless something is done to restore the circulation very quickly death results inevitably in a very short time. But it has been known for many years to physiologists that the lower the order of the animal, the more readily does the heart recover spontaneously and permanently from fibrillation; so that when guinea-pigs, rats, mice, turtles, frogs, and fish are subjected to strong currents the permanency of the cardiac effects is less pronounced.

Owing to the small size of such animals it is practically impossible to prevent a large part of the current from traversing the nervous system, so that the chief physiological effect of the current is, as would be expected, upon their nervous systems, and is identical with that produced by passing the current only through the brain and upper part of the spinal marrow of a dog in such a fashion as not to include the heart in the circuit. When passed in

* From the *Electrical World and Engineer*.

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this way through the brain comparative weak currents (one to two amperes) usually produce a more or less pronounced stoppage of the rhythmical respiratory movements during the time that the current is passing. When the circuit is opened, generally this so-called inhibitory effect passes off in a moment, and the breathing commences again. With very strong currents (six to twelve amperes) usually one or more general convulsions follow the powerful stimulation of the cortex of the brain, and the respiratory inhibition is more pronounced, and last for a longer time after the flow of the current has stopped. Consequently, if the respiratory inhibition persists long enough, death results from asphyxia. If the degree of asphyxia is not permitted to become too profound, such animals can be restored by means of artificial respiration.

When the circuit includes the brain and the heart, one would expect very naturally that the effect would be a combined one, and such is the case. The heart is thrown into fibrillation, the blood supply to the brain stops, and the effects due to the excessive stimulation of the nervous system either by the current or by the complete anæmia, if the shock is brief, become prominent and finally cease.

To resuscitate an animal under such circumstances it is quite evident that the co-ordinate heart-beat and the circulation must be re-established before that most perishable part of the body, the central nervous system, becomes too profoundly depressed by the prolonged absence of the necessary blood. Unfortunately, the vitality of the more important nerve centres does not withstand such a degree of anæmia usually for more than a few minutes, so that an attempt at re-establishing the circulation must be extremely prompt in order to be successful. Now, as I have pointed out elsewhere, it is comparatively easy to re-establish the co-ordinate heart-beat in the fibrillating dog's heart after its removal from the body by injecting defibrinated dog's blood through the nutrient blood-vessels of the heart; but to accomplish the same result with the heart intact in the body, and at the same time cause enough blood to circulate through the nervous system so that it will not die, is a much more difficult feat to accomplish even in a laboratory with all the necessary apparatus at hand. To accomplish the above result, I established an artificial circulation through the electrocuted dog by injecting blood with a specially-devised apparatus, which is fully described and depicted in a previous article, into a large artery in the neck, and at the same time withdrawing blood from the right side of the heart, after passing a tube down into it through one of the large neck veins in order to prevent over-distension of the heart and veins.

To avoid the difficulty and the necessity of keeping up the artificial circulation for the considerable time that often elapses before the fibrillating heart recovers, I applied several varieties of powerful, momentary electrical stimuli or shocks to the exposed heart, and found that when the properly-adjusted brief discharge of a condenser—for instance, that from the outer coating of two one-quart Leyden jars arranged in series and charged on their inner coats by an 8in. induction coil—was sent momentarily through the fibrillating heart it gave a co-ordinate beat, which was maintained, provided defibrinated blood continued to be injected through the arteries of the heart. To produce the same result upon the fibrillating heart within the body much larger condensers were found to be necessary. In other words, that variety of powerful physiological stimulus appears, so to speak, to throw the contractions of fibrillating muscle bundles into phase for a moment; and once in phase the muscle bundles remain so, provided the necessary blood continues to flow through the heart vessels, a condition that is maintained automatically with the return of the co-ordinate heart-beat.

Although the above facts were discovered by me independently during the early part of last winter—as many who witnessed my experiments can testify—their publication was delayed for certain reasons mentioned in my article in the New York *Medical Journal*. But others beside myself were evidently studying this subject in a partly similar manner, and to Messrs. Prevost and Battelli, of Geneva, must be given the credit for first publishing the statement that continuous and certain kinds of alternating currents kill some varieties of animals by producing fibrillation of the heart, while others die from respiratory inhibition. In their papers another very interesting statement is made also—namely, that if a momentary shock from a 4,500-volt transformer (amperes not mentioned) was given to a dog, within a few seconds—that is, as I judge from their tracing, before the circulation has ceased completely and the blood pressure fallen to zero—after it had received a shock of brief duration from a low-voltage current of a strength usually sufficient to produce permanent fibrillation of the heart, the heart immediately resumed its co-ordinate beats in response to the powerful momentary stimulus. If many seconds elapsed before the application of the powerful stimulus, the co-ordinate heart-beats failed to reappear, a result due, in my opinion, very probably to the fact that the circulation had become totally extinguished. As the foregoing procedure in conjunction with my method of creating an artificial circulation through the body is evidently easier of application than my method of stimulating the fibrillating heart with a sudden condenser discharge, I am engaged at the present time in investigating whether or not it is as efficient.

Brief shocks of one or two seconds' duration from alternating currents of high voltage (4,500 volts and above) do not throw the fibrillation, according to Prevost and Battelli, but kill by causing a more or less permanent inhibition of the respiration. Low-voltage alternating currents kill in the manner described above. This curious and interesting fact I have lately been able to verify to a certain extent during several recent but unsuccessful attempts to quickly recover the fibrillating heart by injecting it with blood and applying brief shocks from a high-voltage transformer. For instance, six amperes, at about 12,000 volts, was passed across the chest of a dog for five seconds without producing more than a momentary stoppage of the heart, but no fibrillation occurred. When the head was included in the circuit, a temporary cessation of the breathing took place. Electricians and others receiving shock from such high-voltage alternating currents should by all means have one of the methods of artificial respiration performed upon them the moment the breathing begins to appear shallow.

It is clear from the preceding statements that it is possible for the lower animals to be resuscitated by the above-mentioned means, after they are electrocuted by certain kinds of electric currents, provided the application of the current is not too prolonged; but such a fact need not lead one to conclude that when an electrocuted criminal reaches the autopsy table, if a similar method of resuscitation is applied to him he could be resuscitated. At the official electrocutions a strong current, about eight amperes, followed by a current of two or three amperes, is applied for a minute or more; a medical examination is made, and the individual pronounced dead; the body is removed from the chair, and by the time that it is ready for the pathologists so many minutes have elapsed that it is extremely probable that the individual's nervous system has become totally incapable of revival, owing to the prolonged arterial anæmia.

As I have already remarked recently in this journal, animals do not appear to be killed instantaneously by the above varieties of currents, although death supervenes with great rapidity, and the same statement applies very probably to men if clinical data are to be relied upon. Nor does there seem to be an instantaneous loss of consciousness—that is, consciousness is not lost synchronously with the beginning of the shock. It is true, this period of consciousness may be extremely brief; but this brief period seems to be invariably ample for the individual to perceive that he is in contact with some kind of an electric current, although this sensation seems to be comparatively painless, according to the statements of those who have received severe but not fatal shocks.

As regards the minimum intensity of current necessary to produce cardiac fibrillation in man, and thus cause death, I can give no reliable data; although, judging from my experimental experiences, as well as from the clinical reports of fatalities from low-tension illuminating currents, it is very probable that the physiological susceptibility to the current varies in different individuals, and also that an individual is more susceptible at certain times than at others. In many dogs, ·2 ampere applied for a quarter of a second

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across the chest-wall prove just as lethal as a current of three amperes applied for a minute. Since the 110-volt illuminating current seems capable of electrocuting certain individuals, my concluding advice to everyone is to avoid coming in contact with the bare mains conveying such currents; for though one may often touch live 110-volt mains with impunity at certain times, it is possible that he may do it at a time when his susceptibility to the current is heightened, and thus receive a shock that may readily produce physiological effects.

ELECTRIC LIGHTING IN PRETORIA.*

Although Pretoria, viewed in the light of its present-day importance as capital of the South African Republic, is a comparatively small town, the lighting of the place seems to be entirely satisfactory to the residents. The Pretoria central station has not yet assumed large proportions, but the installation is larger than most people would surmise, and it meets the town's requirements. The service is, moreover, of excellent quality. It is interesting to note that the Pretoria central station is to-day generating and has for the last five years disposed of a larger output than the corresponding plant at Cape Town, which has a far larger population to cater to. Even taking it for granted that there are private installations in Cape Town, and that gas is there an important competitor, while Pretoria possesses neither, it is plainly evident that the smaller town is as well if not better off in the matter of electric light than the Cape metropolis.

A Johannesburg contemporary gives the following data: in 1896 Cape Town generated 188,753 units (kilowatt-hours); in 1897, 312,300 units; in 1898, 362,711 units. In 1896 Pretoria generated over 300,000 units; in 1897, over 350,000 units; in 1898, over 450,000 units, and it is more rapidly increasing its output than Cape Town.

Electric light was introduced in Pretoria eight years ago, when small belt-driven dynamos were installed for the purpose. These machines, which formed the original plant, are still effective for use, and consist of five Crompton continuous-current bipolar dynamos designed for 120 volts and 320 amperes and a speed of 770 revolutions a minute. Each machine is belted to a Davey-Paxman horizontal compound engine, working at 140lb. steam pressure, and capable of exerting 75 h.p. at a speed of 120 revolutions a minute. The engines are supplied with steam from a battery of five Davey-Paxman 30-h.p. locomotive boilers, the gases from which escape by one main flue to a brick smokestack about 60ft. high. A Crompton switchboard, with a suitable arrangement of switches, voltmeters, and ammeters, and a light overhead traveller, may be said to complete what is now termed the old plant. As this equipment has been superseded by the new plant, it is not in use now, and is not likely to be put in operation again unless the latter is disabled through accident.

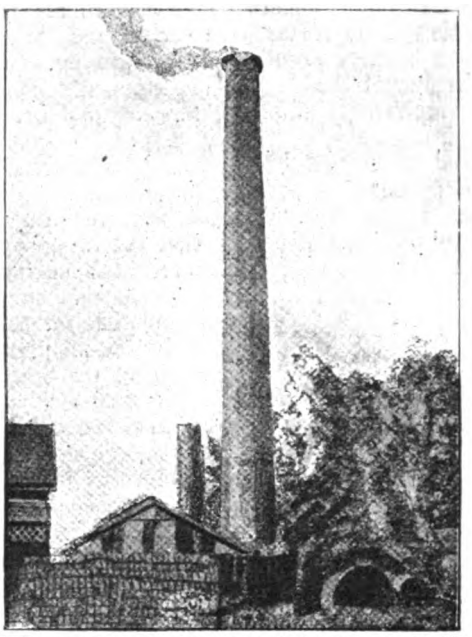

FIG. 2.—General View of the Electric Lighting Works at Pretoria

The new plant (shown in Fig. 1) was installed about two years ago by Messrs. Hubert Davies and Spain, and the generating portion consists of two 126-kw. generators, designed for 260 volts pressure. These are coupled direct to two Bumsted and Chandler compound-condensing engines, working under a steam pressure of 160lb., and running at 340 revolutions a minute. The cylinders are: low pressure, 22in.; high pressure, 14in.; and stroke, 9in. All the working parts of the engine, excepting the Chandler governor, which is operated off the crankshaft, are entirely enclosed. Each engine is provided with forced lubrication, an engine counter, and a Geipel steam-trap.

Two equalisers are used. One is wound for 120 amperes

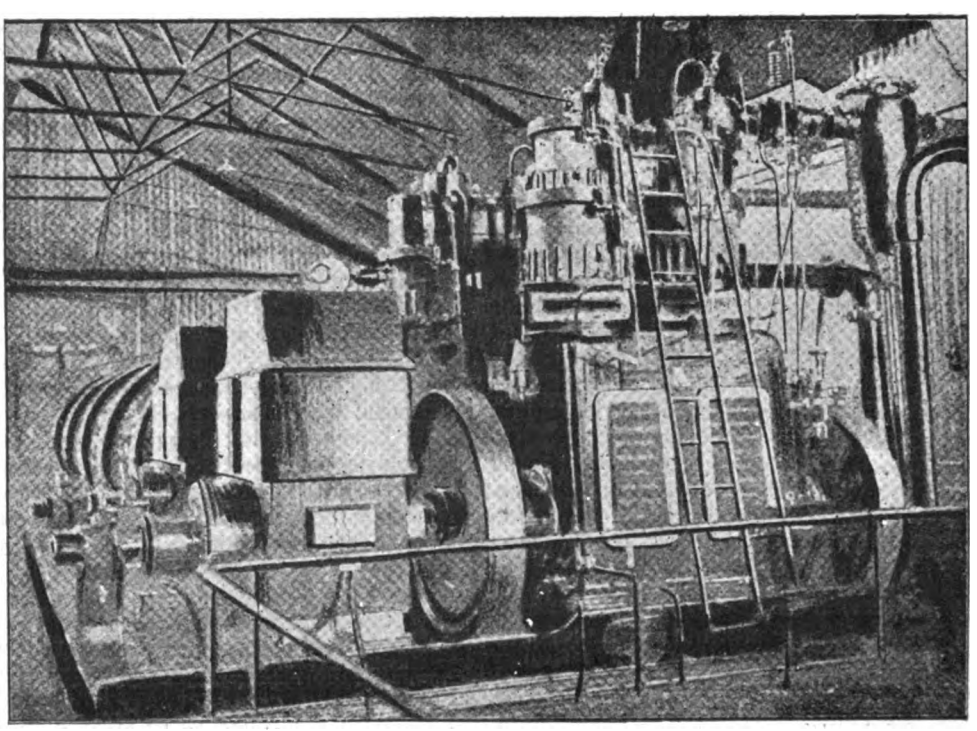

FIG. 1.—The Electric Lighting Station, Pretoria.

* From the *Western Electrician*.

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at 120 volts, and the other, made by Siemens and Halske, is of similar capacity. A separate switchboard serves the new plant. The main cables from the generators are laid underground throughout the town, and consequently no trouble is experienced from lightning shocks. Thomson-Houston lightning arresters are used where necessary, however. The cables now in use are steel-armoured, in the place of lead-covered, which were at first tried, but did not prove entirely satisfactory, owing to their too rapid depreciation. The present cables, on the other hand, are giving satisfaction.

Although water is very plentiful and of excellent quality for steaming purposes, a complete condensing plant is worked in conjunction with the new engines. This is situated at one end of the engine-room, about 6ft. below floor-level, and consists of a horizontal 14in. air-pump, working at 55 revolutions a minute, and a 5in. centrifugal pump, running at 600 revolutions a minute, for circulating, and a return-water pump, at 850 revolutions a minute, driven by a 10in. by 14in. Marshall vertical engine. The condensers, of which there are two connected together, are situated outside the building. These, which were made in Germany, are of the vertical type, the tubes being enclosed in a cylindrical casing open at the top. The water passes in jets through small holes in the tops of the tubes, and runs down in thin films, the cooling being aided by forced draught obtained by means of a separately-driven fan. The condenser has a much larger capacity than the present steam plant requires, and appears to be giving a high efficiency.

The new boiler plant, erected to generate steam for the Bumsted and Chandler and condenser engines, consists of four 100-h.p. "Marshall's Heine" water-tube boilers, designed for 160lb. working pressure. It is provided with low-water alarms, in addition to the usual regulation mountings. The gases are led into the chimney through a flue 15ft. 6in. by 3ft. wide. The chimney (Fig. 2) is probably the largest brick chimney in South Africa, being 151ft. 6in. in height by 13ft. 6in. outside diameter at the bottom and 9ft. 3in. at the top. The flue is 7ft. in diameter.

A test of Onspoed coal made with these boilers gave the following very satisfactory result: 20,000lb. of water was evaporated at and from 212deg. F. by 2,500lb. of coal, or 8lb. of water for each pound of coal. The consumption of the same African coal in these boilers works out at from 11lb. to 12lb. per electrical unit generated.

During 1898 the output for the year was 476,000 units, being an increase of 90,000 units over the previous year. The whole output is utilised for lighting only, no current being generated for power purposes. At the end of the year the company had an equivalent of 14,000 8-c.p. lamps connected, in addition to 77 arcs of 500 c.p. each. Current was supplied to the mains for 4,660 hours, and to the street lamps for 3,000 hours. How rapidly the demand is increasing may be gauged from the fact that 28,250 units were generated in June, 1895; 35,700 in June, 1897; 43,440 in June, 1898; and 48,250 in June, 1899.

The price to consumers ranges between 1s. 3d. and 1s. 9d. a unit, and even at this very respectable price the demand is ever increasing. On this account the new generating plant, which cost £20,000, is to be increased by another direct-coupled set and two more Heine boilers.

THE ECONOMICAL GENERATION OF STEAM POWER.

BY BENJN. A. TAPP.

(Concluded from page 166.)

In concluding, the author would add a few general remarks on the subject of machine stoking, the design and general efficiency of which appears to be a vexed question among engineers. Needless to add that the circumstances of adoption bear greatly upon the ultimate success or otherwise of machine stokers. Some engineers have a decided preference for sprinkling stokers, such as the Proctor and Bennis types, which by their action promote as far as possible a live fire, and this type of stoker is very suitable for Lancashire boiler installations. The construction is such as to easily vary the rate of feed, say from 15lb. to 50lb. per square foot of grate area, and so increased combustion can be easily effected when required. In a paper read before the Municipal Electrical Association the results of comparative tests of sprinkling and coking stokers were stated to be as follows:

	Coking stoker, Vicars.		Sprinkling stoker, Bennis.
Duration of trial	120 hours.	...	120 hours.
Description of fuel and price	Small slack about 4s. per ton at pit.	...	Ditto
Fuel per hour	708lb.	...	885lb.
Temperature in flue (F.)	608deg.	...	831deg.
Temperature of feed (F.)	161deg.	...	161deg.
Steam pressure	80lb.	...	80lb.
Water evaporated per hour	4,372lb.	...	6,916lb.
Water evaporated per pound fuel from and at 212deg. F.	6·72lb.	...	8·48lb.

These figures would appear to favour the sprinkling stoker, the more so as that machine costs rather less in repairs. Sprinkling stokers are particularly adapted for consuming coke breeze and similar classes of fuel, while coking stokers are employed for highly bituminous fuels.

Among the advantages of machine stoking may be mentioned: gain of efficiency owing to even rate of combustion, less risk of smoke nuisance, saving in cost of labour in stoking, saving in cost of fuel by use of cheap coal. The full advantage of the stoker as a labour saver is obtained when the fuel is fed from an upper floor direct

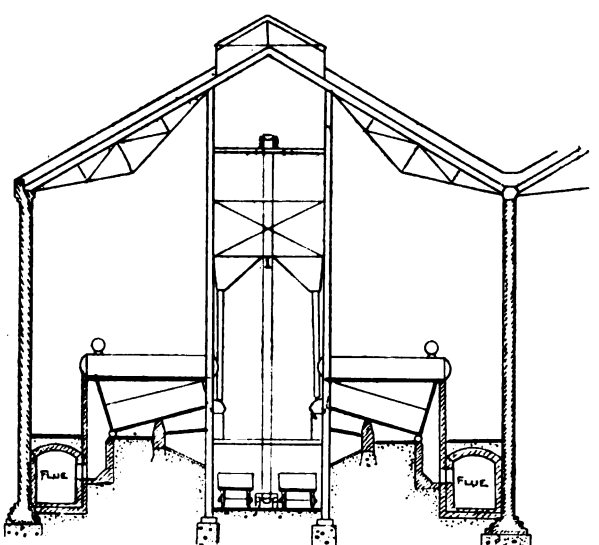

FIG. 24.—Section of an English Boiler-House, showing Coal Bunkers Overhead.

into hopper of stoker. There is little economy in the use of machine stokers, when only two or three boilers are used, as far as labour is concerned. With machine stokers and coal conveyors suitably arranged one man can attend to firing of five boilers, but with hand firing it is impossible for one man, however skilled, to look after more than four. The saving, therefore, in machine stoking five boilers would be three men's wages against seven, or a saving of £6 per week.

Against this is the cost of working the stokers, say 3s. per week; interest and sinking fund, 17s. 10d. per week; repairs, etc., 13s. 5d. per week; or a saving of £4. 5s. 9d. per week, independent of the cheaper fuel. The following extracts are from a paper by Mr. A. B. Mountain, the borough electrical engineer of Huddersfield, read before the Northern Society of Electrical Engineers: "Having decided to adopt water-tube and Lancashire boilers, it is necessary to arrange the fittings, and the question as to whether the boilers should be fired by hand or with mechanical stokers. Closely connected with this is the question as to what kind of fuel is to be used. It may be considered as settled that smoke in any considerable quantity will not be permitted to rise from the chimney top. With water-tube boilers it is difficult to stop smoke if hand-fired, unless a very hard steam coal can be obtained. The flames rising from the fire come in contact with the cool tubes and are to a great extent extinguished,

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causing smoke. If coke can be bought at a reasonable price, excellent results may be obtained, and the smoke nuisance entirely removed; but coke has the disadvantage of requiring a very thick fire to stop the air rushing through, and a considerable quantity is usually thrown into the furnace when firing. This cools down the boiler and reduces for a short time the generation of steam. Then when the charge is being rapidly consumed the steam is generated at a very rapid rate; if one boiler is used it therefore requires careful firing to keep a steady steam pressure, but if several boilers are used in combination it is very easy to fire alternately. If coke cannot be obtained cheaply and the ordinary bituminous slack has to be used, it is necessary to fix mechanical stokers, otherwise there will be considerable trouble with smoke; and, in the author's opinion, the coking form of stoker is the only one which can be fixed to a water-tube boiler with any certainty of success. The firing of the Lancashire boiler does not require the same care as the water-tube, as the flame from the fire passes over the bridge and helps to ignite any gases which may be passing away unconsumed, and as the flues are connected underneath the boiler, the flame from one fire assists in the combustion of the gases from the other fire. Mechanical stokers have, however, a great advantage over hand firing in the fact that the class of fuel may be very considerably reduced in quality, and therefore in price. It is not necessary to fix the coking form of

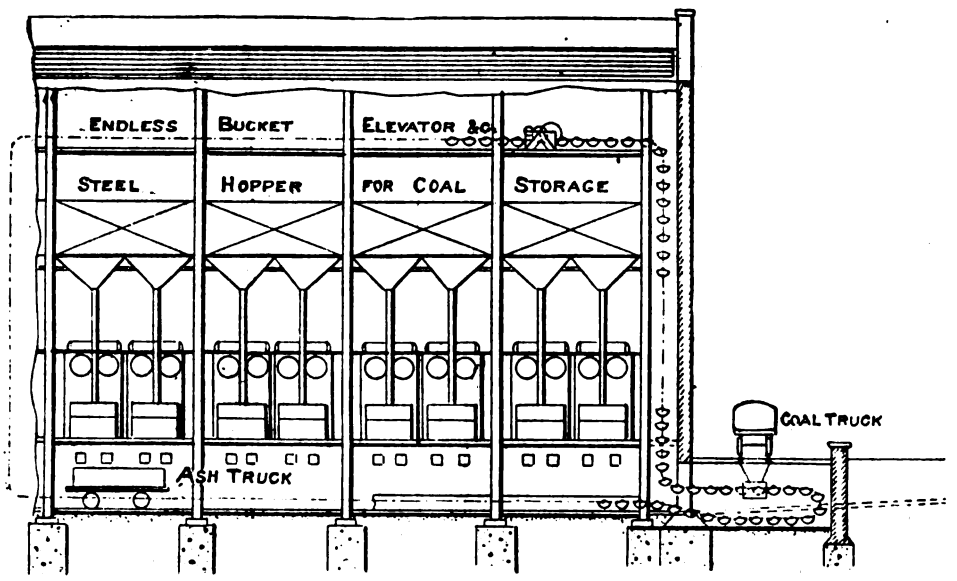

FIG. 25.—Sectional Elevation of an English Boiler House, with Coal Elevators and Conveyors.

stoker upon a Lancashire boiler; the sprinkling form of stoker will do equally well, and has certain advantages. It more easily admits of the fire being forced, which, in an electricity works, is an important point. The heat generated is distributed over the whole length of the bar, whereas in the coking form of stoker the heat is confined to a small portion of the fire, and the damage to the bars is considerable; and the author was of the opinion that the maintenance of the coking stoker is considerably higher than the maintenance of the sprinkling type."

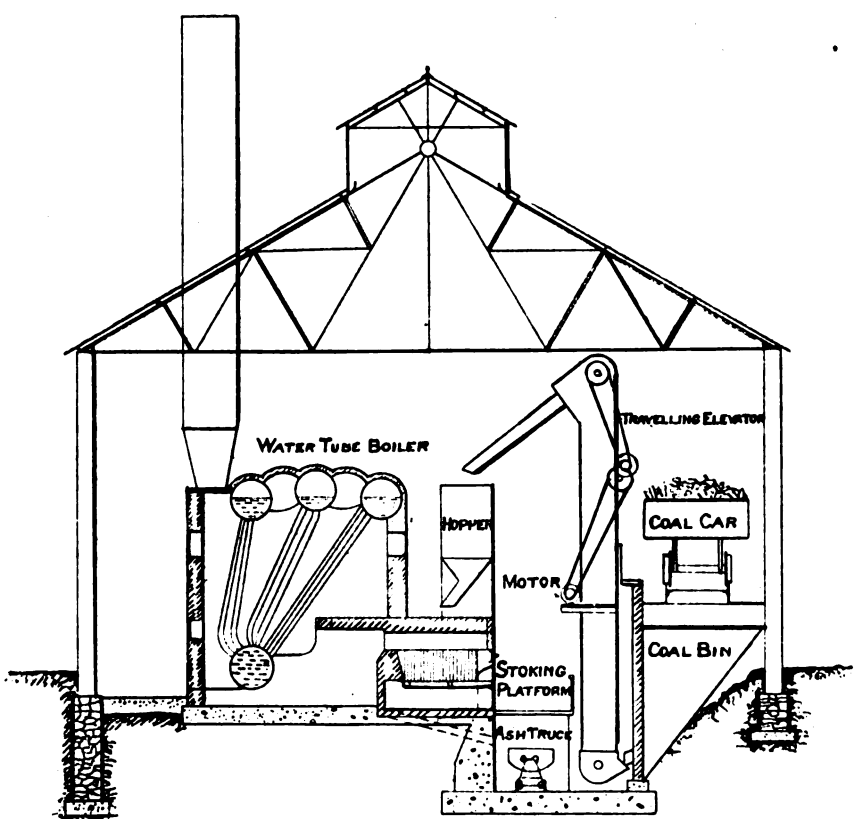

FIG. 26.—Section of an American Boiler House.

From tests made at the Bristol electricity works, and recorded by the engineer, Mr. H. Faraday Proctor, it appears that a chain and bucket elevator, worm conveyor, and machine stokers on seven Lancashire boilers are driven by a non-condensing vertical engine through a belt and one

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pair of spur wheels, the speed reduction being 12·5 to 1 of stoker shafting. Power absorbed was as follows:

		Indicated horse-power.
Speed per minute, 200 revolutions.	Engine running light	·60
	Engine and shafting only	2·72
	Engine and shafting and conveyor	3·28
	Engine and shafting and conveyor and seven pairs of stokers	4·67

It therefore appears that the power absorbed was:

		Indicated horse-power.
Speed per minute, 200 revolutions.	Engine running light	·6
	Shafting	2·12
	Elevator and worm loaded	·56
	Seven stokers, all parts loaded	1·40

Having reviewed the various devices and apparatus by which the modern engineer may utilise to the utmost a steam-generating plant, it may be of interest to describe some typical station arrangements in so far as they concern the steam-producing appliances. For this purpose we select one English and one American example, although it is only fair to state that the former station has been equipped by American engineers, but we suppose to English designs. The outline drawings shown herewith (Figs. 24 and 25) illustrate a recently erected power station in London. From these it will be seen that the boiler-house contains two rows of Babcock and Wilcox boilers, fronts facing each other, all fitted with machine stokers. Two rows of steel stanchions, level with the boiler fronts, support the riveted steel coal bunkers just below the roof and immediately over the stoking floor, the bottoms of the bunkers being connected by spouts with the hoppers of the stokers. The bunkers are supplied with coal by means of an endless bucket conveyor, the chains of which pass up the inside of the end wall of building and over the tops of bunkers, down the opposite end wall, and back along the subway under the stoking platform to a filling hopper under a railway siding at the end of the building. A suitable discharging apparatus is provided over the bunkers, enabling any particular one to be filled as desired. The subway under the stoking floor is of large size, and accommodates also two railway tracks for the reception of ash wagons, which are thus enabled to collect and remove their loads direct. Owing to the inclined ashpits, their contents fall easily into an adjacent truck, and this arrangement provides for the removal of ashes in a cheap and efficient manner.

Fig. 26 represents a cross-section through the boiler-house of an American power station. It will be seen that the station is equipped with Stirling water-tube boilers, the section being taken through the end one of a battery of over a dozen. The boilers are fitted with the Murphy automatic stoker, previously described in this article, and it will be seen that this furnace is erected in front of the boiler, and is practically distinct from it. Above the furnace is a hopper, with a spout immediately underneath, for feeding the fuel down to the automatic furnaces. On the right of the diagram will be seen the coal storage bins, constructed of steel plates, and capable of holding 30 car-loads of fuel, a car being shown in position over the bins. These bins empty at the bottom into a travelling elevator running on rails, and worked by a motor (shown attached about half-way up). The elevator may be used to fill a furnace hopper at any part of the building from the bin in front of it. Underneath the stoking platform is a tramway, along which ash-trucks are run, and filled with ashes direct from the inclined ashpits shown. The ash-trucks are electrically hauled. The above is a typical arrangement of labour-saving devices in a boiler-house, the fuel being mechanically conveyed from the truck to the firegrate, and the ashes collected and carried away with a minimum of manual labour.

Catalogue.—We have received from Messrs. Ford and Co., of Stalybridge, their price-list of electrical and other machines. A great point is made in the catalogue of different small sets, such as reading lamps, pocket galvanometers, alarm clocks, etc., which are supplied with small portable accumulators. The firm also manufacture dynamos, meters, and gas and oil engines, and other similar machines and apparatus.

AN ELECTROLYTIC CENTRIFUGAL PROCESS FOR THE PRODUCTION OF COPPER TUBES.*

BY SHERARD COWPER-COLES, MEMBER

Introduction.

The electro-deposition of copper is now carried on in many large engineering works for the coating of hydraulic rams, barrels of guns, shell and shot, and is extensively employed in the manufacture of tubes and sheets, and for the production of large copper vessels, and most of the copper used by electrical engineers is refined electrolytically. Over one-third of the total copper output of the world is now electrolytically refined. It is difficult to obtain exact figures, as the copper returns for various countries do not distinguish between raw and electrolytic copper. But it is estimated that one-half of the copper produced in the United States in 1897 was electrolytically refined, and in 1898 the proportion was slightly over that amount. The demand for electrolytic copper is on the increase, and the capacity of most of the electrolytic refining works has or is being increased.

Progress and Extent of the Electrolytic Copper Refining Industry.

The following figures published in *Industries and Iron* show the rapid growth of electrolytic refineries. The world's total output of electrolytic copper 10 to 15 years ago, did not exceed 10 to 15 tons a week. In 1881 to 1882 this amount was increased to about 60 tons, as the result of the refineries erected in Swansea. During the next four or five years several of the American refineries got to work, and by this time, say 1888 to 1890, the world's total production was probably not more than 280 to 300 tons per week. Since that date, up to

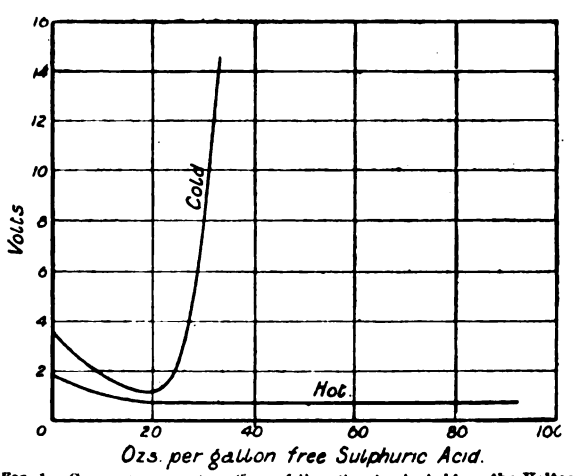

Fig. 1.—Curve showing the effect of Free Sulphuric Acid on the Voltage in Hot and Cold Solutions of Copper Sulphate.

the present time, many refineries of gigantic size have come into existence, not only in America, but in England, France, Germany, and even Japan, and it is quite safe to estimate the world's production at the present moment at no less than 500 tons per day, or about 180,000 tons of electrolytic copper per annum, and during the refining of this quantity of metal there are not less than 20,000,000oz. of silver and 100,000oz. of gold recovered. When these weights are converted into money value, the following astonishing figures are obtained: annual copper value, £9,000,000; annual silver value, £2,500,000; annual gold value, £400,000, or, in round numbers, a total value of £12,000,000 sterling. This startling result has been achieved in a maximum of 25 to 30 years: this industry has had a growth probably unparalleled in the history of commercial enterprise.

Increase of Current Density in Copper Refineries.

It has been the object of those engaged in the electrolytic refining of copper to increase the current density as much as possible, so as to get a larger output per vat. A considerable increase of current has been effected of late years by attention to details, such as (1) proper circulation of the electrolyte; (2) the purity of the electrolyte; (3) the chemical composition of the electrolyte; (4) the arrangement of the electrodes. In a review of the position of the electro-copper refining industry by Mr. Titus Ulke, he mentions that it was not at all uncommon 10 years ago for the copper refiners to stock their tanks with 75 to 100 times as much copper as was daily produced in every-day work. This enormous disparity has been gradually reduced, so that to-day only one-fourth to one-fifth of that amount is required, or an average of 15 to 20 tons per ton of output. He attributes the cause of this marked improvement to the method of handling the baths, and especially to the higher current

* Paper read before the Institution of Electrical Engineers, Jan. 25.

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densities now made practicable. Whereas formerly currents of only two to four amperes per square foot were thought permissible, to-day current densities of from 15 to 20 amperes are said to be employed in some establishments, and the end is not yet in sight. The conclusion arrived at by Mr. Ulke is that the average proportion between the total copper in process of treatment and the yearly capacity (measured by output) in our electrolytic copper works is now about 4 per cent., as against two or three times that amount formerly, and that the average proportion is likely to diminish still more within the next year or two.

Description of Various Methods for Improving the Physical Properties of Electro-deposited Copper.

One of the best-known electrolytic processes for the manufacture of tubes is that in which an agate burnisher is used for consolidating the deposit during electro-deposition. This process has met with considerable success, the chief drawback being the tendency of the copper to laminate or exfoliate where the burnisher has been at work, the pressure on the burnisher requiring to be regulated to a great nicety. Elmore has sought to build up electro-deposited tubes equal to drawn ones by causing a burnisher to constantly traverse the length of the tubes backwards and forwards as they slowly rotate in the bath, and so obtain a copper possessing a high density. The current density originally employed for this process was about 16 amperes per square foot, but this, the author believes, has been considerably increased. Copper deposited by the Elmore process has stood a stress of 26·5 tons per square inch, with an extension of 16·5 per cent., the limit of elasticity being reached with a load of 23·3 tons per square inch, the specific gravity of the metal being as high as 9·2. Von Hübl has succeeded in producing, by simple deposition without the aid of a burnisher, a specimen of copper which broke at a stress of 23·6 tons; commercial cast copper breaks at about 8·4 tons per square inch. Another process, that is now being operated on a large

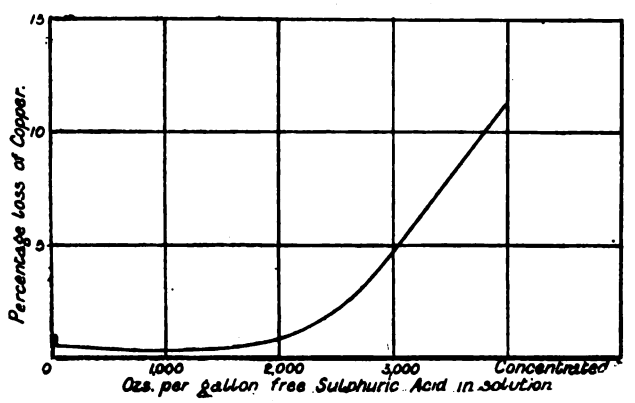

Fig. 2.—Curve showing the Solubility of Copper in Sulphuric Acid. 1,000ozs. per gallon represents a percentage concentration of 86·2.

commercial scale, substitutes a sheepskin burnisher for an agate one, smooth deposits being obtained by the application of an insulating coating to the inequalities on the surface. The sheepskin impregnators, which move over the surface of the metal, coat all projecting parts with a thin film of animal fat, which hinders further deposition until the surrounding depressions have been raised to the common level. In later patents impregnators are mentioned composed of organic gelatinous or albuminous matter free from excess of grease, rendered insoluble by treatment with bichromate, or the softening of the albuminous or gelatinous constituents of the impregnators is prevented by soaking them with a solution of formic-aldehyde (within the limits of 10 per cent. and 40 per cent.), after which it is washed in water to remove the aldehyde, or this substance is neutralised or decomposed by means of sulphuric acid. It is claimed for impregnators so treated that they may be employed with equal facility in a hot or cold bath. The current used is from 35 to 40 amperes per square foot of cathode area; the voltage required is about 1·6 per vat. Tubes are deposited 12ft. in length and 16in. diameter, and ⅛in. thick, which are longitudinally cut and opened to form sheets. Several investigators have patented methods to improve the physical properties of electro-deposited copper by injecting the electrolyte on to the copper during deposition. Craydon Poore has devised a method for producing plates by projecting the electrolyte forcibly on to a cathode placed in a horizontal position.

Centrifugal Copper Process.

The author has lately developed a centrifugal process, which is now being worked on a practical scale, for copper refining and the manufacture of copper tubes, sheet, and wire by electro-deposition, which does away with the troubles of lamination and enables a much higher current density to be used than has hitherto been the case, smooth tubes having been produced 12in. in diameter at the remarkably high current density of 200 amperes per square foot, the voltage being from ·5 to ·7. Solid-drawn copper tubes of such diameters cost about three times the price of tough copper cake. The centrifugal process is distinct from those already referred to, inasmuch as there are no burnishing tools employed, but the cathode on which the copper is deposited is revolved at a high rate of speed, the result being that the skin friction between the deposited metal and the electrolyte keeps the copper beautifully smooth and compact. Any gas bubbles evolved at the cathodes, or impurities in mechanical suspension in the electrolyte which would have a tendency to settle on the cathode, are thrown off by centrifugal force. Mr. J. W. Swan has found that regularity and smoothness of deposit were almost entirely dependent on the absence of solid particles held in suspension in the electrolyte, and that excrescences could be entirely avoided by taking care that the electrolyte was free from solid floating particles. He observed that at the seat of each "nodule" was a speck of some foreign substance. Dr. G. Gore has given the matter some thought, and has observed that the greatest length of "nodule" is in the direction of the greatest intensity of current and amount of copper in solution. [The centrifugal action was then illustrated by the photographs projected on the screen.] On the table are a number of specimens of tubes and sheets produced by this process, some at a current density of 200 amperes per square

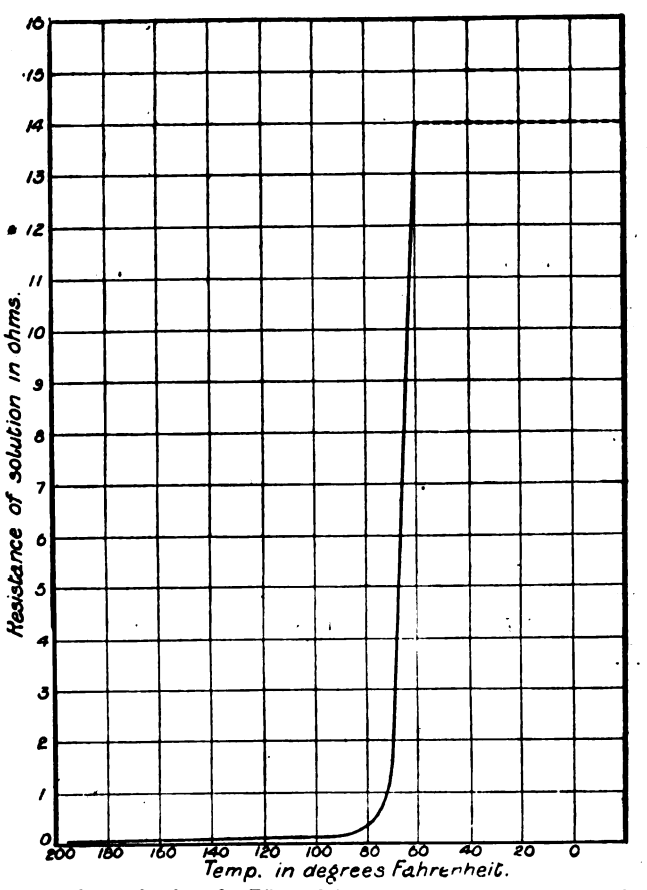

Fig. 3.—Curve showing the Effect of Temperature on the Resistance of a Solution containing 1 gallon of Water, 2lb. of Copper Sulphate, and 60ozs. of Free Sulphuric Acid.

foot, which were deposited from solutions of approximately the following composition, the copper anodes containing about 30oz. of silver to the ton:

	Ozs. per gallon.	Percentage.
Copper sulphate ($CuSO_45H_2O$)	22·44	10·95
Sulphuric acid (H_2SO_4)	22·34	10·90
Ferrous sulphate ($2FeSO_4$)	·05	·02
Water	160·00	78·13
		100·00

The following series of microphotographs show the results obtained with rapidly revolving and stationary cathodes, all other conditions being the same:

		Electrolyte.
Fig. 4.	100 amperes per square foot, revolving	Hot.
Fig. 5.	150 amperes per square foot, revolving	,,
Fig. 6.	220 amperes per square foot, revolving	,,
Fig. 7.	40 amperes per square foot, revolving	Cold.
Fig. 8.	40 amperes per square foot, stationary	Hot.
Fig. 9.	100 amperes per square foot, stationary	,,
Fig. 10.	10 amperes per square foot, too much grease on mandrel	Cold.
Fig. 11.	10 amperes per square foot, no grease on mandrel	,,
Fig. 12.	Copper crystals from a voltaic cell.	

The apparatus employed for the centrifugal process consists of

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a wooden vat, A (Figs. 13 and 14), in which are placed anodes composed of crude copper. The cathode is a hollow mandrel, B, made of brass, which is supported on a revolving shaft, C. The shaft is brought through the bottom of the vat to the top of the cell, and is protected from the acid copper sulphate solution by a lead-cased wrought-iron column. The shaft is caused to revolve by gearing placed beneath the depositing cell, the speed varying with the size of the mandrel employed. The mandrel at one end is fitted with an eye bolt, D, for lifting purposes, and a circular brass casting, E, against which the contact brushes, F, rub for collecting the negative current. The brushes are fitted to arms, G, which are made to turn back to allow of the easy withdrawal and insertion of the mandrel. H is a baffle plate made of an insulating material, placed at the bottom of the mandrel to prevent the formation of copper "trees" or "nodules"; Figs. 15 and 16 show the "trees" and "nodules" which have a tendency to form if a baffle plate is not used. The electrolyte is briskly circulated through the cells by means of an acid-proof pump or air-pump, the solution being forced or pumped to a reservoir, where it passes through a filter to rid it of all impurities in suspension. When it is

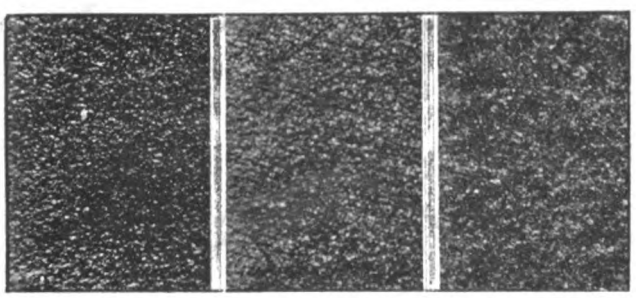

FIG. 4. FIG. 5. FIG. 6.

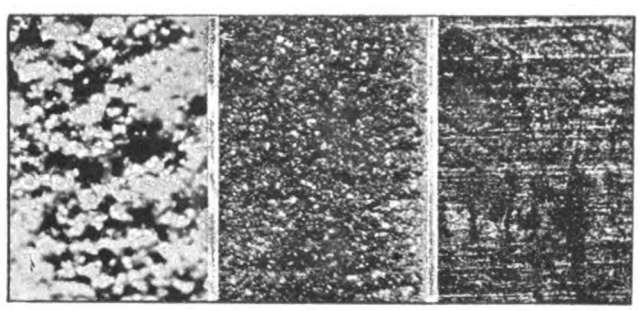

FIG. 7. FIG. 8. FIG. 9.

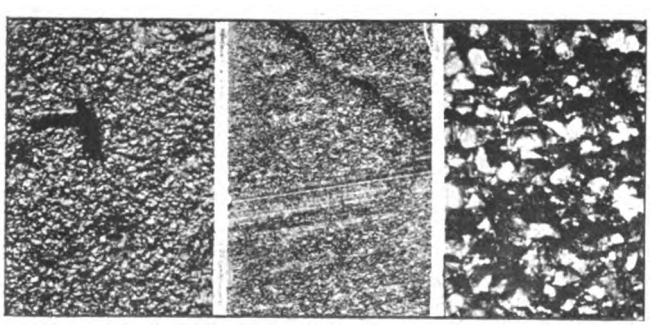

FIG. 10. FIG. 11. FIG. 12.

desired to obtain a sheet of copper, the tube, after being removed from the mandrel, is cut, flattened out, and annealed; when a wire, a piece of insulating material is wound round the mandrel in the form of a spiral, and copper deposited between the threads until the thickness of copper is equal to the distance between the threads, the spiral is then removed, and after annealing is drawn out in the usual manner. The mandrel is given a small taper, and is slightly greased to facilitate the removal of the tubes. Figs. 17 and 18 show a modified arrangement for driving the mandrel above instead of from below. Another interesting feature of the centrifugal progress is that it enables a hot and more acid solution to be used than is generally employed. The amount of free acid has a very marked effect upon the voltage required, but a very small effect upon the actual weight of copper obtained compared with the theoretical, as shown by the following table and by the curve, Fig. 1. The amount of copper sulphate was 32oz. per gallon of water =16·66 per cent.

The solution was circulated at such a rate that it was renewed in the depositing cell every five minutes. The above table shows the advantage of increasing the acidity of the solution up to a certain point, and the disadvantage of increasing it beyond

TABLE I.

No.	Current density.	Solution, cold—Voltage.	Solution, cold—Ozs. of H_2SO_4 per gallon by weight.	Percentage of free acid by weight.	Peripheral speed, feet per minute.
1	100	3·5	0	0	471
2	100	2·5	6	3·03	471
3	100	2·0	8	4·00	523
4	100	1·8	10	4·95	471
5	100	2·2	25	11·52	523
6	100	8 0	30	13·51	523
7	100	12 0	40	17·24	471
8	100	14·0	60	23·81	523
9	100	20·0	100	34·24	628

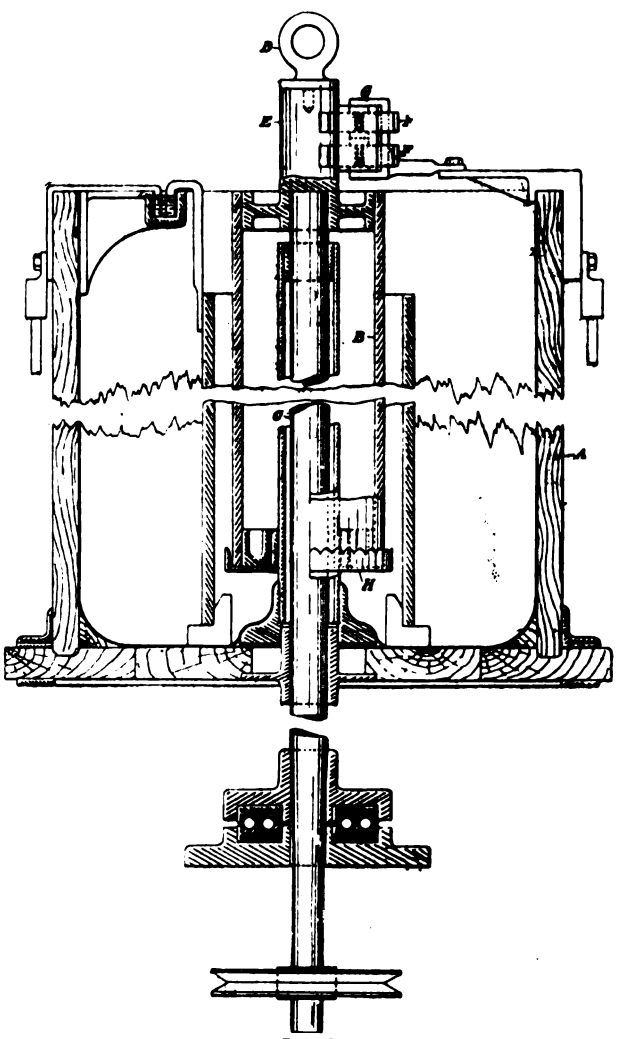

FIG. 13.

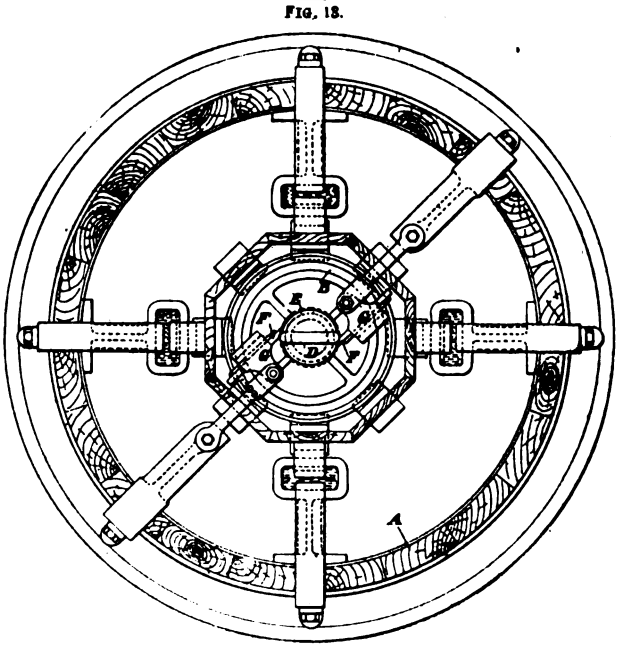

FIG. 14.

that point; the critical point seems to be about 15oz. of free sulphuric acid per gallon=14·71 per cent. The rise of voltage

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n a cold solution is explained by the fact that the addition of sulphuric acid to a copper sulphate solution causes the copper sulphate to crystallise out; this takes place on the electrodes, and largely increases the resistance. It has been shown that a saturated copper sulphate solution is the best conductor, and that a 25 per cent. solution of sulphuric acid offers the least resistance. With too much acid the polarisation ensues from its own decomposition by the action of the current. The latter trouble is said to set in when the copper sulphate solution has reached an acidity of about 13 per cent.; these remarks apply to stationary anodes.

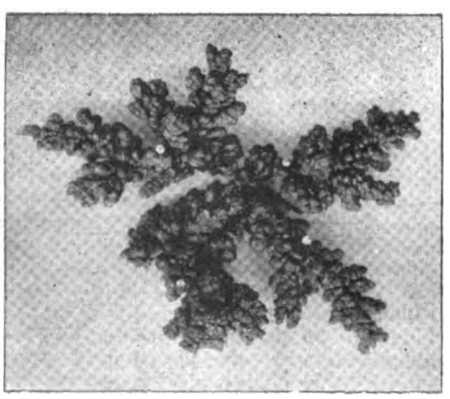

FIG. 15.

The following table and Fig. 1 give the voltage required when depositing at 100 amperes per square foot from a solution containing 32oz. copper sulphate per gallon = 16·66 per cent., the temperature being 160deg. F., various amounts of free acid being used, the anodes being of commercial copper.

TABLE II.

No.	Current density.	Voltage.	Ozs. of H_2SO_4 per gallon by weight.	Percentage of free acid by weight.	Peripheral speed, feet per minute.
1	100	3·5	0	0	500
2	100	1·3	10	4·95	500
3	100	0·9	20	9 43	500
4	100	0·8	30	13·51	500
5	100	0·75	40	17·24	500
6	100	0·75	50	20·66	500
7	100	0·7	60	23 81	500
8	100	0·7	100	34·24	500

The solution in this experiment was not circulated. Comparing this table with No. I., the advantage of using a hot

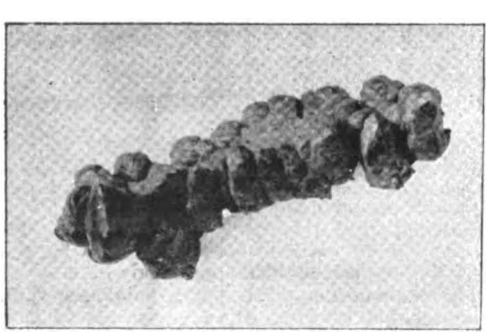

FIG. 16.

solution is shown, also the advantage of increasing the acidity. Table III. gives the variation of current and voltage due to increasing the temperature of the electrolyte.

TABLE III.

Amperes.	Volts.	Temperature of solution.
0 55	8 0	60deg. F.
4·00	7·0	70 ,,
8·00	5·0	75 ,,
10·00	4·0.	78 ,,
14·00	2·0	82 ,,
16·00	1·0	90 ,,
16·00	0·85	100 ,,
16·00	0 80	120 ,,
16 00	0·75	140 ,,
16·00	0·70	180 ,,
16·00	0·70	200 ,,

This table shows how a hot solution allows a heavier current to pass at a much lower voltage; 150deg. F. is probably the most economical temperature to work at. The curve on the diagram was arrived at by dividing the E.M.F. by the current, giving the resistance in ohms,

It is well known that from a neutral or slightly basic solution copper comes down in a cross-grained brittle condition, whereas the amount of free acid has a very marked effect on the voltage, as is shown by Table II. This may be due to the production of a small amount of cuprous acid from a neutral or basic solution, or to the influence of a large percentage of free acid on the mode of crystallisation of the metal.

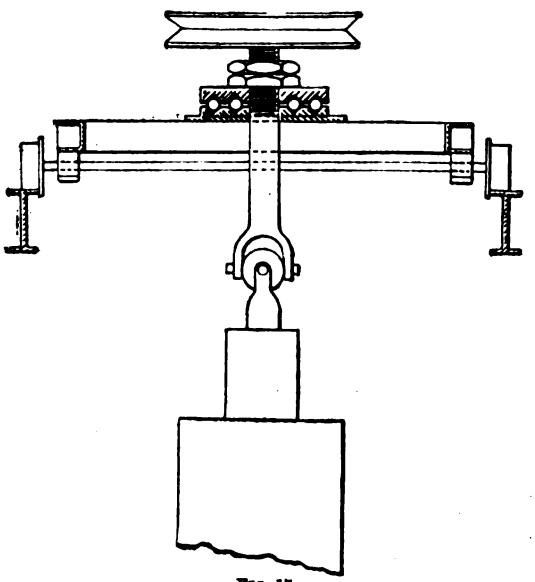

FIG. 17.

Von Hübl has observed that the dark-coloured spongy deposits produced by too high a current density occur the more readily the poorer the electrolyte round the cathode is in copper. According to the same authority this dark deposit is not due to the presence of cuprous oxide, but to the formation of a hydride. Hydrogen may under certain circumstances be occluded by electrolytic copper, which has been proved by the analyses which have been made of the gas pumped out of various specimens of the metal. Thus, a certain sample gave up 4·4 times its volume of gas, consisting of 77·3 per cent. of hydrogen, 8·4 per cent. of carbon monoxide, 11·1 per cent. of carbon dioxide, and 3·2 per cent. of water vapour. Foerster and Liedel have studied the influence of temperature on the character of copper deposited from acid solutions. The experiments were not very conclusive, but they tend to show that tougher copper is obtained with hot solutions than with cold. The experiments of Foerster and Liedel also show that the precipitation of brownish-red powdery copper is

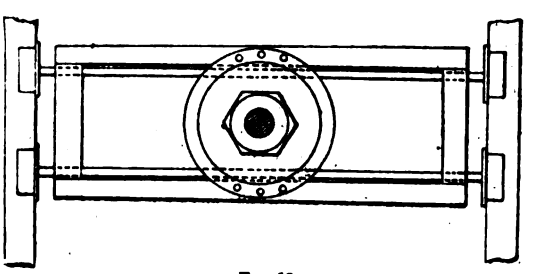

FIG. 18.

connected with a certain low concentration of the copper ions in solution. Owing to the rapid revolving of the cathode in the centrifugal process, the solution is kept well mixed, so the difficulty of having the solution poor in metal round the cathode is overcome.

The experiments on the loss of copper by corrosion with a revolving mandrel are not very reliable, but there is no apparent reason why the loss should differ from that with a stationary mandrel. If the solution is kept thoroughly saturated with copper sulphate, the corrosion ought not to be more than a very small percentage of the total copper deposited. This loss might be reduced by using a higher current density. For instance, if the current is doubled, the percentage loss will be halved.

ON THE LOSS OF COPPER BY CORROSION.—TABLE IV.

No.	Current density.	Ozs. of free H_2SO_4 by weight.	Per cent. of H_2SO_4 by weight.	Loss on cathode, per cent.	Loss on anode, per cent.
1	25	10	4·95	3 0	7·5
2	25	20	9·43	2·7	8·1
3	25	30	13·51	2·8	7·1
4	25	40	17·24	2·2	6·7
5	25	60	23·81	1·8	5·1
6	25	100	34·24	2·5	6·7

In these experiments (run in series) the time temperature (160deg. F.) and current to the cathode were kept the same.

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The greater loss at the anode is accounted for by the fact that the anodes were all much larger, and therefore a greater surface was exposed to the action of the hot acid.

The following table (Table V.) and Fig. 2 show the solubility of copper foil in sulphuric acid :

TABLE V.

No.	Percentage of H_2SO_4 per gallon by weight.	Loss per cent. Hot solution.
1	0	0
2	3·03	0·9
3	5·88	0·5
4	34·44	0·49
5	75·75	0·4
6	86·20	0·27
7	92·59	0·7
8	Concentrated acid	10·7

From this table the solubility of the copper in dilute sulphuric acid appears to be greatest at 3 per cent., and gradually falls to 10 per cent., a greater increase taking place when concentrated acid is used. The following table shows a steady increase in the solubility of copper in sulphuric acid from 10 per cent. to 50 per cent., the copper foil being immersed in the hot for three hours and in the cold solution for 15 hours.

TABLE VI.

No.	Ozs. of H_2SO_4 per gallon by weight.	Per cent. of H_2SO_4 by weight.	Loss per cent. hot solution, three hours.	Loss per cent. cold solution, fifteen hours.
1	10	5·88	1·27	0·218
2	20	11·11	1·17	0·180
3	30	15·79	1·14	0·150
4	40	20·00	0·85	0·145
5	60	27·27	0·74	0·11
6	100	38·46	0·69	0·97

ANODE SLUDGE.

As already mentioned, a very high current density can be used with the centrifugal process, and smooth deposits can be obtained with a current density of even 200 amperes per square foot. This is a matter of great importance, as in copper refining with high current densities less anode sludge is formed. It has been observed by Foerster and Liedel that when a high current density and a high temperature are used there is far less sludge formed on the anodes. With a current density of 0·3 ampere per square decimetre at the ordinary temperature a weight of 0·5 kg. of anode copper consumed left 3·7 grm. of sludge, containing 60 to 70 per cent. of copper, partly as cuprous oxide. Under the same conditions, but working at 40deg. C., the sludge was only 1·2 grm., and was nearly free from copper. With a higher current density—viz., one ampere per square decimetre—the quantity of anode sludge was about the same at 20deg. C. and 40deg. C.—viz., 2·5 grm. from 1 kg. of copper. These results, although far from exhaustive, go to show that the high current densities used in modern copper refining have the incidental advantage of reducing the quantity of anode sludge, and thus making the working up for silver and gold easier and more economical. A yet higher temperature—viz., 60deg. C.—increases the quantity of sludge ; a good deal of the increase is due to the presence of metallic copper, which may be regarded as having been formed during the spontaneous resolution of cuprous sulphate, momentarily produced at the anode, thus :

$$Cu_2SO_4CuSO_4Cu.$$

Gold is not dissolved from the anode, and silver only to a small extent, and selenium and tellurium not to any appreciable extent when present in small quantities.

Arsenic is found to be most readily soluble, and bismuth the least soluble, amongst the impurities in the anodes. According to Dr. Börcher, the mud or slime deposited on the anode may contain, after drying, gold, platinum, silver, silver sulphide, cuprous oxide and sulphide, basic sulphates of bismuth, tin and antimony, antimonic acid, arseniate of copper, arseniates and antimoniates, lead sulphate and slag constituents in which may be iron, lime, magnesia, and silica, and with these there will also be a certain amount of metallic copper in a pulverulent state. If the anode contains too high a percentage of impurity, it leads to several practical difficulties, such as the periodical scrubbing of the anodes. Some of the impurities found in electrolytic copper are electrolytically deposited from the electrolyte, and others are mechanically thrown down. Centrifugal action seems to prevent any matter in suspension settling on the rapidly revolving cathode. E. Koller has communicated some interesting figures to the *Journal* of the Chemical Society. He found that the average composition of the vat deposit obtained (I.) during a year's treatment of reverberatory and (II.) from three months' treatment of converted copper, are as follows, exclusive of oxygen and combined water :

	(I.) Per cent.		(II.) Per cent.	
Ag	53·894	[0·3064]	55·15	[0·3076]
Au	0·296		0·198	
Cu	11·01	[0·0093]	13 82	
Pb	0·91	[0·0093]	2·07	
Bi	3·93	[0·0320]	0·34	[0·0035]
Sb	6·25	[0·0651]	2·44	[0·0510]
As	2·11	[0·0586]	1·09	[0·0189]
Se	0·39	[0·0098]	0·72	
Te	1·17		0·89	
Fe	—		0·80	
SO_4	5·27		10·68	
H_2O	2·36		2 60	

The numbers in square brackets represent the percentages of the various elements in the unrefined copper, and show therefore the nature and the extent of the refining effected by electrolysis. From these numbers it may be found that the whole of the silver, gold, selenium, and tellurium remain in the residue, whilst of the other elements there are left in the slime in the two cases respectively,

Cu, 0·07, 0·08 ; Bi, 78·22, 60·71 ; Sb, 61·14, 29·90 ; and As, 22·90, 37·84 per cent.

PHYSICAL PROPERTIES OF ELECTRO-DEPOSITED COPPER.

Copper prepared by electrolysis may have as low a density as 8·00; the figure for normal copper is 8·9. Hard rolling, cold hammering, and hard drawing increase the tensile strength and limit the elasticity of copper considerably. The extensibility of annealed copper becomes less at high temperatures, and that of mechanically worked copper becomes higher. Some copper sheet (not annealed) deposited by the centrifugal process, ·0245 of an inch in thickness, broke at 433lb., which is equal to 22·1 tons per square inch. Hard-drawn wire made by this process has a tensile strength of 29 tons per square inch, annealed 20 tons, the electrical conductivity being 99 per cent. The author has obtained excellent tough deposits of copper with the theoretical yield from a solution composed of :

	Ozs. per gallon.	Percentage by weight.
Copper sulphate ($CuSO_4 + 5H_2O$)	32	14·87
Sulphuric acid (H_2SO_4)	12·6	10·77
Water	—	74 36
		100·00

S. Sheldon has carried out a number of experiments to determine the electric conductivity of copper when annealed at various temperatures. A sample of copper was drawn several times without annealing so as to become very hard, and was then cut up into different lengths, which were separately annealed at different temperatures both in a vacuum and in hydrogen, and tested for conductivity. The effect of the different annealings in vacuum in relation to conductivity is shown by the following figures ; the conductivities of the same were calculated from measurements of resistance, length, weight, and specific gravity.

TABLE VII.

Annealed in a vacuum— Annealing temperature. Deg. C.	Conductivity. Per cent.	Annealed in hydrogen— Annealing temperature. Deg. C.	Conductivity. Per cent.
20	101·5	20	99·0
37	101·5	45	99·0
54	101·5	105	99·3
118	101·6	234	99·8
215	102·0	360	101·0
300	102·1	483	101·9
600	102·4	1,050	89·33
755	102·7	—	—
930	99·0	—	—

COST OF DEPOSITING COPPER.

According to Dr. Kiliani, the back E.M.F. is 0·12 volt, which has to be overcome with each pair of electrodes in the electrolyte under normal conditions. This back E.M.F. is due to the polarisation at the surface of the anode, and increases with the impurity of the raw copper used.

The following figures give the approximate cost of producing electrical energy on a large scale with condensing engines, the cost per kilowatt-hour working out to ·3995, in which case the cost of the electrical energy required to deposit one ton of copper is 14s. 5d. A large installation of 10,000 h.p. is now being put up near Manchester, which will supply electricity at ½d. per kilowatt.

ESTIMATED COST OF WORKING A 2,100 KW. PLANT, THE PRICE BEING BASED ON THAT PREVAILING IN ENGLAND. (Staff arranged in three shifts for continuous running of 150 hours per week.)

Stokers	6 at	£1	13	3	per week	£9	0	0
Trimmers	3 ,,	1	4	6	,,	3	13	6
Engine-drivers	6 ,,	1	17	6	,,	11	5	0
Oilers	12 ,,	1	8	0	,,	16	16	0
Dynamo and switchboard hands	6 ,,	1	8	0	,,	8	8	0
Superintendent	1 ,,	4	0	0	,,	4	0	0
Total wages per week						£53	2	6

(At 150 hours = 7s. 1d. per hour.)

Per Kilowatt-Hour.	Pence.
Salaries and wages	·0405
Coal, 2·4lb., at 16s. per ton	·2050
Water, at 6d. per 1,000 gallons	·0014

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Oil and sundry stores, waste, etc.	·0400
Standing charges, office expenses, rent, insurance, etc.	·0300
Repairs	·0100
Interest on capital, £29,000 at 5 per cent.	·0222*
Interest on buildings, £5 000 at 5 per cent.	·0038*
Depreciation on plant, 10 per cent.	·0443*
Depreciation on buildings, 3 per cent.	·0023*
Total cost per unit generated	0·3995

* On basis of working 50 weeks in the year.

The Anaconda Mining Company has recently made public the cost of electrolytic refining during the year 1897 to 1898 at its works at Anaconda, Montana; the figures given are as follows:

Assay expenses and salaries	£3,062	7	8½
Electric light	475	11	11
Expenses	775	16	2
Labour	28,408	13	2
Legal expenses	426	7	1
Power-house expenses, coal	27,589	0	8½
,, ,, labour	9,880	9	10
,, ,, machinery and repairs	4,020	19	7

Making a total of £42,812. 6s. 6d. for power, of which £1,250 was charged to silver mill, leaving a net expense of £41,562. 6s. 6d. for power for the electrolytic refinery.

For recasting scrap anodes	£3,585	4	8
Regenerating plant expenses	2,460	5	9½
Salaries, including management	3.252	9	11½
Stable expenses	391	17	6
Sundry supplies	2,362	6	6
Switching product	181	5	0
Taxes	1,146	19	3
Repairs on buildings	1,076	8	5
Repairs on machinery	1,521	0	11
On refining tanks	1,659	2	1½
Making a total of	£92,308	7	11½

The output of electrolytic copper was 59,505,711lb., consequently the cost of production was 3s. 1½d. per cwt., or £3. 2s. 6d. per ton. In the above calculations the dollar was taken at 4s. 2d.

Discussion.

In opening the discussion on the paper, the Secretary read a letter from **Mr. Wilde**, an hon. member of the Institution, stating that he had read with much interest Mr. Coles's paper. He thought the process was exactly similar to one which he patented in 1885, and which had since been successfully used at Manchester. Mr. Coles had rendered good service by exposing the fallacy of trying to obtain a good surface of metal by the simple process of deposition.

Prof. Perry asked if the last figure in the last column of Table VII. was correct, as if it were it was one of the greatest discoveries of the age.

Mr. W. M. Mordey asked if in Table VII. the figures representing conductivity could not have been expressed in ohms? He agreed with Prof. Perry that the last figure in Table VII. must be wrong.

Mr. Ferranti said that when in Paris, some six or seven years ago, he saw a process almost identical with the one described by Mr. Coles. It was being worked in a laboratory for the purpose of selling patents and not commercially. In this case, however, the mandrel was horizontal. This mandrel was revolved very rapidly, and showed a great tendency to throw the electrolyte about. A good smooth sheet of metal was, however, obtained. This kind of copper plate could be sold in the market at a very high price. He also saw a rotary process of a similar nature arranged by Mr. R. D. Saunders, of Eastbourne. In this a wire was twisted round a mandrel and the whole rotated. The deposit then formed on the wire in the form of a spiral. He himself thought highly of this latter process, but it had not been applied in this country because it was not thought possible that wire could be produced cheaper than at present. Here, however, were two applications of centrifugal processes which had been most successful in accomplishing the results hoped for.

Mr. G. L. Addenbrooke said he should like to ask Mr. Coles in what way the process differed from that described by Mr. Swan in a lecture some time since? In this he showed the good effects of rapid motion, and he also was able to use great current densities. The process seemed to the speaker exactly the same.

Prof. S. P. Thompson, president, said that Mr. Wilde had mentioned the process that he himself had patented, and in a note accompanying the letter gave some of his claims. In this he imparts a rapid whirling to the solution. This seemed to be the opposite of the process Mr. Coles described. One thing interested him (the speaker) exceedingly, and that was the rough and nodular deposit, and the very smooth deposit which occurred at a certain high speed. The author spoke of a critical speed for the difference. Could this speed be given in feet per minute? What would be the peripheral speed? It might not be known that a committee of the Institution had been at work investigating the conductivity of copper. The object of the committee was to estimate conclusively what was the actual purity of copper. The report of the committee would be published in the *Journal of the Proceedings* next to be issued. In this report the results are given in conductivity, taking Mathiessen's standard as 100. He thought it would be an advantage to have the actual resistance set down in ohms by the side of the conductivity figures.

Mr. S. Cowper-Coles, in reply, said that, with regard to Mr. Wilde's letter, all he (the speaker) claimed to have found out was the use of centrifugal force in obtaining a smooth deposit of copper. Mr. Wilde did not appreciate the fact that centrifugal force could be brought into play to produce smooth and pure deposits. He understood that Mr. Swan's experiments were made with horizontal mandrels and not vertical, and also by the method employed by Mr. Swan, lines of rotation came out on the deposit and spoilt it. As regarded the critical speed, he thought it would be at least 1,000ft. per minute; this was when using a large percentage of free acid, as in the paper. As regarded Table VII., the last figure was evidently a misprint. He would, if he might, add a column showing the conductivity in ohms when the paper was printed in the *Proceedings*. As to the remarks of Mr. Ferranti, in the processes described by him the danger from lamination would be great.

ACCUMULATOR TRACTION.

An article recently concluded in the *Elektrotechnische Anzeiger* deals fairly exhaustively with the question of accumulator traction in Berlin. The writer also criticises the several existing types of accumulator plate in turn from the point of view of their respective suitabilities for traction purposes, and in the course of his remarks advances the opinion that the disadvantages accruing from the relatively quick diminishment of the capacity and practical utility of the Planté type of plate are in some measure counterbalanced by the possibility which it affords of employing greater current densities. The correct estimation of the allowable current density does not seem to be attainable. On the other hand, the construction of a Planté plate for traction purposes entails a considerably greater thickness of plate than would be the case with the lighter form of grid plate supporting an active material in the shape of paste. The latter type of plate is, therefore, more suitable for the purpose in question from the writer's point of view. It appears from succeeding remarks that considerable trouble has been experienced in Berlin on account of the objectionable leakage of sulphuric acid gas into the interior of the cars equipped with the Planté type of accumulator. But, as the writer points out, this is not consequent entirely on the type of accumulator employed, but rather owes its origin to defective arrangement and management. The difficulty might be satisfactorily overcome by removing the primary cause—*i.e.*, gas generation—as, indeed, it has been in many other instances. To attain the desired end attention should be given to the proper proportioning of the battery in respect to the number of its component cells, so as to prevent the maximum discharge current generating gas. So far as the Berlin system is concerned, this would mean an increase in the number of cells provided per car and the employment of cells of greater capacity than hitherto. The writer points to the favourable results obtained with accumulator traction in Dresden, Hanover, and other towns in support of his contentions. In the former place accumulator plates of the grid type are employed, and these have conclusively proved their ability to withstand prolonged discharges of heavy currents better than the Planté type of plate. Another example referred to is that of Bremerhaven, where a tramway has been laid and equipped for accumulator traction by Messrs. Goottfried Hagen, of Kalk, near Cologne, which firm also works the line. Some figures are given showing the results obtained, from which it appears that before commencing the regular service of motorcars with trailers the mean consumption of energy per motorcar mile amounted to about 750 watt-hours of charging current, which is very little more than is reckoned for cars of equal dimensions run on the overhead trolley system of electric traction. And this consumption included the current taken by six 16-c.p. lamps employed for illuminating the car. These results obtained in actual practice, coupled with the many obvious advantages peculiar to accumulator traction, lead the writer to conclusions in favour of its extended application, especially in large cities or towns like Berlin, where the introduction of any other form of electric traction would entail immense disturbance of the streets, not to mention future trouble through earth currents, etc.

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ELECTRICAL ENGINEERING AND THE MUNICIPALITIES.

This is the title of an article by Mr. Campbell Swinton in the current number of the *Nineteenth Century*. Before making any comment upon the article, it will be well to give the gist of the author's argument, only remarking for the moment that we entirely agree with the facts as stated, though we do not always agree with the reasons that the author presumes have led to the present position of affairs. The author points out England's backwardness in the utilisation of applied electricity, and contends that this state of things is not due to lack of scientific discovery, inventive genius, or engineering skill. The mention of the names of Davy, Grove, Varley, Wheatstone, Swan, Hughes, and Hopkinson as discoverers and inventors gives point to his remarks on this head, while among the earliest users are found Armstrong, on the one hand, for lighting Craigside, and the Portrush Tramway Company for traction purposes. The — according to the author — misguided action of legislators and municipal authorities brought about a standstill of at least six years, during which period America and the Continent forged ahead. Even after this time he holds that red-tapism and the dog-in-the-manger policy of local bodies contributed to great delay and effectually quenched private enterprise in lighting, and still more so in traction undertakings. The discussion of the effects of this delay is perhaps the best portion of the article, and will be referred to later on. The powers that be, the author contends, do not "yet recognise the fatal mistake . . . in allowing municipal avarice to impede English engineers," urging that though we may lack the water power of America, Switzerland, and Norway, we have a practical equivalent in the shape of coal, which ought to enable us to generate and distribute economically on a large scale. Legislative procrastination even in the face of the joint committee's report is cited as a proof of this "fatal mistake." The moral of the whole is summed up in the following paragraph:

"At bottom all improvement is due to individual effort, and where, as has hitherto been the case in the electrical world, the municipality is allowed always to step in and reap the rewards that are rightly due to private enterprise, progress must inevitably suffer, if it does not entirely cease."

It is difficult in this year of grace 1900 to realise the position of affairs twenty years ago. Most of the gentlemen now engaged in the industry have joined it within the past fifteen years; perhaps within the past ten years, and only realise the position of their own time, being in happy ignorance of "prior knowledge." Just try and look back to 1882. The Paris Exhibition of 1878 proved the apotheosis of Jablochkoff and Planté, but the exhibition of 1881 was the time when men first began to truly realise the possibilities of electricity. At the close of 1881 four companies had been formed, with a capital of £1,322,000, to exploit electric lighting. At the close of 1882 the capital asked for jumped from the modest million and a quarter to close upon twenty-one millions. Truly, in 1882

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company-mongering flourished, and what was the experience upon which to base the right to ask for this huge sum of money? We need not enter into that point, though at some other time it may serve a useful text for consideration. Parliament, sober-minded men, thought a race of speculators had gone mad. The company-mongers issued glowing prospectuses, and hinted at the money to be made out of town-lighting. Need there be any surprise, when the matter is calmly viewed, that the Act of 1882 was imperfect and stringent. Municipalities had in many cases come to the conclusion that lighting was within their sphere of operations; hence this influence was directed to safeguard their interests. There is but one other point the limits of space allow us to consider—the one mentioned above: delay. The author says: "Now, to some it may not appear very important whether a town obtains a system of electric supply or of electric tramways one year or another," and goes on to point out that the old argument of waiting for something superior is utterly false and foolish. How is experience to be obtained, how are faults in design to be known, how are improvement to be made, if everybody waits for perfection? It is pointed out that our waiting meant the gaining of experience by our rivals, that they went ahead and practically controlled the major markets of the world, while we looked on in fear and expectation. The man who urges this waiting-for-perfection policy is a fool. The point to be ascertained is not perfection or equality with what will be known ten or twenty years hence, but is that which is now offered superior to that we have now got. To stay progress because finality is not reached is a wrong policy, and we congratulate Mr. Campbell Swinton for putting his case in so effective a manner. Finally, we again admit his statements as to the present condition of affairs, but cannot well see how legislators in the early eighties could have foreseen the development of the later nineties. Even now the remedy of the so-called "fatal mistake" is not clear. The outcry is for large central stations situated at the coalfields, with distribution over large areas, but, as was asked in 1882, "is progress stayed," will "invention rest," and will such stations be advocated in 1920? Whatever the answer may be, there is nothing more certain than if legislation does not encourage development, development will cease, and 1920 will see us no forwarder in this direction than 1900; hence, when proposed in situations wherein vested interests are not injured, or where vested interests are so small in value as not to be compared with the value of the improvement, surely the improvement should be encouraged, while the vested interests may be safeguarded

AUTOCRATIC CONTROL.

We are glad to note that the Cardiff Electric Lighting Committee have at last arrived at the conclusion that they must have one responsible engineer in their electric lighting department, who should have supreme control of the staff both as regards the appointment and discharge of practically every employé. This conclusion was come to at a meeting of the committee held on Monday to look into the cause of the breakdowns in supply which have been all too frequent this winter. We have carefully looked through the report of this meeting and the three reports which the committee had to consider from Mr. Appelbee and the second and third engineers. One gathers from these that the whole department has been disorganised in consequence of the action of the committee in the engagement of certain members of the staff against the wishes of their electrical adviser. Still, as the committee see the error of their ways, and have given full powers to their chief engineer, it is useless to stir up an old sore. Mr. Appelbee is given six months only to reform matters, and we trust that he will by using a firm hand be able to improve the *esprit de corps* of his staff. When this is done, there is no doubt that the complaints as to the faulty supply will be reduced to a minimum.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

WIRING RULES.

SIR,—In your issue of the 26th ult. your correspondent, Mr. Rupert H. Waite, writing on Jan. 24, proposes a "rule"—namely, "That no wiring should be allowed to be done out of sight unless run in iron or earthenware pipes" I beg to disagree entirely with him in the case of wires having to be carried between floor and ceiling in wooden structures.

My practice since I first compiled a wiring specification in 1886 has been to lay down that wherever wires have to be laid between the floor and ceiling, those of opposite poles (the opposite poles being distinguished by coverings of a different colour) are never to be on the same side of any one joist when run parallel with it, or never to be nearer to one another than 6in. Where they are carried transversely to the joists, they are to rest in notches cut in the top of the joist of a depth equal to three times the diameter of the conductor. Where a branch horizontally crosses the conductor of an opposite pole, the distance apart in the vertical plane must be obtained by threading it through a hole to be made in the lower part of the joist, the attachments of the conductors to the joists to be all made with wooden cleats.

If any of your readers care to try it, they will find it impossible to make an arc between conductors so laid, even (which is a very remote contingency) if the surface of the joists becomes wetted, and at the same time if the insulation has been removed from the copper. I have also always prescribed that where conductors are so laid they must be covered in by a special floorboard, which must be screwed down, and on which the words "*Electric Light*" are painted.

I am sure that in the case described by Mr. Crackenthorpe, Q.C., some little time ago in a letter to the *Times*, *if* the wires between floor and ceiling had been laid in the above-described way, the accident he so graphically described would not have occurred. Another advantage of not having to confine the conductors of opposite poles in a tube which is placed out of sight is that where they *must* be brought closer to one another than 6in.—namely, at ceiling roses—they can be laid so as to join the fitting at opposite sides, and, therefore, kept as far apart as the size of the fitting permits. Again, where conductors are made to ascend a wall to a fitting, they can be kept apart until they reach the upper side of the floorboards, where they are in sight.

I have trespassed on your space at this length because we are all interested in keeping down the cost of wiring consumers' houses, so long as safety is thoroughly assured,

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and because there is no way in which the cost is less than in the manner which I describe.—Yours, etc.,

C. E. WEBBER.

COHERERS.

SIR,—I received a copy of your valuable paper, which I presume was mailed from your office, containing a short note in reference to the wireless telegraphy experiments that Prof. Reginald A. Fessenden and I have been making.

I am sorry that such a sensational report has gained such publicity, as, of course, you are doubtless aware that such a remarkable discovery as that report would lead one to suppose had been made would have been published in some scientific paper by this time, had such a one been made.

We have to be very guarded over here in regard to what we give the daily Press reporters, and the statement that our receiver was 2,000 times as sensitive as Marconi's all came from our stating that the receiver we were using at that time was 2,000 times as sensitive as the first one we tested when we first undertook to develop the subject. We have never made a comparative test, and, of course, are not in a position to say positively that our instrument is more sensitive than Marconi's.—Yours, etc.,

S. E. N. KINTNER.

Western University of Pennsylvania, Allegheny.

[This is a striking example of the way false statements on electrical matters are propagated by the daily Press in America. We presume the statement that the new coherer would enable signals to be sent across the Atlantic also had its origin in the active mind of the untechnical reporter. We are much obliged to Prof. Kintner for his explanation.—ED. *E. E.*]

REVIEWS.

Heat for Advanced Students. By EDWIN EDSER, A.R.C.S., etc. Macmillan and Co. Price, 4s. 6d.

The student of to-day can never realise the position of the student of half a century ago. The works of Rankine, Balfour Stewart, Tyndall, and Clerk Maxwell revealed almost a new world. The lesser lights in authorship interpreted the words and ideas of the masters to those not fledged enough to soar without such help. Before these masters commenced to labour, to arrange, to systematise, and to teach from a firm foundation, the subject was in a state of chaos. Marvellous experimental results had been obtained even by Bacon and Rumford, and laws deduced, but this information was not for the many, only for the few. Now all is altered. The youngest student revels in primers that tell him more, and more truthfully, than was known to many an accomplished scholar of the earlier half of the century, while the advanced student is still better off, for he can revel in text-books that would have been tough reading for the then leaders in the study of heat, and, indeed, which contain much that was then unknown. The author says: "My aim in writing this book has been to give a comprehensive account of the science of heat in both its theoretical and experimental aspects, so far as this can be done without the use of the higher mathematics." It may at once be said that the aim has been excellently achieved. The whole book consists of 21 chapters, with an appendix of tables. We should prefer to speak of the works as of two parts—the first part consisting of the first 11 chapters, treating of the tools necessary to be familiarly used in the due understanding of the second or concluding part, which treats more especially on thermodynamics. Thermometry, expansion, calorimetry, latent heat, change of state, properties of gases, and similar knowledge is a knowing of the tools, and the better their purposes are known and the more practised the student is in handling those tools, the better he will be equipped for understanding and *applying* the subject-matter of the latter part of the book. We have italicised the word *applying*, for, after all, unless the student is able in the years of his usefully working life to apply his knowledge in a strictly utilitarian manner, the time of his studentship has been wasted. Not only is the matter of this book good, but the method merits the highest praise. The scientific student of education might prefer the Socratic method of teaching, and probably we should prefer that method in the abstract; but life is short, and Socrates's are not born every day. Thus the dogmatic method is the one purely adopted at the end of the nineteenth century. Here, then, we get a series of paragraphs, each paragraph clearly explaining a particular point, and, if necessary, further elucidating by means of experiments, suitable diagrams, and examples. The experimental work is carefully explained, and is such as ought to be carried out by every student. It is all very well to be told the end of the poker gets hot when the other end is put among the glowing coal, but it is just as well to try it once; then memory gets doubly assisted. A summary of each chapter is given at its end. These summaries might well form lecture notes for the use of teachers. Then a series of questions is given upon the information contained in the chapter. There is just one point raised by the book, but having nothing to do with its value, which we should like to mention. Throughout the scientific, as against the common, system of weights and measures is used. No doubt the pure scientist revels in this uniformity, and there is much to commend it, but the knowledge has to be applied, and in its application the student will have to labour through a course of translation. This is not the place to argue which is the better—grammes or pounds, centimetres or inches, yet it does seem hard upon the young brain that its teachers should talk in a language not common in the shop or the mart. It is merely an *ex parte* statement to say that at present there is absolutely no indication of a general change to the metric system, or to the terminology adopted in scientific circles. But we must back to the book. The second part, according to our division, is as good as the first. Each paragraph is clear, succinct, and complete. If we had to select a portion for special commendation, it would consist of the paragraphs on "Determination of γ from the Velocity of Sound," and the succeeding paragraphs, which show so clearly where even Newton erred, and how the error arose; or a little earlier in the book, on "The Kinetic Theory of Gases." It had been our intention to have compared the present knowledge of gases with the knowledge known in Boyle's time, but this would be somewhat outside our present purpose. Suffice it to say that the information in this book is compendious and comprehensive. It is accurate and for the most part simply expressed, the mathematics used are not difficult, and the illustrations are good; in a word, this book on heat systematically traverses the whole ground of the subject, putting the student into possession of all the facts and theories which he must know in order to succeed in practical work. The tools supplied are excellent; it will be the fault of the student if he cannot carefully employ them.

We wish that the ordinary newspaper authorities could see and would profit by the remarks made on p. 390 upon "Unfounded Claims as to the Production and Utilisation of Liquid Air." Notwithstanding the great advances of science and the teaching of the schools, the silliest and most impossible suggestions are published broadcast in daily papers, causing the vast body of the population to believe in things which are no more and no less than the fantastic fantasies of lunatics. These daily papers rave about the value of their space and the cost of telegraphing news, yet every year fill columns with the rubbish to which this paragraph refers. Mr. Edser has done good service in calling attention to this matter.

THE ELECTRICAL ENGINEERS VOLUNTEERS.

The detachment of Electrical Engineers Volunteers which is under orders to proceed to South Africa will consist of one field officer—namely, Major Crompton—five other officers, and 46 rank and file. Major Crompton is stated to be forming two baggage trains, each of which is to be composed of a Burrell traction engine, a tender carrying food and water for a 30 miles journey, a store wagon, and two four-wheeled carriages, similar to those used for Maxim guns, which are intended to carry the searchlight projector. There is a also a two-wheel vehicle to be fitted

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with a drum of electric cable. There is to be a novel innovation in the equipment of the corps in that half of the men are to have cycles.

We learn from the *Cyclist*, which describes the equipment of the first section of Electrical Engineers, R.E., that they are to take with them 20 cycles. Major Crompton is stated to have devised a system of field telegraphy by which three cyclists can carry three sets of telephone and telegraph instruments and sufficient wire to lay one mile of field telegraph in 10 minutes over ground practicable to cycles, or 25 minutes if the cycles have to be pushed instead of ridden. Six cyclists can lay two miles of wire, and so on. This should prove a very useful service in the field, being much handier than anything at present employed. The cycles which are to be used must necessarily be very strong, and will cost at least £15 a-piece.

The corps is to mobilise on Feb. 22 at Chelmsford, and will then go into camp until March 2, when it is expected that the transport will be ready. Major Crompton also, in view of the fact that oil-engines may be more useful than compound traction engines if water and coal are scarce, enquires of the Automobile Club's *Notes and Notices* where he can obtain a suitable engine. The motor must be one that can use heavy oil, and it would be of advantage if it were air cooled. The speed on the road should be from three to six miles per hour. The engine which would be required is practically equal in output to a 12-h.p. Daimler. A speed of from 500 to 600 revolutions would be convenient.

We also notice that, in addition to the send-off dinner by certain electricians, mentioned in this week's issue, a dinner is to be given by the Automobile Club, of which Major Crompton is a member. This dinner is to be held at the club on Wednesday next, Feb. 14, at 7.30 p.m. At the conclusion of this dinner Mr. Crompton will make a statement concerning the corps he is to command. We also note that before his departure Major Crompton is to receive his colonelcy in the regular service.

FORTHCOMING EVENTS.

SATURDAY, FEB. 10.

Institution of Electrical Engineers.—Students' visit to Messrs. Siemens Bros. and Co.'s works, Woolwich. Train leaves Charing Cross for Charlton at 9.20 a.m.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "The Bacteriological Treatment of Sewage," by Mr. W. Shanks.

MONDAY, FEB. 12.

Society of Arts.—At 8 p.m., Cantor lecture, "The Nature and Yield of Metalliferous Deposits," by Mr. Bennett H. Brough.

Institution of Mechanical Engineers.—At 7.30 p.m., students' meeting.

TUESDAY, FEB. 13.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Further discussion on papers on "Moving Loads on Railway Underbridges," by Mr. W. B. Farr; and "Note on the Floor System of Girder Bridges," by Mr. C. F. Findlay, M.A.; and, time permitting, a paper on "Corrosion of Marine Boilers," by Mr. J. Dewrance.

WEDNESDAY, FEB. 14.

Institution of Electrical Engineers.—At 7.30 p.m., students' meeting. Discussion on "Wireless Telegraphy."

Society of Arts.—At 8 p.m., ordinary meeting. Lecture on "The Diffraction Process of Colour Photography," by Prof. R. W. Wood.

THURSDAY, FEB. 15.

Chemical Society.—At 8 p.m., ordinary meeting.

FRIDAY, FEB. 16.

Institution of Civil Engineers.—At 2 p.m., students' visit to the Great Northern Railway, King's Cross and Hornsey widening. Assemble at Hornsey Station; train from King's Cross (suburban) to Hornsey, 1.47 p.m.

Northern Society of Electrical Engineers.—At 6.45, at Grand Hotel, Manchester, annual dinner.

SATURDAY, FEB. 17.

North-East Coast Institution of Engineers and Shipbuilders.—At Newcastle-on-Tyne, graduates' meeting.

Institution of Electrical Engineers.—At 11 a.m., students' visit to the Davis-street station of the Westminster Electric Supply Company. Meet at Davis-street station.

General Electric Company.—At 6 p.m., at the Trocadero, tenth annual dinner.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Standardisation of Electrical Engineering Plant.

BY R. PERCY SELLON, MEMBER.

To the user of electrical engineering plant, not less than to the producer, the subject of its standardisation is one of great practical importance. By "standardisation" is meant the general acceptance, to a far greater extent than at present obtains in this country, of certain standards of output, quality, efficiency, or other characteristics of electrical engineering plant, to meet ordinary requirements of usage for light, traction, and power.

1. Of the four chief ingredients of successful competitive production—viz., (*a*) cheap labour, not to be confounded with low wages; (*b*) cheap materials; (*c*) efficient management; and (*d*) repetition manufacture—much has been said and written of the first three, but little of the last. And yet every manufacturer of experience knows that it is as influential a factor in determining not only his own profit but decisive advantages to the user, as any of the factors of labour, materials, or supervision. In order to convince oneself of this, it is only necessary to consider the influence of repetition manufacture upon the price and reliability of any article of common use—say, in our own industry, incandescence lamps and their accessory fittings, in respect of which some measure of standardisation has been evolved; and to reflect what, on the other hand, the cost would be if many manufacturers or users adopted different standards. In the early years of an industry, experiment and development by trial and error are desirable and inevitable in order to ascertain the possibilities and limitations of the art. But as the stage of repetition public demand is reached, standardisation becomes increasingly possible and advantageous. Its advance is, however, liable to be retarded by a number of causes, notable among which are the folly of some producers and the ignorance of many users. There are always some manufacturers who think that by supplying a special or unique type of apparatus to the buyer they will force him into placing his future orders with them. Hence they resist any tendency towards standardisation. There are also many buyers who allow themselves to be persuaded into the belief that in securing something new and different from previous usage they are doing well for themselves and giving evidence of superior intelligence, whereas the probability is that they are paying a higher price for a less reliable article. There is a third class who believe that standardisation is the business of the producer only; and that the user need not concern himself to assist in bringing about a condition of things for which every manufacturer who knows his business eagerly strives. This view is erroneous. The intelligent producer is undoubtedly deeply concerned in the advent of standardisation, because it means for him the possibility of repetition manufacture—on the manifold advantages of which it is not necessary to dwell. But to the user, if he would only realise it, the fruits of standardisation are equally beneficial, for they involve for him the following advantages: (*a*) less capital outlay; (*b*) prompt delivery; (*c*) immunity from the risks attendant on novel designs; (*d*) full manufacturers' guarantees.

2. Viewed from the "patriotic" standpoint, this subject acquires also special significance in these days of acute struggle between British, American, and Continental manufacturers for our own and the world's markets in electrical wares. The causes which underlie the ability of American and Continental producers to compete keenly and successfully with the British electrical manufacturer are several, and generally outside the scope of this paper. But conspicuous among them is the fact that the former have (as anyone who has visited their leading workshops can testify) attained to a degree of repetition manufacture superior to the British producer. This fact is so noteworthy as to constitute in itself a telling argument in favour of increased standardisation among us: for the flood of American electrical engineering plant into Great Britain is swelling in spite of the fact that we have

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the advantages of lower wages (on the whole), cheaper materials, and a longer experience of factory organisation.

3. It therefore becomes important to endeavour to trace the cause of this preferential position held by our foreign rivals. The explanation would appear to lie in a difference of procedure. According to American and Continental practice the producer determines, in a large measure, the character of the plant employed by the user; while according to British custom the buyer very generally imposes upon the manufacturer, not merely a specification of the ends he wishes to attain, but the details of means by which he desires those ends to be achieved. This is due to the fact that under the American and Continental system producers largely secure outlets for their manufactures through the agency of powerful financial organisations created by and allied to their interests, who are concerned simply with commercial results, and are content to leave the technical means of attaining them to the manufacturing interests with whom they co-operate In America these organisations take the form of colossal trusts or consolidations of competing interests; on the Continent that of industrial banks. In either case there is a close relation between producer and buyer. In Great Britain, on the other hand, the demand for electrical engineering plant in recent years has issued chiefly from local authorities, or from private users unconnected with any manufacturing interests; and these have very naturally had recourse to electrical engineers acting in a consulting capacity or passing permanently into their service, to guide them in the choice of plant to fulfil their requirements. That the practical operation of this system in the past has been primarily responsible for the relative absence of standardisation in this country, with its attendant evils alike to user and producer, appears certain. For the user's engineer has frequently been out of touch with manufacturers, and the temptation to strike out on new and "showy" lines, suggestive of individuality, ability, or foresight, has, in the very nature of things, been great. The result has been the issue of specifications too often calling for wanton divergencies from previous practice or existing manufacturers' standards. The source of the evil is traceable to the fact that the buyer's engineer has gradually overstepped the rational function of stating the ends or performance required by the buyer, and has proceeded to specify in minute detail the means or constructional methods by which the required results are to be achieved, without taking responsibility for the result. It is not necessary to adduce specific examples in illustration of this statement, because the author believes that it is one which no fair-minded electrical engineer acquainted with the facts will dispute. There is no difficulty in producing overwhelming evidence of its truth if such be required. To the same primary cause may probably be traced the variety in size and character of the power units in many of the central stations of Great Britain—another instance of "splendid isolation" in our methods, for foreign practice is at one in adopting fewer and larger units, uniform in size and character from the commencement. Whether advantages of temporarily reduced capital outlay and higher efficiency under our system are a sufficient compensation for loss of interchangeability and periodical relegation of plant to the old metal market, remains to be proved when the bills are presented later on and contrasted with one another. Meantime, it is interesting to note that one result of our procedure is the comparative unpreparedness of British manufacturers to compete with foreign producers in the common markets of the world as regards large units.

4. Whether British collectivism is on the whole a more healthy medium than American or Continental private enterprise for the progressive growth of the electrical engineering industry is a large question outside the scope of this paper. We have here to accept it as a fact, and consider whether an evil which it has brought in its train is a necessary one; and if not, how it can be averted for the future. Assuming then that the buyer's engineer has come to stay, it would appear that a condition precedent to the standardisation of plant is the standardisation of the buyer's engineer. The fundamental fact requiring appreciation is that standardisation, to the greatest degree possible, is in the interest of the user at least as much that of the manufacturer. From this we may pass on to postulate that standardisation is primarily the function of the producer and not of the user or his engineer, because the former is in a better position to determine experimentally, and by his more intimate knowledge of the means of production, the direction and extent to which it is possible. Inasmuch as the manufacturer's success is dependent on the judgment with which he creates or responds to public demand, there exists always an efficient safeguard that he will not (consciously) standardise on unsuitable or inefficient lines. The user, on the other hand, is, of course, the proper judge as to the results he wishes to achieve. It would appear, therefore, that the initial obstacle to a greater measure of standardisation than at present obtains would be removed if the user or his engineer would confine himself to stating the ends he has in view, leaving it to the producer to furnish the means whereby they may be attained. If this procedure were adopted, users would still retain full liberty of choice between the products of different manufacturers, while the latter would have an opportunity (which under the present system of detailed specifications they do not enjoy) of undertaking repetition manufacture, assuming that they have sufficient confidence in the substantial harmony between their designs and public requirements to take the risk of quantitative production. This system would have the incidental advantage that the producer could then be properly called upon to guarantee results, since the responsibility of selecting the means to attain them would rest exclusively with him. The present custom too often imposes upon the manufacturer a mass of fantastic detail emanating from the brain of the user or his engineer, for which he is called upon to take responsibility—an illogical system which can only be compared to the proposition that every man should be expected to father another man's child. It may be objected that the general adoption of the course suggested would lead to stagnation in development, and that the producer, relieved from the constant pressure of change now exerted by the user, would settle down to the perpetuation of antiquated designs, to the disadvantage of the public and the fetish of progress. The answer to this is, firstly, that much of the change hitherto demanded has been wanton and retrogressive; secondly, that competition within the ranks of manufacturers themselves must always prove a sufficient stimulus to keep abreast of public demand; and, finally, that it is largely by the adoption of the system suggested that American and Continental producers are snatching trade from the British manufacturer in his own market.

(To be continued.)

THE BRITISH INSULATED WIRE COMPANY.

The directors of the British Insulated Wire Company, Limited, have issued their report for the year ending Dec. 31 last. The gross profits for the year amount to £92,653, and after deducting costs of administration, fees on patents, interest on debentures, depreciation, etc., there is a balance of £54,473. To this are added the credit balance from the previous quarter's account and transfer fees, bringing the amount up to £56,557. The dividend on the preference shares and an interim dividend on the ordinary shares have already been paid, and the final balance is £36,432, out of which the directors recommend that a dividend of 15 per cent. on the ordinary shares be declared for the year, which, after deducting the interim dividend, will leave a balance of 10 per cent. to be now divided. This will absorb £20,000, and leave a balance of £16,432, out of which the directors recommend that a bonus of 5 per cent. be paid to the ordinary shareholders and the balance of £6,432 be carried forward. The directors state that the results of the year's working have been most satisfactory. The existing capital is fully employed, and it is absolutely necessary to provide a large amount of additional capital which can at once be profitably utilised. To this end, after the annual meeting of the company at Prescot on the 16th inst., an extraordinary general meeting will be held to authorise the increase of the capital of the company to one million by the creation of 60,000 new preference share of £5 each and the same number of ordinary shares of the same value.

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THE SEND-OFF DINNER.

With reference to the send-off dinner to be given to the Electrical Engineer Volunteers about to start for South Africa we have received the following letter from Mr. W. G. McMillan, the hon. secretary to the Dinner Committee. He also asks us to call attention to the fact that it is not intended to confine the dinner to members of the Institution. On the contrary, it is believed there are many engineers not on the Institution member roll who would be glad to avail themselves of this opportunity of showing their sympathy with the movement. They are cordially invited to become hosts, and, should they wish to do so, are requested to send their remittances to the hon. treasurer. It is with pleasure that the committee announce that the Right Hon. Lord Kelvin, G.C.V.O., F.R.S., has promised to preside if the date which may have to be selected renders it possible for him to do so. The circular letter which will be sent to all members and associates of the Institution is dated Feb. 6, and reads as follows:

Departure of Electrical Engineer Volunteers for Service in South Africa.

Dear Sir,—As you have probably seen by the electrical journals, it is proposed to give a "send-off" dinner in London to the South African contingent of the Electrical Engineer (R.E.) Volunteers. Particulars as to place and date cannot be definitely fixed until the War Office shall have announced the date of departure, but it is expected to be about the end of February. Meanwhile, it has been decided to invite members of all classes of the Institution of Electrical Engineers who care to do so to become hosts on the occasion of the dinner, each host subscribing two pounds (£2), which will be devoted to defraying the expense of the dinner both of the hosts and of the members of the volunteer contingent, the balance, if any, to be applied to some fund connected with the corps.

Should you desire to become a host, please send, before Feb. 20, a remittance of £2 to the honorary treasurer, Mr. Henry Edmunds, 2, Queen Anne's-gate, London, S.W., and also state whether you desire to be present at the dinner.

In order to save unnecessary correspondence and expense, a dinner ticket will be sent to each host, and it is requested that these tickets will be accepted in lieu of a formal receipt.—I am, dear Sir, yours faithfully,

W. G. McMILLAN,
Hon. Secretary to the Dinner Committee.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. Conditions are given in our last issue.

QUESTIONS.

243. Assuming a supply company charges 4½d. per Board of Trade unit, what is the smallest quantity required by any one user for which it will be cheaper to establish an isolated plant, gas being 2s. 2d. per 1,000 cubic feet or coal 12s. 6d. per ton delivered?—F. J. A. M.

244. How can a 5-h.p. shunt motor be designed and arranged to run at speeds varying between 300 and 1,200 revolutions per minute with good efficiency?—F. W.

ANSWERS.

Question No. 237.—Give the results of actual tests showing the relative fusing currents of copper and tin wire in air and in insulating oil.

Best Answer to No. 237 (*awarded* 10s.).—Some results of an actual experiment for the determination of the current-carrying capacity of copper and tin wire respectively both in air and oil are as follows, but, of course, the time taken in the reading the respective currents will have had some effect upon the results. In this instance, however, the time was in both cases kept the same—that is, the time which was necessary for correct readings to be taken upon the instrument used being approximately 25 seconds.

To obtain the results relatively to pure metals, copper and tin foil were employed in both cases. Four pieces were prepared having the same length, the same radiating surfaces, their sectional area being corrected by weight. These had the current passed through 6in. of their length in air and a viscous oil of insulating property, and the relative currents were as follows:

Copper in air	26·4 amperes
Tin in air	6·1 amperes
Copper in oil	66 amperes
Tin in oil	17 amperes

So that from the above the current-carrying capacity of copper in air is to that of tin as 4·33 is to 1. Likewise when immersed in oil the current-carrying capacity of copper is 3·88 times that of tin.—J. C. B.

AN ELECTRIC TRAVERSER FOR RAILWAY CARRIAGES.

BY M. SABOURET.

In the Orleans Railway Station at Paris an electric traverser is used to carry railway carriages from one line of metals across on to adjoining rails, and the apparatus used is of particular interest because no trench is used for the same. The rails on which the traverser runs are practically level with the ordinary running rails, a system of duplicate bearing axles being used to get over the difficulty

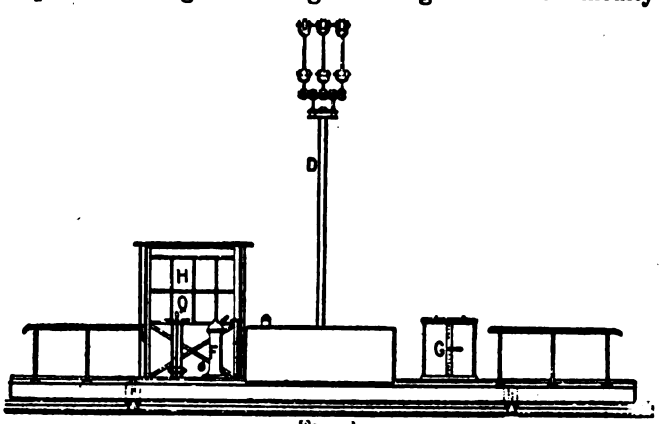

FIG. 1.

of the gaps left in these rails where the ordinary running rails are crossed. In the illustrations herewith, for which we are indebted to the *Revue Général des Chemins de Fer*, drawings of the arrangement of the traverser carriage are shown, from which it will be seen that there are two distinct trucks, one of which takes the railway carriage, while the other is provided with the electrical arrangements for moving the same. The motor truck only differs from the carrying truck in slight details.

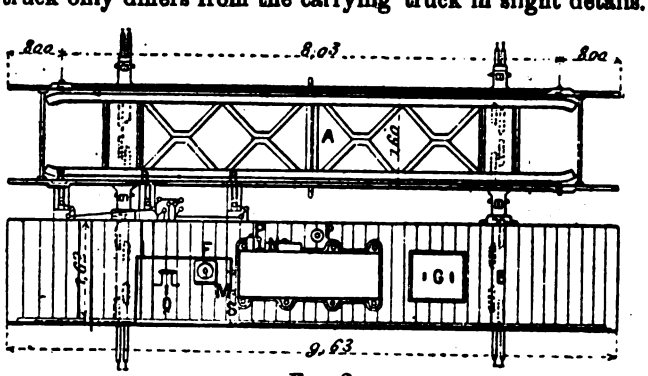

FIG. 2.

Of course, it could be kept much shorter, but it is convenient to use the same traversing rails, and hence it is made practically of the same dimensions. This truck is also fitted with a hauling arrangement, by which the carriages can be drawn on to the transporter truck. The details of the gear, etc., can be seen from the illustrations. Thus Fig. 1 shows the general view of the truck with collecting gear, while Fig. 2 is a cross-section of the same. Fig. 3 is a plan of the apparatus showing the two trucks coupled together.

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Fig. 4 is an end elevation showing the driving gear, and also one view of the hauling rope. Fig. 5 is a front elevation of the driving gear, showing the way in which the motor is mounted, which can also be further seen in the plan (Fig. 6) Three trolley wires are used to take the current to the motor, because in this railway station

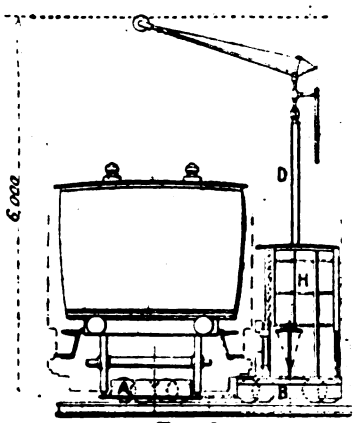

Fig. 3.

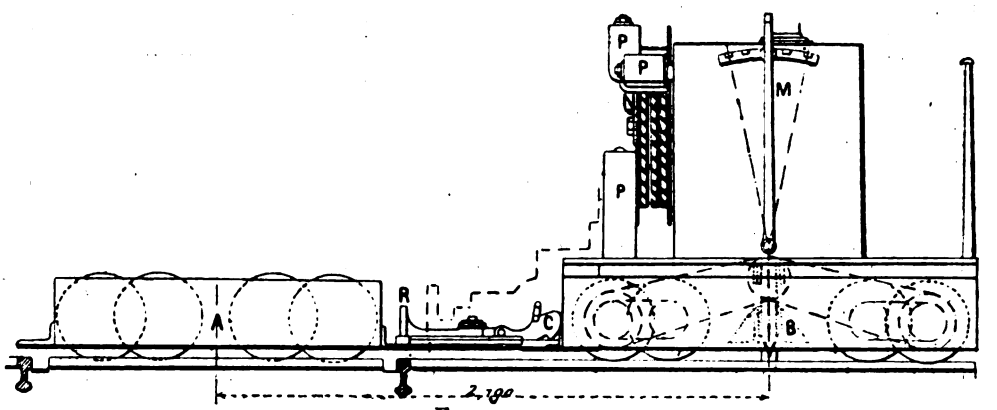

Fig.

electricity is distributed on the continuous-current system at 375 volts with 125 volts between each pair of wires. We gather from the description that two of the trolley wires supply the armature at 375 volts. The remaining wire is used for excitation purposes, there being 125 volts between it and one of the first pair. The rails are not

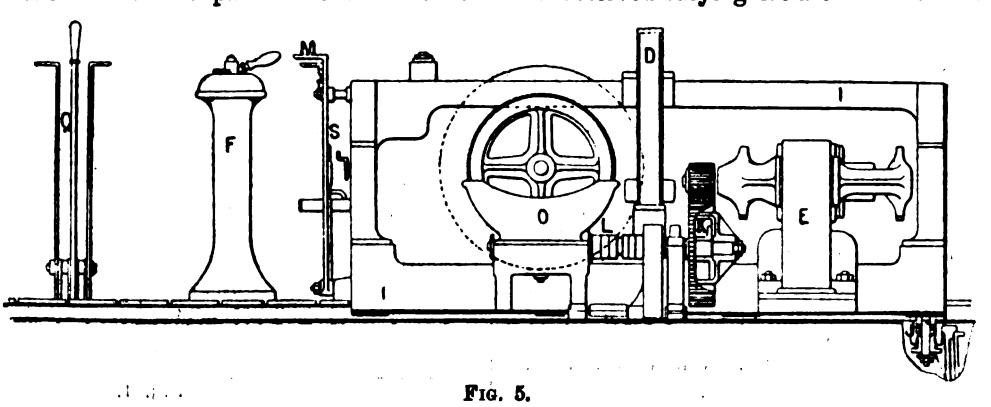

Fig. 5.

used at all for conducting the current. The arrangement of the reducing gear between the motor and the axle can be readily seen in the drawings, as also the arrangement of clutches for throwing the hauling rope in and out of action, and for connecting and disconnecting the driving power to the axles. Chains are used to transmit the motion to the

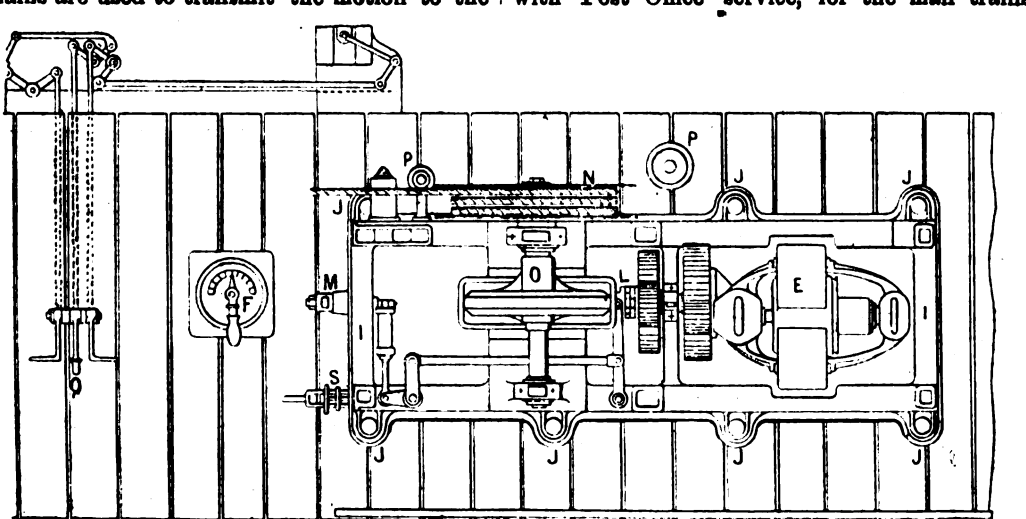

Fig. 6

two axles of the truck, and these axles are also geared to the other two by means of chain gear. The controlling gear, which was manufactured by the firm of Sautter-Harlé, provides for five different speeds. The first of these corresponds to a connection of all the resistances in circuit; the second and third steps are obtained by successively cutting out resistances; the fourth step reduces the series excitation of the magnet, while in the fifth step a resistance is inserted in the shunt circuit. From trials made on the railway the following consumption of energy was found to be required: first when the traverser was working without load, and next when it was loaded with 13 tons. In starting it took from 8 kw. to 9 kw. light, and 12 kw. to 15 kw. when loaded. At a small speed of about one yard per second the kilowatts varied from 2·5 to 3·7 with the traverser light, and from 3·7 kw. to 5·2 kw. when it was loaded. At higher speeds up to about 1½ yards per second only a slight increase in the consumption of energy was observed varying from 3·7 kw. to 4·5 kw. when the traverser was running light, and from 6·4 kw. to 8·2 kw. when the traverser was loaded. It seems that the apparatus is doing good service at the above railway station, as no less than 250 to 350 vehicles are transported during 24 hours. It is used particularly in connection with Post Office service, for the mail trains which are made up at this station. In this case the hauling gear is almost as often needed as the traverser, but owing to the limited time it is found advantageous to move the trucks to the traverser by horses. The cost of the whole, including the necessary rails for crossing 20 sets of metals, the truck for transporting the carriages, the motor truck, and all the electrical apparatus, came out at £1,800.

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LEGAL INTELLIGENCE.

RUCKER v. THE LONDON ELECTRIC SUPPLY CORPORATION.

(Concluded from page 170.)

Mr. W. R. Bousfield, Q.C., M.P., commenced his summing-up for the plaintiffs by a consideration of the effect of low resistance on the regulation of transformers. Even granted that there were in 1885 no new scientific principles to be discovered, it followed that practical experience was required to render the known principles available and to make a practical transformer. It was in this practical application that the invention lay. He thought it was remarkable that Mr. Moulton had not appreciated the fact that the object of the low resistance was fully explained by Ohm's law. Others, like Lord Kelvin and Mr. Ferranti, fully recognised this, and found it very difficult to put themselves back to the time when they had not grasped this simple application of Ohm's law to transformer design. It was quite true that the available E.M.F. of a transformer coil was independent of the internal resistance while it was not loaded, but the specification pointed out that as soon as the available load was put on the coil the internal resistance was a very important factor. Mr. Bousfield pointed out that with a Ruhmkorff coil supplied from a battery with a contact breaker in circuit, the E.M.F. had been shown in evidence to depend on the rapidity of the break. He then reviewed the evidence as to the resistance of transformer coils and their reaction, and Mr. Ferranti's evidence as to the induction effects in conductors supplied with alternating currents. This induction effect due to the choking action was known by Mr. Rankin Kennedy before the plaintiffs' specification, but he thought that the voltage drop due to the load in the transformer was not so known. He proceeded to show that the energy given to a transformer could be divided into two parts: first, that required by Ohm's law to drive a current through the coils of the transformer; and second, that which was transformed from one coil to the other in the transformer and used on the secondary circuit. Having shown that Ohm's law was applicable in calculating the energy required to drive the current through the primary and secondary coils, Mr. Bousfield claimed that the patentees had seen this, had worked it out, and had put it in their specification. He quoted from the evidence given by Lord Kelvin to show that Lord Kelvin even now could not answer directly as to the effect of the resistance in the coils of a transformer connected in series on the Gaulard and Gibbs system. Lord Kelvin had taken from Friday to Monday to think the matter over, and came to the conclusion that resistance had effect in these circuits, whereas it was obvious that by regulating the constant current you could put more resistance in without upsetting the voltage on the lamps. He argued from this that it was obvious that what the patentees had done was not well known at the time. The inventors had considered the question fully, and had solved practical difficulties which had occurred, and hence it was not a mere question of jumping to a conclusion, but rather working the thing out on scientific principles to arrive at practical results. He proceeded to quote a case, which went to the House of Lords, on the use of a steam disinfecting plant. The patentee in this case had claimed the use of dry steam superheated and at considerable pressures, and his patent was said to be invalid because someone had previously worked a disinfecting plant using steam at 4lb. or 5lb. above atmospheric pressure. As in this previous plant automatic relief was given should the pressure rise above 4lb. or 5lb., it was held that the patentee of the high-pressure system, although using the same details, had made an invention because he recognised the essential requirements for disinfecting by steam. Mr. Bousfield also quoted largely from the records of the law case over the Hopkinson three-wire system, and argued that the present case was an analogous one. In 1885 the question of distribution was being carefully considered, and high-tension system for supplying low tension on the lamps was required. Lord Kelvin and Gaulard and Gibbs had both worked on the problem without arriving at a practical decision. The Gaulard system had been tried extensively on the underground railway and at Turin, but had not succeeded in solving the problem of delivering constant potential at the house of each consumer. Mr. Rankin Kennedy had pointed out the reason for the failure of this system, but failed to grasp the solution, which he had almost discovered. They did not in any way wish to interfere with consumers using transformers on their own premises, as Mr. Moulton had suggested, as their system was outside the consumers' terminals. Even if the consumer set up a minlature system of distribution in his house, it would not affect the patent, which was for distribution at high pressure over considerable areas. In the same way a transformer invented for use with an incandescent lamp as invented by Thiel did not affect the case any more than the transformer system of Jablochkoff. He argued that Brush and Fuller were only using transformers for certain reasons without any idea of the distribution of electric current by their means. Edison, however, had the problem of distribution in his mind, and also the importance of the saving of the copper in the conductors. But Edison had no idea of the importance of low resistance, and in his specification repeatedly spoke of high-resistance coils. He argued from this that Edison did not understand that counter E.M.F. prevented excessive currents going through the transformers when no lamps were on the secondary. Thus, while Edison was facing the very problem, he missed the goal and failed to see the practical solution. With the large number of patents which Edison had taken out, one could fairly assume that he would have protected the idea had it occurred to him. Again, Mr. Ferranti, who knew all about the Gaulard and Gibbs system and made their transformers, immediately adopted the Zipernowsky and Déri system when he heard of it in 1886. He also patented and improved an arrangement of the transformers, but evidently it did not occur to him before that the parallel connection of transformers would solve the distribution troubles. Mr. Bousfield then quoted authorities as to the reading of the amended patent specification which supported his contention that the amended specification could be read without reference to the original specification.

The Court then adjourned.

THURSDAY.

Mr. W. R. Bousfield resumed his summing-up for the plaintiffs by criticising Mr. Moulton's construction of the claim of the specification. He said that Mr. Moulton put forward one construction, that it was merely a claim for keeping the voltage in the primary conductors as constant as possible, and a construction which would make the claim simply mean putting transformers in parallel. In order to refer to this first construction, Mr. Bousfield quoted from the unamended specification to explain the apparatus which Messrs. Zipernowsky and Déri had devised for keeping the primary voltage as constant as possible.* This apparatus consisted of an automatic means of varying the field excitation so that the voltage at the terminals should be independent of the load taken from the alternator. In the first few lines of the old specification the following words occurred: "Now the object of this invention is to make all individual points of consumption quite independent one from another, all necessary regulation being made by us at the generator of electricity." Mr. Bousfield argued from this that, whereas Figs. 1, 2, 3 in the unamended specification described this apparatus for regulation, Fig. 4, which was retained in the amended specification, only referred to the system of distribution, using the constant potential in the primary, however obtained. He considered, therefore, that the claim referred to a case where the current was at a potential kept as constant as possible "at the generator" as distinguished from "by the generator." He denied that the connection of the transformers in parallel on the primary was the whole of the invention. It was a distinctive feature and the main feature, but the object of the invention was to enable a practical system of distribution to be used, and the specification gave further indications of other essential features in the invention. With respect to the objection that high and low tension were not mentioned in the claim of the amended specification or in the provisional, Mr. Bousfield quoted from Lord Kelvin's evidence and from the work done by Gaulard and Gibbs to show the statement that electrical energy could be cheaply conveyed over lines of considerable length and be utilised in a number of local circuits, disclosed the fact that high tension was to be used. In consequence no one with the common knowledge of 1885 would doubt that the specification had reference to a high-tension system using low tension at the consumer's terminals. Mr. Bousfield next gave a *résumé* of the evidence in connection with the Zipernowski and Déri article which had been published prior to the date of the patent. The statement that "if a consumer had 200 lamps in his installation he could switch on any number he may please without disturbing the economy of distribution in the slightest degree, and without the other consumers or the central central being in any way affected by the alteration," was inconsistent with the plaintiffs' system, and the variation in the primary voltage of 1,000 to 1,200 seemed to be a misleading statement. The essence of the plaintiffs' system was that they should have a constant potential in the primary circuit, and the statement that this might vary from 1,000 to 1,200 showed that the writer of the article did not appreciate what he had seen. The current in the two circuits of six or seven amperes respectively was also to be explained by different connections to those used by the plaintiffs', and he held that the description would not give the requisite knowledge to enable the plaintiffs' system to be devised in view of the fact that the Gaulard and Gibbs system of alternate-current distribution was the only one then known. With the present knowledge it was, of course, obvious that the writer referred to the plaintiffs' system, but that was in consequence of what had been done since.

Mr. Moulton here interposed to make two objections to statements in the earlier part of Mr. Bousfield's summing-up. The first was the statement that "the ratio of E.M.F. between the transformer coils was independent of the materials and their resistance," was misleading. In making this statement a difference was made between the ratio when the circuit was open and when it was closed, which had not been brought up in evidence. The second point was as to the applicability of Ohm's law to alternating currents. Mr. Moulton said that in Mr. Bousfield's opening speech he had said that alternating currents would distribute themselves, like continuous currents, according to Ohm's law, except where inductive effects supervened. He had afterwards suggested that Ohm's law would not be known to apply to alternating currents in 1885.

Mr. Bousfield explained that he held it was not known in 1885 that in the regulation of transformers Ohm's law was applicable. As regards the Edison patent, he thought that Mr. Ferranti's evidence that the system with rectifiers would work on a small scale was an argument in his favour, as on a small scale high-tension distribution was not required. If Edison had seen that by simply using an alternator and transformer, as had been done by the plaintiffs, he would have had a practical system, but would not have dreamed of using a complicated arrangement of apparatus

* Specification reprinted in our issue for Aug. 12, 1898, illustrates this device.

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such as he had patented. Again, Edison repeatedly referred to primaries as resistance coils, and said that high resistance was objectionable. Edison evidently thought that high resistance was required, because he did not know of the choking action which occurred. It had been stated that Edison's patent contained all that was in the plaintiffs', and something more, but he held that no one who had invented a tricycle with three wheels could not claim to have invented a bicycle because he had only to leave out one of the wheels in his previous invention. The problem which Brush had before him was not that of distribution, but of preventing the extinction of one arc lamp affecting other lamps in the same circuit. His patent showed that he did not understand the action of transformers, and simply used them to maintain an unbroken circuit in the event of a lamp becoming extinguished. In the same way, the article by Fuller in the *Times* showed no device for distributing electricity, but for transforming it up to suit special lamps.

This closed the summing-up for the plaintiffs.

Mr. Justice Farwell asked Mr. Bousfield, should the verdict be in his favour, what remedy he should want. He presumed that he would want an account going as far back as the Statute of Limitations allowed.

Mr. Cripps said that this would have to be considered, and that there would have to be an enquiry afterwards, and he did not think there would be any difficulty about the arrangement.

Mr. Justice Farwell asked, in the event of his verdict being for the plaintiffs, what action should he take with reference to the cost of certain particulars which had not been referred to at all in the case.

Mr. Bousfield said that the cost should only be for those particulars which had been actually referred to.

Mr. Cripps said that in his opinion this point could be settled very quickly.

An agreement was then made as to the correction of certain misprints in the reports of the evidence which were to be forwarded on to his Lordship.

Judgment was deferred, as announced in our last week's issue.

COMPANIES' MEETINGS AND REPORTS.

PORTRUSH AND GIANT'S CAUSEWAY ELECTRIC TRAMWAYS.

The twenty-fourth ordinary meeting of shareholders of the above Company was held at the offices, Portrush, on Tuesday.

Dr. Anthony Traill, J.P. (chairman of the directors), presided. The report stated that the receipts were £3 010. 17s. 10d., showing an increase of over £600 for the year, due to the increase in the number of passengers carried during the year from 74,877 to 94.151. The number of miles run by electricity during the year have been 17,875 (11,333), and the miles run by steam have been reduced from 13.979 to 11,771, making the total miles run last year 29,646 (25,312). The lawsuit instituted by the Urban Council of Portrush to compel the Company to discontinue running cars by electricity through the street of Portrush, and to remove the poles which maintain the overhead wire, was referred to.

The report was adopted.

The engineer's report was also submitted by Mr. Wm. A. Traill, C.E., and considered satisfactory. Messrs. C. M'D. Stuart, J.P., and W. A. Traill, the retiring directors, were re-elected.

NEWCASTLE DISTRICT ELECTRIC.

The annual report of the Newcastle and District Electric Lighting Company, Limited, has just been issued. It states that 1,008,622 units of electrical energy have been supplied, as against 778,828 units in 1898. The gross earnings amount to £8,811; and after paying interest, placing £1,000 to reserve, and providing for depreciation, the directors recommend a dividend of 5 per cent. for the half-year, making, with the interim dividend, 8½ per cent. for the year. The retiring directors are Mr. J. D. Milburn and the Hon. C. A. Parsons, and they and the auditors, Messrs. Strachan and Co., offer themselves for re-election.—*Newcastle Daily Chronicle.*

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

Directors: Alfred Sohier Bolton, Esq.; Sir Frederick J. Bramwell, Bart., F.R.S.; Sir Charles Grant, K.C.S.I.; Granville R. Ryder, Esq.; R. W. Wallace, Esq., Q.C.

Report of the directors (with abstract of accounts) to be presented at the thirteenth ordinary general meeting to be held at 1, Great George-street, Westminster, on Wednesday, Feb. 14, 1900, at 4 p.m.:

During the year the number of houses and shops connected with the system has increased from 1,851 on Dec. 31, 1898, to 2 110 on Dec. 31, 1899, while the number of lamps calculated on the usual basis of 8 c.p. has increased from 156,158 to 183,462. The directors have strengthened the renewal account by transferring to it £4 764 9s. 10d, making the total amount placed to that account £30,379. 19s 7d. After providing for the above amount, and paying the dividends on the 6 per cent. first preference shares to June 30, 1899, on the 5 per cent. second preference shares to Sept. 30, 1899, and an interim dividend at the rate of 10 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1899 is £10,297. 15s. 5d. Of the above sum £1,450 has been appropriated to the payment of the first preference dividend to the end of the year, and £404 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date, leaving £8,443. 15s. 5d., out of which it is proposed to pay a further dividend on the ordinary shares of 6 per cent. for the past half-year, making, with the interim dividend paid on Aug. 3, 11 per cent. for the year. This will leave a balance of £4 093. 15s. 5d. to be carried forward. The directors are glad to be able to state that a Bill in Parliament, which was approved by the shareholders at the commencement of last year, for the purpose of obtaining powers to erect a new generating station at Wood-lane in conjunction with the Notting Hill Electric Lighting Company, Limited, has passed into law, having received the Royal assent on July 13 last. The directors believe that the powers thus secured will afford substantial advantages to both the companies interested. No time has been lost in proceeding with the necessary steps for carrying the scheme into effect. The land has been acquired, and contracts for the erection and equipment of the new works have been placed. The directors hope that before next winter the new station will afford an effective addition to the Company's sources of supply. The cost of the new station will be borne by this Company and the Notting Hill Company in proportion to the extent to which each company shall participate in the output of the new works. This Company will therefore have to make provision for its proportion of the capital expenditure required. In accordance with the articles of association, Mr. R. W. Wallace, Q.C., and Sir Charles Grant, K.C.S.I., retire from the directorship, and, being eligible, offer themselves for re-election. The auditors, Messrs. Lovelock, H. W. S. Whiffen, and Dickinson, offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1899.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£6,558	7	7			
Oil, waste, water, and engine-room stores	906	13	5			
Proportion of salaries of engineers, superintendents, and officers	839	14	8			
Wages and gratuities at generating stations	2,279	16	2			
Repairs, renewals, and maintenance, less received for plant and old material sold: buildings, £495. 0s. 4d.; engines, boilers, and dynamos, £2,415. 9s. 4d.; other machinery, instruments, and tools, £169. 16s. 5d.; accumulators and accessories, £2 776. 12s. 7d.; switchboards, £388. 17s. 5d.	6,245	16	1			
				16,830	7	11
Distribution of Electricity.						
Proportion of salaries of superintendents and officers	174	0	0			
Wages and gratuities to linesmen, fitters, labourers	393	16	6			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	1,981	18	10			
Repairs, maintenance, and renewals of meters	529	4	1			
Sundry expenses	12	6	1			
				3,091	5	6
Rents, Rates, and Taxes.						
Rents payable	273	7	5			
Rates and taxes	3,822	15	8			
				4,096	3	1
Management Expenses.						
Directors' remuneration	1,000	0	0			
Salaries of managing engineer, secretary, accountants, clerks, messengers	2,102	17	6			
Stationery and printing	280	2	3			
General establishment charges	332	14	4			
Auditors of Company	63	0	0			
Auditor appointed under the provisions of the order	60	0	0			
				3,838	14	1
Law expenses				343	6	6
Depreciation.						
Depreciation in respect of leasehold works	290	0	0			
Renewal and maintenance of buildings, plant, mains, etc., £13,521. 8s. 10d.; less amount expended during the year as above, £8,756. 19s.	4,764	9	10			
Special Charges.						
Insurances	452	2	11			
Cost of conversion to 200 volts	147	9	0			
				5,654	1	9
Total expenditure				33,853	18	10
Balance carried to net revenue				19,201	7	7
				£53,055	6	5

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Cr.	£	s.	d.
Sale of current per meter 5d., 6d. per B.T.U. less rebates and bad debts	49,893	13	11
Sale under contracts (units 2,463,950)	760	16	11
	50,654	10	10
Rental of meters and other apparatus on consumers' premises, £1,595. 18s. 2d.; sale and repairs of lamps, etc., £14. 14s. 8d.	1,610	12	10
Leasehold property: rents receivable, £839. 8s.; less repairs, £54. 7s. 9d.; and transfer fees, £5. 2s. 6d.	790	2	9
	£53,055	6	5

General Balance Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	248,435	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., on open accounts to Dec. 31, 1899	7,557	5	6
Net revenue account—balance at credit thereof	10,297	15	5
Renewal fund account—balance at credit thereof	30,379	19	7
Depreciation fund account—works on leasehold property	2 144	12	6
	£298,814	13	0

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	273,813	11	5
Stores on hand Dec. 31, 1899: coal, £249. 2s.; oils, waste, etc., £229. 6s. 6d.; general, £1,119. 4s. 9d.	1,597	13	3
Sundry debtors for current supplies to Dec. 31, 1899	18 362	10	9
Other debtors	347	12	0
Cash at bankers, in hand, and on deposit	4,693	5	7
	£298,814	13	0

ANGLO-AMERICAN TELEGRAPH.

The ordinary general meeting of this Company was held on Thursday last week.

Mr. F. A. Bevan, who presided, moved the adoption of the report, already noted by us. The traffic receipts had amounted to £197,318, an increase over the corresponding half of last year of £6 797. The chartering of the steamship "Minia" brought them in £9 850. There was also an increase of £375 in interest, making altogether an increase in receipts of £13,183. On the other side, the working expenses were £47,412, an increase of £869, which they would agree was not large considering the increased traffic receipts. The expenses were now only 37½ per cent., having been greatly decreased since 1894, when they were 48 per cent. The net increase of receipts was £2,396 for the half year. In addition to that they brought forward from last year a sum of £24.701, against £7,120, the amount brought forward in the corresponding period of the previous year. The result was that they had £153,605 to deal with, after setting aside £12.000, which they were in the habit of putting to the renewal fund. They proposed to divide £152,250, which meant, so far as the shareholders were concerned, that the preferred shareholders would get their full £6 per cent., the ordinary shareholders £3. 13s. 6d. per cent., and the deferred shareholders £1. 7s. per cent. The renewal fund had increased to £820 000, of which £730,000 was invested in securities. A considerable portion of the dividend paid to the deferred shareholders represented the earnings of the "Minia." With regard to the laying of the new German cable to America, *vid* the Azores, he said that their agreement with the German Government expired at the end of the year, but as the German company did not so far seem to have matured their arrangements, they were still carrying their messages. The new cable would be laid before the end of the year, and although it would probably divert a large portion of the German messages, the Company hoped to get some of the German messages from this side, and a great deal of the German traffic from the other side. The German company had been anxious to obtain an alternative route, and had entered into an arrangement with the Commercial Cable Company. One of the objects aimed at by these two companies required the sanction of the British Government. Representations having been made to the Government that British interests would thereby be interfered with, sanction was refused.

The motion was seconded by **Sir G. Fitzgerald**, and adopted.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT.

Directors: Eustace J. A. Balfour, Esq. (chairman); Walter Leaf, Esq. (vice-chairman); Sir John H. Morris, K.C.S.I.; Bennett Fitch, Esq., M.I.C.E.; Marlborough R. Pryor, Esq. General manager and secretary: Frederick J. Walker. Chief engineer: Sydney T. Dobson, M.I.C.E.

Report of the directors (with abstract of accounts) for the year ending Dec. 31, 1899, to be presented to the ordinary general meeting of the shareholders to be held at the offices of the Company, Carnaby-street Central Station, Golden-square, W., on Tuesday, Feb. 13, at 12.30 p.m.:

The Carnaby-street and Mason's-yard stations have been working satisfactorily throughout the year, and have proved fully adequate to meet the largely-increased demand for current. The Bill mentioned in the report for 1898, authorising the Company to acquire by compulsory purchase certain property adjacent to the Carnaby-street station, has received the Royal assent; the property has been acquired, and the extension of the station is in progress. The Bill promoted by this Company in conjunction with the Westminster Electric Supply Corporation, Limited, under the title of the Central Electric Supply Company, Limited, authorising the establishment of a station on certain property to be acquired in the parish of St. Marylebone, has also received the Royal assent, and steps are being taken to give effect to its provisions. The 100 founders' shares of £1 each, which formed part of the original capital of the Company, have been cancelled, and their nominal value has been carried to capital reserve account. Eight thousand and twenty ordinary shares, the balance of the new capital created in February, 1898, and January, 1899, were offered to the shareholders, *pro ratâ*, in October last at a price of £12. 10s. per share, and have all been issued. The premium on calls payable up to Dec. 31, 1899, amounting (less expenses) to £36,923. 0s. 11d., has been carried to capital reserve fund. On the other hand, the premium of 5 per cent. paid on the redemption of the debenture stock, amounting to £2,500, has been charged to this account. The net earnings of the Company for the year 1899 were £31,834. 9s. 10d, which, after payment of interim dividends of 7 per cent. on preference shares and 10 per cent. on ordinary shares, left an amount now to be dealt with of £20,428. 8s. 11d. The directors propose to divide this amount as follows: (*a*) by payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year, £3,500; (*b*) by payment of a dividend on the ordinary shares for the second half-year of 7s. 6d. per share, and a bonus of 2s. per share, making, with the interim dividend paid on Aug. 1 last, a total distribution of 14½ per cent. for the year, £15,190. 10s.; (*c*) amount to be carried forward, £1,737. 18s. 11d.—total, £20,428. 8s. 11d. The chairman, Mr. Eustace J. A. Balfour, and Sir John H. Morris, K.C.S.I., are the directors who retire by rotation under Clause 79 of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and, being eligible, offer themselves for re-election.

Revenue Account, Year ending Dec. 31, 1899.

Dr. Generation and Distribution of Electricity.	£	s.	d.	£	s.	d.
Coal, including dues, carriage, etc.	£9,545	2	10			
Oil, waste, water, engine-room stores	1,151	13	6			
Salaries of engineers and officers	1,982	16	0			
Wages at generating and distributing stations	4,146	8	2			
Repairs and maintenance: buildings (including alterations), £771. 11s. 10d.; engines and boilers, £1,426. 3s. 7d.; dynamos, £64. 4s. 1d.; other machinery, instruments, and tools, £747. 2s. 4d.; accumulators, £81. 6s. 4d.; lamps (at stations), £78. 8s. 3d.	3,168	16	5			
Attending and repairing lamps	393	17	8			
Repairs and maintenance of mains	2,951	1	11			
Miscellaneous expenses	142	8	10			
				23,482	5	4
Rents, Rates, and Taxes.						
Rents payable	198	9	0			
Rates and taxes	2,829	1	4			
				3,027	10	4
Management Expenses.						
Directors' remuneration	2,500	0	0			
Salaries of manager and secretary, engineer, clerks, canvasser, etc.	4,079	19	5			
Stationery, printing, and advertising	217	12	9			
General establishment charges	362	19	8			
Auditors of Company	78	15	0			
				7,239	6	10
Law expenses				161	19	11
Special Charges.						
Insurance	670	19	0			
Fees for testing meters	7	19	10			
Board of Trade audit	65	0	0			
				743	18	10
Depreciation.						
Depreciation on buildings	529	19	8			
Depreciation on plant, machinery, etc.	11,721	2	4			
				12,251	2	0
				46,906	3	3
Net loss on sales of old materials, stores, etc.				73	7	3
Balance carried to net revenue account				31,347	1	11
				£78,326	12	5

Cr.	£	s.	d.
Sale of current, after deducting provision for bad and doubtful debts (at 6d. per unit less rebates).	73,382	12	5
Ditto under contract	515	12	10
Public lighting	1,827	10	0
	75,725	15	3
Rental of meters on consumers' premises	2 016	1	8
Rents receivable	248	3	8
Transfer fees	49	5	0
Discounts on purchases	101	9	7
Sale of old materials, stores, etc.	42	19	2
Sundry fees, shareholders' lists, sold, etc.	14	9	6
Sale of steam	128	8	7
	£78,326	12	5

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Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount received	283,935	0	0
Capital reserve fund	49,523	0	11
Lloyds' Bank, Limited, temporary loan	20,000	0	0
Shareholders for call due Jan. 1, 1900, paid in advance	8,150	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	7,747	0	6
Sundry creditors on open accounts	4,382	6	8
Unclaimed dividends	45	10	2
Balance at credit of net revenue account, £31,923. 8s. 11d.; less interim dividends paid on preference and ordinary shares, £11,495	20,428	8	11
	£394,211	7	2

Cr.	£	s.	d.
Capital account—amount expended for works, less depreciation to date	317,282	19	11
Central Electric Supply Company, Limited—expenditure on freehold site, etc.	26,946	6	5
Stores on hand: coal, £1,095. 2s. 6d.; lamps, £29. 18s. 11d.; meters and switches, £1,558. 10s. 8d.; general, including oil, waste, etc., £1,262. 2s. 6d.	3,945	14	7
Sundry debtors for current supplied, £19,445. 15s. 8d.; other debtors, £2,763. 16s. 10d.	22,209	12	6
Cash at bankers and in hand	8,826	13	9
Investments on account of capital reserve fund, cost of Canada 3 per cent., Cape 3½ per cent., and India 3 per cent. stock	15,000	0	0
	£394,211	7	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Board of Trade units generated			4,686,192
Quantity utilised	Private supply	4,063,274	4,269,902
	Public lighting	137,830	
	Used on works	68,798	
Quantity expended in distribution			416 290
Number of lamps on circuit			164,750

CITY AND SOUTH LONDON RAILWAY.

The ordinary general meeting of the City and South London Railway Company was held on Feb. 5 at Winchester House.

Mr. C. G. Mott, who presided, moved the adoption of the report (published in our last issue), and referred to the increase of capital required for the extension of the line from Moorgate-street to Islington in the north and to London Bridge in the south, and from Stockwell to Clapham. The Moorgate-street line would probably be opened in the next fortnight, and it was hoped that the Clapham extension would be ready in three months' time. Some delay had been caused through the difficulties placed in their way by the London County Council.

Mr. E. Tate seconded the motion, which was adopted.

BRISTOL TRAMWAYS AND CARRIAGE.

At a meeting of the directors held on the 31st ult. it was resolved to recommend a dividend at the rate of 8 per cent. per annum for the past half-year, and the reserve funds are increased from £80,832 to £90,314. The dividend at the corresponding period was 7 per cent. per annum. The number of passengers (excluding postal riders) carried during the year on the company's cars and omnibuses was 25,330,806.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Newington.—The Vestry invite tenders for two water-tube boilers, etc., for the electric light station. Tenders by 20th inst.

Birkenhead.—The Corporation invite tenders for the supply and laying of feeder and distribution mains. Tenders by March 1.

Islington.—The Vestry invite tenders for supply of electrical and engineers' stores for one year from March 15. Tenders by Feb. 22.

Hammersmith.—The Vestry invite tenders for the supply of electrical stores. Tenders by Feb. 14. Particulars in our advertisement columns.

Salford.—The Electric Light Committee invite tenders for supplying and fixing iron and steel work required at the electricity station. Tenders by 12th inst.

Newcastle-upon-Tyne.—The New Tramways Committee of the Corporation invite tenders for copper bonds. Tenders by Feb. 22. Details in our advertising columns.

Rochdale.—The Corporation invite tenders for the supply and delivery of electricity meters. Tenders by 28th inst. Full particulars in our advertising columns.

Chingford.—The Walthamstow Urban District Council invite tenders for the supply and erection of electric and Dowson gas plant at their isolation hospital. Tenders by Feb. 17.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for 130 car bodies, trucks, and electric equipment. Tenders by March 2. Details in our advertising columns.

Aberdeen.—The Tramways Committee invite tenders for the supply of four electrically-equipped tramcars and other material. Tenders by Feb. 28. Details in our advertisement columns.

Stoke-upon-Trent.—The Guardians invite tenders for the proposed electric lighting of a portion of the workhouse premises. Tenders by Feb. 15. Full particulars in our advertisement columns.

York.—The Corporation invite tenders for the conversion of the wiring of the Courts of Justice to suit the higher voltage of the supply mains. Tenders by Feb. 15. Details in our advertisement columns.

York.—The Corporation invite tenders for the conversion of the wiring of the public library to suit the higher voltage of the supply mains. Tenders by Feb. 15. Details in our advertisement columns.

Beetle.—The Corporation invite tenders for the supply and laying, within the borough, of certain underground electric cables. Tenders by Feb. 17. Details in our advertisement columns.

Bath.—The Corporation invite tenders for the supply, etc., of cables (high and low tension), arc lamps, posts, and accessories, transformers, sub-station switchboards, and main works switchboards. Tenders by Feb. 12.

Sunderland.—The Corporation invite tenders for the supply of steam, exhaust, feed, and other pipes, and two steam-driven induced-draught fans and accessories. Tenders by March 2 Details in our advertising columns.

Kingston-upon-Hull.—The Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked, to seat about 51 passengers). Tenders by Feb. 19. Details in our advertising columns.

Hastings.—The Corporation invite tenders for the supply and delivery of 12 20-kw. alternating-current transformers and high and low tension sub-station switch gear. Tenders by Feb. 12. Details in our advertisement columns.

Great Yarmouth.—The Corporation invite tenders for the supply and erection of two water-tube boilers (Section A); three 200-kw. continuous-current steam dynamos (B) Tenders by Feb. 15. Full particulars in our advertisement columns.

Glasgow.—The Corporation invite offers for the supply of 200-300 motorcar trucks; 200-300 motors and equipments; the supply, delivery, and erection complete of the overhead trolley. Tenders by Feb. 17. Details in our advertisement columns.

Sydney.—Tenders are invited by the Public Works Department for the erection of electricity works, engines, dynamos, cables, and telephone apparatus. Tenders are to be addressed to the Chief Engineer, Road, Bridges, and Sewerage Branch, by March 20.

Hull.—The Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked, to seat about 51 passengers). Specifications, etc. (£1), may be obtained of Mr. A. E. White, city engineer, Town Hall, Hull. Tenders by Feb. 19.

Keighley.—The Corporation invite tenders for the supply and erection of two Lancashire boilers, with mechanical stokers, economisers, feed pumps, etc.; and 120-kw. and 200-kw. high-speed direct coupled steam dynamos for continuous current. Tenders by Feb. 13. Full particulars in our advertisement columns.

Keighley.—The Corporation invite tenders for the supply and erection of switchboard and balancer, 10-ton overhead travelling crane, storage battery, mains, conduits, arc lamps and posts, ejector condensers, exhaust pipes and tanks, and main, steam, and feed-water pipes. Tenders by March 1. Details in our advertising columns.

Salford.—The Corporation invite tenders for the supply and delivery and erection of electrically-driven mechanical stokers, economisers and fittings, jet condensers and pumps, with steam, exhaust, and water pipes, electrically-driven feed pumps and feed pipes, and travelling crane. Tenders by 28th inst. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of tramways switchboard. Specifications and forms of tender can be obtained of Mr. J. F. C. Snell, borough electrical engineer, at his office, Dunning-street, Sunderland, on payment of two guineas. Tenders to Mr. Fras. M. Bowey, town clerk, by 12 noon on 26th inst. Details in advertisement columns.

Middleton (Lancs.).—The Corporation invite tenders for the building of electricity works, in accordance with plans and specifications prepared by Messrs. Lacey, Clirehugh, and Sillar, electrical engineers to the Corporation, 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester. Plans, etc., may be obtained from Mr. Frederick Entwistle, town clerk, Town Hall, Middleton. Tenders by Feb. 14.

Horsham.—The Urban District Council invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, &c., pipework, etc., in engine and boiler house, two steam dynamos (vertical enclosed high-speed engines), and motor boosters, storage batteries, main switchboard and connections, six-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed type) and posts, station lighting. Tenders by March 1. Full particulars in our advertising columns.

Melbourne (Victoria).—The Corporation invite tenders for the supply and delivery of the necessary plant, and the superintendence of its erection, and of the carrying out of the work in

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connection with the electric lighting of the city, to specifications as follows: (1) boilers (dry-back or water-tube type, with superheaters) and economiser; (2) steam-engines, dynamos, equaliser booster, and switchboard; (3) feeders, mains, and arc light leads, with all bitumen or insulating material; (4) accumulators. Specifications, etc., can be obtained from the Agent-General for Victoria, 15, Victoria-street, Westminster, London, S.W., on and after the 28th instant, on payment of £1. 1s. for each specification, to be returned on receipt by the Corporation of a bona fide tender. The specifications and drawings may be seen at (but not obtained from) the office of Dr. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders by March 1. Full particulars appear in our advertising columns.

RESULTS OF TENDERS.

Manchester. — The Electricity Committee recommend the acceptance of the tender of Messrs. Ferranti, Limited, for two 1,000-h.p. generating sets.

Lancaster.—The Council have accepted the tender of Messrs. Meldrum Bros. for the construction of a refuse destructor, amounting to a little over £5,000.

St. Helens.—The Electric Supply and Tramways Committee have accepted tenders for a 500-h.p. engine and dynamo and a 1,000-h.p. condensing plant.

Hull.—The Corporation have accepted the tender of the Electric Railway and Tramway Carriage Works Company, Limited, for converting five tramway trailers into motorcars at £300 each.

Wigan.—The Electric Light and Tramway Committee have accepted the tender of Mr. W. H. Baker, Wigan, for 500 boxes, and that of Messrs. Babcock and Wilcox for mechanical stokers.

St. Annes-on-the-Sea. — The Urban District Council have accepted the following tenders: British Insulated Wire Company, Prescot, mains; Crompton and Co., Chelmsford, street arc lighting.

Southampton.—The Town Council have received the following tenders for lighting the tramway depot at Shirley by electricity: F. Shalders, £267. 3s. 5d.; Macartney, McElroy, and Co., £225. 10s. (accepted).

Bradford.—The Tramways Committee have recommended the acceptance of the tender of Macartney, McElroy, and Co., Limited, for the complete electrical overhead equipment of the Lister Hills, Stanningley, Whetley Hill, and Thornton tramway sections for £12,064. 15s. 2d.

Shoreditch.—The Vestry have received the following tenders:

W. T. Henley's Telegraph Works Company, Limited (accepted)	£899	6	1
W. T. Glover and Co., Limited	922	19	0
British Insulated Wire Company, Limited	924	6	7

Harrogate.—The Town Council have accepted the following tenders for the extension to the electric lighting station: masons' work, C. Myers and Sons, Leeds, £1,535; ironwork, executors of O. Atkinson, £573; joiners' work, G. H. Carrick, £149; slaters' work, Thomas Rayner, £34. 12s.; painters' work, G. A. Terry, £17. 17s.

Hull.—The Council have received the following tenders for a new dynamo of 2,000 volts: Earle's Shipbuilding Company, Limited, £3 725 (accepted); Thomas Parker, Limited, Wolverhampton, £5,035; Electric Construction Company, Limited, Wolverhampton, £5,275; and Crompton and Co., Limited, Chelmsford, £6,313.

Barking. — The following tenders have been received by the Council for boilers, engines, cars, switchboard equipment, etc., for the Barking and Becton light railways: (Section A) water-tube boilers with fittings, economiser, feed pump, etc., Messrs. Babcock and Wilcox, £1,704; (B) pipe work, etc., in engine and boiler house, Messrs. Babcock and Wilcox, £506; (C) two 100-kw. steam dynamos (vertical enclosed high-speed engines), Thames Ironworks Company (Allen), £2,094; (D) main switchboard and connections, General Electric Company, Limited, £506. 10s. The Council have deferred the consideration of the tenders for Sections E, F, and G of the plant until the tenders for the opening bridge and embankments are under consideration.

Tunbridge Wells.—The Council have received the following tenders:

400-kw. steam alternator.

Electric Construction Company (E.C.C. and Willans)	£4 615
Ferranti (Ferranti and Willans)	4,677
Ferranti (Ferranti and Ferranti)	4,820
F. Suter (Willans)	4,827
General Electric Company (Oerlikon and Willans)	4 834
Crompton and Co. (Crompton and Willans)	4,896
Brush Company (Raworth and Brush)	5,310
Parsons (turbo-alternator)	4,375

Condensing plant.

W. H. Allen and Co.	4,505
W. H. Allen and Co. (if with centrifugal pump)	3,855
Wheeler Condensing Company	4.471
Klein Engineering Company	4,621
Worthington and Co.	4,975
Worthington and Co. (their own pump)	4,647
Worthington and Co. (on the baths scheme)	4.167

Two Lancashire boilers.

Tinkers, Limited	3,060
E. Danks	3,070
Yates and Thom	3,296
Musgrave and Sons	3,413

Wrexham.—The following tenders have been received and referred to Mr. Trentham for report for alterations to buildings for electricity supply works purposes: James Hughes, Wrexham, £1,344. 13s.; Davies Bros., Wrexham, £1,112; Hughes and Stirling, Liverpool, £1,055 (recommended for acceptance). Destructor: James Baker and Sons, Manchester; the Horsfall Destructor Company, Limited, Leeds and London; Meldrum Bros., Manchester; Heenan and Froude, Manchester; Hughes and Stirling, Liverpool; Manlove, Alliott, and Co., Limited, Nottingham; William Harris and Son, Shrewsbury (prices ranging from £1,941 to £1,250).

Felsted School.—The contract for the whole work has been placed with Messrs. Reavell and Co., of Ipswich, for £2,994. This price includes Crompton electrical machinery, Babcock boiler, Western Electric cables, and Chloride accumulators. The following tenders were received:

Section 1.—Boiler, two 27-kw. steam dynamos, condenser, and pipework, etc.

Reavell and Co. (accepted)	£2,318	10	0
Rooper and Robins	2.434	6	0
Johnson and Phillips	2,740	0	0
Ernest Scott and Mountain	2 767	0	0
Crompton and Co.	2,837	0	0
G. Wailes	2 922	17	6
Allen, Son, and Co.	2,982	0	0
Clark and Aiton	2,991	0	0
Brush Electrical Engineering Company, Limited	3,067	10	0
Christy Bros.	3,101	16	0
Foote and Milne	3 102	0	0
Foote and Milne (alternative)	2 870	0	0
C. A. Parsons	3,159	0	0
T. Metcalfe	3,335	0	0
Electrical Construction Company	3,341	0	0
F. Nell	3,697	0	0

Section 2.—Accumulators.

W. J. Fryer and Co., Limited (P. and G. cells)*	415	0	0
W. J. Fryer and Co., Limited (extra for Chloride)	66	0	0
Pritchett and Gold	422	0	0
Hart Accumulator Company, Limited	425	0	0
Chloride Electrical Syndicate, Limited	483	0	0
W. G. Horne and Co.	530	18	0
Tudor Accumulator Company	546	0	0
Christy Bros.	549	6	0
Electrical Power Storage Company	551	17	6
Foote and Milne	580	0	0
Rooper and Robins	584	0	0
Ashmore, Benson, Pease and Co.	587	0	0
Gudgeon and Co.	760	0	0
Cassells and Co.	789	0	0

Section 3.—Cables.

Fryer and Co., Limited*	354	18	11
British Insulated Wire Company, Limited	468	17	0
Foote and Milne	482	10	0
Christy Bros.	600	7	8
Western Electric Company	690	0	0
Gudgeon and Co.	782	3	9
Johnson and Phillips	790	0	0
Glover and Co., Limited	845	0	5

Section 4.—Switchboard.

Gudgeon and Co.	98	15	0
Fryer and Co., Limited*	110	0	0
Middleton and Co.	126	0	0
General Electric Company	126	0	0
Electric Transmission Company	130	0	0
Rooper and Robins	135	0	0
Christy Bros.	158	0	0
Scott, Anderson, and Co.	160	0	0
Foote and Milne	175	0	0
Crompton and Co., Limited	181	0	0
R. D. Cassells and Co.	197	8	0
Edison and Swan, Limited	250	0	0
Electric Construction Company	250	0	0

* Accepted as sub-contractors to Reavell and Co., Limited.

BUSINESS NOTES.

TRACTION.

Wardle.—The District Council have adopted a petition against the Rochdale Tramways Bill.

Hathern.—The Parish Council have agreed to the Loughborough and district light railway proposal.

Little Hulton.—The District Council have finally consented to the South Lancashire Tramways Bill.

Bramhall.—The Parish Council intend to petition against the Stockport Corporation Tramways Bill.

Leeds.—A double tramway line along Cardigan-road has been suggested to the Tramways Committee.

Lancashire.—The County Council have resolved to oppose the Southport Extension and Tramways Bill.

Newton-in-Makerfield.—The Urban District Council have consented to the South Lancashire Tramway Bill.

Lytham.—An agreement is still pending between the Council and the Blackpool, St. Annes, and Lytham Tram Company.

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Wigan.—A committee is about to visit various towns to inspect bogies prior to recommending the type of car to be adopted.

Kidderminster.—The electric tramway company are pressing forward the proposal to construct a tramway from Kidderminster to Bewdley.

Deal.—A meeting has been arranged between the Deal and Walmer committees in order to discuss the proposed Cinque Ports light railway.

Musselburgh.—The Town Council have sealed their agreement with the promoters of the electric tramway between Musselburgh and Portobello.

Bromley.—On Thursday last week, a meeting of ratepayers decided to oppose the South-Eastern Metropolitan Tramways Company's Bill.

Welstanton.—The Rural District Council have decided to strongly urge the tramways company to commence running their cars to Goldenhill.

Burnley.—The minutes of the Tramway Committee, which provided for the proceeding with the Tramway Bill in Parliament, were confirmed on Wednesday.

Aberdeen.—The Corporation Tramways Committee have appointed a sub-committee to promote the new Tramways Bill in Parliament and prepare evidence.

Pwllheli.—The correspondence relating to the proposed light railway along the existing roads from Pwllheli to Nevin has been referred to the surveyor for report.

South Lancashire Tramways.—The Bill for the carrying out of a large electric tramway scheme to connect St. Helens and Bolton has passed the examiners of private Bills.

West Hartlepool.—The Town Council have decided to oppose the Bill of the County of Durham Electric Power Supply Company as regards the provisions affecting the Hartlepools.

Southampton.—The widening of the quay required by the tramways proposal is to be carried out at the joint expense (about £5,000) of the Corporation and of the Harbour Commissioners.

Hove.—A meeting of owners and ratepayers of the borough has expressed its consent to the resolution recently passed by the Town Council to oppose the Brighton Corporation Tramways Bill.

Bradford.—The Corporation are negotiating for the purchase of unexpired leases of 25 miles of tramways now held by two local companies. The Corporation already own six miles of electric tramways.

Beckenham.—The tramway extension scheme will not be proceeded with so far as it affects Beckenham, because the London County Council and the Lewisham Board of Works have refused their sanction.

Airdrie.—The Town Council have approved of the Bill to incorporate the Airdrie and Coatbridge Tramways Company, and to empower that company to make and maintain tramways, and for other purposes.

Cleator Moor.—The proposal to apply for a provisional order to make an electric tramway between Cleator Moor, Whitehaven, and Workington has been referred to the Works Committee by the Urban District Council.

Wallasey.—The Local Government Board have refused to sanction the loan of £18,500 for the purpose of electric traction until the result of the appeal of the Wallasey Tramways Company at the House of Lords is known.

Cornwall.—The County Council have consented to the application of the Urban Electric Supply Company to the Board of Trade for a provisional order to authorise them to construct a tramway between Camborne and Redruth.

Grimsby.—The Town Council have decided to oppose the Grimsby Street Tramways Bill in Parliament this session, the cost to be defrayed from corporate funds. A public meeting of ratepayers has endorsed the Council's action.

Hensingham.—The Parish Council have passed a resolution approving of the scheme of the English Industrials Company to lay an electric tramway on the overhead wire system between Cleator Moor and Distington by Hensingham and Whitehaven.

Nuneaton.—The Light Railway Commissioners have approved of an application for an order to authorise a light railway running from the stations of the London and North-Western and the Midland Railway Companies through the town of Nuneaton to the parish of Ansley.

Folkestone.—The borough surveyor has prepared plans showing the routes of the tramways as suggested by the committee. The cost is roughly estimated at £40,000 for construction alone. After further discussion the report was referred back for a proper estimate to be produced.

Wednesbury.—A report of the Board of Trade on the electrically-equipped portion of the South Staffordshire tramways has been received by the General Purposes Committee, and is of a satisfactory nature. The use of electrical traction is renewed for a further period of four years.

Cork.—At an adjourned quarterly meeting of the County Council last week the application of the Cork Electric Tramways and Lighting Company for the consent of the County Council to the proposed extension of their tramways from Ballintemple to Blackrock was again discussed.

Stirling.—At a recent special meeting of the Police Commission, held to consider the Stirling and Bridge of Allan tramways, it was remitted back to a committee to ascertain whether the tramway company would consent to an extension of the Commission's right of pre-emption till February, 1902.

Greenock.—The Police Board Law and Finance Committee on Monday appointed a sub-committee to consider the offers now submitted, with power to confer with the offerers, if so advised, and to take such advice as they may think fit and to report.

Leicester.—The County Council have decided in connection with the proposed construction of a light electric railway or tramway in Loughborough, and to Hathern, Quorndon, and Mountsorrel, that the project should be unopposed as regards Loughborough, and to oppose the parts referring to the rural districts.

Baker street and Waterloo Railway Co.—A special general meeting of the proprietors in this Company will be held at 4.15 o'clock on the 15th inst. at 43, Lothbury, E.C., for the purpose of considering and, if thought fit, of approving the Bill to confer further powers upon the Baker-street and Waterloo Railway Company.

Barnsley.—The Town Council on Tuesday approved an agreement with the British Electric Traction Company, and decided to withdraw their application for powers to construct and work electric tramways. The company agree to construct tramways within three years, and after 12 months' working the Corporation are to have the option of purchasing the lines.

Salford.—The Town Council on Wednesday decided that the Electric Light Committee fix and maintain all plant up to the point of contact of the trolley wheel and overhead wires required to work the tramways, and charge the capital cost and maintenance thereof to the Tramways Committee, and charge for electric current separate from any cost or maintenance or other expenses whatever. A petition in opposition to the Lancashire Electric Power Bill, 1900, was sealed.

Loughborough.—The Town Council have adopted a lengthy report on the local light railways scheme submitted by the Parliamentary Committee. The committee recommended the Council to make some contribution towards any street widening which they considered to be a public improvement, and advised that the scheme should be supported. The Council have authorised the committee to take such steps and to incur such expense in regard to the application as in their opinion should be necessary or advisable.

Liverpool Overhead Railway Co.—A special general meeting of this Company is announced for the 14th inst., at which the following resolution will be submitted—viz.: "That £50,000, being the whole of the share capital authorised to be created by the Liverpool Overhead Railway Act, 1899, be and the same is hereby created in 5,000 ordinary shares of £10 each, and that the directors be and they are hereby authorised to issue the same in such amounts and manner, at such times, and on such terms, as they may think fit."

Blackburn.—The *Yorkshire Post* says that at an early date the Lancashire and Yorkshire Railway Company will be approached with respect to a proposal for the construction of a light railway from Greetland to Barkisland. The District Councils of Greetland, Stainland, Barkisland, Soyland, and Upper Greetland are appointing a deputation to wait upon the railway company. Should such a line be constructed, it is anticipated that it would do much to develop the Blackburn Valley, a beautiful country district much frequented by naturalists.

Trawden.—In reference to the proposed clause conferring powers on the Colne Corporation to generate the electricity, the Trawden Council have asked the Light Railway Commissioners to allow the Colne Corporation to have that power, but only to be exercised with the consent of the Trawden Council. If the Commissioners could not consent to such an arrangement, they asked for a clause within their area giving them the same powers as was now asked for by the Corporation of Colne. The Light Railway Commissioners have replied that the matter would receive consideration.

Peterborough.—An enquiry was held on Friday by the Light Railway Commissioners in view of an application made by the British Electric Traction Company, Limited, for an order authorising the establishment of an electric tramway system in Peterborough and immediate districts. The Commissioners said the case of the Great Eastern Railway crossing being similar to that at Doncaster, they could not sanction the company's line at Peterborough being carried over the Great Eastern Railway crossing. They were prepared to sanction the northern scheme down to Bridge-street.

Hampton.—With regard to the District Council's action in regard to the tramways, we learn that the Council in committee received the representatives of the company last week, and that the latter agreed to contribute £500 towards a new footbridge across the water of Pantile Bridge, £300 to erect a wall and fence from The Cedars down to the Park gate, and £200 for setting back the wall at Dr. Tyndale's. They declined to entertain the widening of High-street, Hampton Hill, or to assent to the proposal for the purchase of the tramways 21 years hence, unless the same privilege was accorded to other neighbouring authorities.

London United Tramways.—In compliance with the Standing Orders of Parliament a declaration has been deposited on behalf of the London United Tramways Company showing the manner in which the £337,000 will be provided for the construction of the extensions which are proposed to be constructed under the powers contained in their Bill of this session. The declaration is as follows: "The works proposed to be authorised by the Bill are to be made wholly by means of funds of the Company under the control of the directors, which funds consist of the uncalled capital, or out of money to be raised upon the credit of present surplus revenue."

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Birkdale.—The District Council have resolved to oppose the Southport Extension and Tramway Bill now being promoted by the Southport Council. They also resolved to give notice of their intention to purchase so much of the Southport and Birkdale Tramways Company's lines as lie within the district of Birkdale. The District Council have decided to transfer the duties, liabilities, and works under the Birkdale electric lighting order to the British Electric Traction Company. The work in connection with the laying of the tramways and fixing of the posts is proceeding rapidly. The committee have appointed Mr. Charles Minns as resident engineer.

Marsden.—At the last meeting of the Urban District Council the Clerk read correspondence relative to a question between the Linthwaite District Council and the Huddersfield Corporation in reference to the construction of tramways, which had been forwarded to the Marsden Council because they were interested in the scheme, inasmuch as they desire an extension of the tramways from the Linthwaite boundary to Marsden village. A resolution was adopted regretting that Linthwaite had withheld its consent to the promotion of the Huddersfield Tramways Bill, and urging Huddersfield Corporation to acquire the co-operation of the Linthwaite Council or proceed with the Bill notwithstanding the opposition of the Linthwaite Council.

Arbroath.—The promoters of the proposed tramway between Dundee and Carnoustie have applied to Parliament for powers to construct a double line of tramways between Dundee, Broughty Ferry, Monifieth, and Carnoustie, a distance of 12 miles, and to acquire land for the purpose. The Dundee and Arbroath District Committees formally entered their dissent in order to keep the matter open, and a sub-committee was appointed by the Arbroath District Committee to act along with the Dundee District Committee, Barry Parish Council, and Carnoustie. An agreement has now been drawn up which will safeguard the rights and properties of all parties, and the Dundee and Arbroath District Committee have therefore agreed to withdraw their dissent from the construction of the proposed tramway.

Eccles.—At a recent conference between representatives of the two authorities Salford suggested that the Eccles Corporation should obtain powers to enable them to construct the lines proposed by the South Lancashire Tramways Bill, and lease the same to Salford, when Salford would be prepared to take the lease for at least 21 years, and to take electrical energy from Eccles. The Eccles Council have decided to support the Salford Corporation in their action, and to arrange for a continuous passenger service between the Corporations' boundaries at Peel Green, Patricroft, and Manchester. With the view of obtaining protective clauses in the interests of the borough, the Council will oppose the South Lancashire Tramways Bill, the Manchester and Liverpool Electric Express Railway Bill (which will interfere with the Eccles sewage farm at Peel Green), and the Lancashire Electric Power Bill.

Pembroke.—A settlement has been arrived at in relation to the question of the laying by the Dublin United Tramways Company of conduits for their electric wires within the township, which had been the subject of a suit before the Master of the Rolls, who had granted an interlocutory injunction prohibiting the laying of the conduits outside the tramway company's paved parts of the road. The agreement provides that the injunction should be made perpetual; that the conduits already so laid should be taken up if found to interfere with the works of the Council, the question as to whether they did or not to be submitted to arbitration; and all the costs to be paid by the tramways company. The tramway company offer to widen the Ball's Bridge at a cost of £2,500, or to hand over £3,000 to the Pembroke Commissioners if they will do the work and free the tramway company from any further trouble about it.

Hull.—Alderman Larard's announcement at the Musical Union on Saturday that the electric cars on two out of the six main roads in Hull are in the first year going to save the ratepayers 3d. in the pound was music to the members, says the *Hull Daily Mail*. He said he hoped that when the present works were completed the people of Hull would show sufficient enterprise and go into fresh fields. He was now anxious to tackle a scheme for running the electric tramcars from Hull to Hessle, from Hull to Hedon, and from Hull to Cottingham. In view of the financial success of the Hessle and Anlaby roads sections, Alderman Larard's task—the conversion of the Corporation and the citizens to his views—does not appear to be a difficult one. There is still another point in connection with the tramways, and the transformation of the city now in progress, which seems not far off—the lighting of the main roads by means of arc lamps attached to the poles used for the electric tram current.

Birmingham.—At the last meeting of the City Council, Sir James Smith, in moving that certain Bills promoted by the Great Western Railway Company and the Aston Urban District Council be referred to the Public Works Committee, said that it was necessary for the Aston District Council to obtain a Tramway Bill in order to carry out what had been already reported to the City Council. As the new lines proposed were all within the Aston district, the Public Works Committee saw no objection to the Bill. The Aston authority had to purchase from the tramway company two years before the Corporation lease expired, and Birmingham would know what Aston was going to do before the Birmingham Bill was framed. As soon as possible the Public Works Committee would submit recommendations to the Council, but they had still plenty of time for their Bill to give the Corporation power to work the tramways in the city. They proposed to give notice of the Bill in November, 1901, and hoped to get it passed in 1902. The lease of the Aston line did not expire until December, 1903. The motion was carried.

Liverpool.—At the last meeting of the Tramway Committee of the Corporation, Mr. Bellamy, the general manager, reported that it was proposed to run the Aintree and Walton cars in conjunction with those of the Dingle and Aigburth routes forming a through service between Aintree, Fazakerley, and Aigburth-vale. The report was approved, and six 1d. stages were fixed. The Town Council have approved of the laying of rails in Derby-road and Rimrose-road at an estimated cost of £6,500, the relaying of existing setts within tramway limits in Rimrose-road, and the repairing of Derby-road within the same limits, including such new setts as may be required, at an estimated cost of £8 209; also that the work be carried out at such time as the committee might consider desirable, having regard to the time when the Corporation of Liverpool would be prepared to run the electric car service on the adjoining city lines. Application is to be made for sanction to the necessary loan to cover the expenditure. The carriageway of Derby-road, outside tramway limits, is to be repaired, new material being used where necessary, at an estimated cost of £5,206.

Eccles.—The Council (in committee) have passed several resolutions upon the town clerk's report upon local Bills in the present session, among other matters deciding that the Mayor and Messrs. Aldermen Mellor and Parr be appointed representatives of the Council to deal with any matters in connection with the Manchester and Liverpool Electric Express Railway, and that the matter of the South Lancashire tramway scheme be left in the hands of the Mayor and Alderman Mellor. The town clerk has been instructed to prepare the necessary petitions against the Manchester and Liverpool Electric Express Railway and the South Lancashire Tramways Bill respectively, and to take all necessary steps to obtain the insertion thereof of protective clauses on behalf of this borough. The promoters of the South Lancashire Tramways Bill have undertaken to construct a tramway along Parrin-lane Monton-road, Clifton-road, and Wellington-road, to Eccles Station when required by the Corporation. A special sub-committee has been appointed to negotiate with the Salford Corporation in relation to these tramways, and also to consider necessary arrangements in view of adapting the present tramways for purposes of electric traction.

Private Bills.—On Tuesday the Earl of Morley, chairman of committees in the House of Lords, and Mr. J. W Lowther, chairman of committees in the House of Commons, met in conference with the senior officials to decide in which House the private Bills should originate this session. They afterwards received the parliamentary agents in one of the committee-rooms of the House of Lords, and it was announced that the following local Bills would be brought in in the Upper House: Barnsley Corporation, Dearne Valley Railway, Great Central Railway, Morley Corporation, Otley Urban District Council, Burnley Corporation, Liverpool Overhead Railway, Manchester Corporation Tramways, Mersey Railway, Salford Corporation, Wirrall Railway, and the Withington Urban District Council. Among those which will originate in the Commons are the Blackpool, St. Annes, and Lytham Tramways Bill, Lancashire and Yorkshire Railway Lancashire Electric Power, London and North-Western Railway, Manchester City Railway, Manchester and Liverpool Electric Express Railway, Oldham Corporation, Rochdale Corporation, South Lancashire Tramways, Stockport Corporation Tramways, and the Widnes and Runcorn Bridge Bill.

Lancashire.—The Main Roads and Bridges Committee have presented to the County Council an exhaustive report upon tramways and light railways, which they conclude with a recommendation that in case agreements for the protection of the County Council cannot be made with the promoters of the different undertakings, the Council should petition for protective clauses against the following Bills in Parliament: Southport Extension and Tramways, Preston Corporation Tramways, Lancaster Corporation Tramways, Burnley Corporation Tramways, Rochdale Corporation Tramways, Withington Urban District Council Tramways, South Lancashire Tramways, Manchester Corporation Tramways, Knott End Railway, Manchester and Liverpool Electric Express Railway, Lancashire Electric Power Bill; and also take the necessary steps to obtain the insertion of clauses for the protection in the following provisional orders: Ashton-under-Lyne Corporation Tramways, Whitefield Urban District Council Tramways, Radcliffe Urban District Council Tramways, Garston Tramways Company, Warrington Corporation Tramways, Kearsley Urban District Council Tramways, Prestwich Urban District Council Tramways; and that the Council should, if necessary, present a petition against any Bill confirming any such order.

Bournemouth.—At the last meeting of the Town Council notices of objection from (1) the Poole and District Electric Traction Company, Limited. (2) the South-Western Railway Company, (3) the Bournemouth, Boscombe, and Westbourne Omnibus Company, Limited, to the proposed Corporation tramways were referred to the town clerk, who was instructed to lodge answers to the objections, and to ask that the local enquiry (if any) may be held at as early a date as possible. With regard to the Poole and District Tramways Bill the town clerk and borough surveyor were instructed to take all steps necessary to oppose this Bill. The Town Clerk read a letter from the Poole and District Electric Traction Company, Limited, suggesting as a basis of arrangement between them and the Town Council that the company would be prepared to drop such parts of their scheme as lay within the borough, the Corporation to provide tramway lines within the borough, and lease them to the company for 21 years, with the option of renewal for another seven years; the Corporation tramlines to be joined to those of the company on the Poole-to-County Gates system, and the company's proposed lines on the east, so as to provide a service from Christchurch to Poole. The company

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would be prepared to pay the Corporation an annual sum during the period of the lease equal to the interest on the sinking fund and of costs of the tramways and the costs of the Corporation in obtaining their provisional order. The matter was referred to the General Purposes Committee.

Blackburn.—The following reports have been submitted to the Council:—Audley tramways: At a meeting of the Electricity and Tramways Committee a report was read from the tramways manager in reference to the construction of the Audley tramway (*a*) from Copy Nook to Queen's Park, (*b*) from Mill-lane to Accrington-road (Fountain Inn), with estimate of cost and estimated receipts, and recommending that the tramway should be constructed from Mill-lane, along Audley, and then on to Queen's Park. It was resolved that the tramway be constructed from Mill-lane to Queen's Park, as recommended by the tramway manager, and that the necessary plans and estimates be prepared so that tenders may be obtained for carrying out the work. Electric traction: At a meeting of the Electricity and Tramways Committee a report was considered of the electrical engineer on the tenders received for the overhead line equipment of the Church, Cemetery, and Darwen sections, together with samples of materials submitted. It was resolved that having regard to the amount of the tenders, and the quality of the samples submitted, a tender be not accepted, and that the electrical engineer carry out the work. Extensions of electrical works: the electrical engineer has submitted to the Electricity Committee an estimate of the borrowing powers required for the purchase of the No. 1 gasworks from the Gas Committee, as arranged, the erection of buildings, and extensions to generating plant, cables, and mains, as follows: lands (No. 1 gasworks), £30,374; buildings, £12,121; temporary walls, £375; chimney, £2 175; machinery, £115,045; mains, feeders, and distributors, £48,783; services, £4,200; meters and indicators, £4,000; conversion to 220 volts, £3,000—total, £220,073. It was decided that it be a recommendation to the Town Council to apply to the Local Government Board for their sanction to the borrowing of the sum of £220,000.

LIGHTING AND GENERAL.

Ludlow.—An electric light scheme is under consideration.

Crewe.—Satisfactory progress is being made with the laying down of the electric light plant.

Worthing.—Progress is being made with the plans and specifications of the electric lighting works.

Colne.—The Town Council on Wednesday decided to oppose the Lancashire Electric Power Bill, 1900.

Gateshead.—The Town Council will support the Bill promoted by the Tyneside Electric Power Company, Limited.

Warrington.—Sanction has been received for loans of £45,000 for electric lighting and £9,335 for a dust destructor.

West Hartlepool.—The extension of the electric mains along Mainsforth-terrace and to Foggy Furze has been agreed to.

Hull.—The installation of electric light instead of gas on the tram route is being urged on members of the City Council.

"English Illustrated Magazine."—The February number of this elegant and sprightly magazine is quite up to its usual excellent standard.

Radcliffe.—The District Council have sealed an agreement with the Earl of Wilton for the purchase of land in Dale-street for electric lighting purposes.

Blackpool Electricity Extension.—Colonel Luard held an enquiry on Tuesday into the Council's application to borrow £42,515 for purposes of electric lighting.

British Electric Transformer Manufacturing Co.—The directors have declared an interim dividend at the rate of 10 per cent. per annum for the six months ended Dec. 31.

Berwick.—The Town Council have entered into an agreement with the Urban Electric Supply Company, and thus consented to the application for a provisional order by the company.

Barry.—The Public Works Committee are objecting to an application made by the National Telephone Company for power to lay wires underground along the public roads of the town.

Dalkeith.—At a meeting last week a proposal to introduce electric light into the burgh was discussed. It was suggested to include the burghs of Bonnyrigg and Lasswade in the scheme.

Telegraph Construction and Maintenance Co.—The directors propose a dividend of 10 per cent. (£1. 4s. per share), in addition to the 5 per cent. already paid, making 15 per cent. for the year 1899.

Oswestry.—The Local Government Board have refused the application for sanction to borrow £18,000 for the purchase of the undertaking of the Oswestry Electric Light and Power Company, Limited.

Book Received. — We have received from the *American Electrician* Company, of New York, a copy of their new publication, entitled "American Telephone Practice," by Mr. Kempster B. Miller, M.E.

St. James's and Pall Mall Electric Light Co.—The share transfer books of this Company will be closed until the 21st inst. preparatory to the payment of dividends for the half-year ended Dec. 31, 1899.

Hendon.—At the last meeting of the Urban District Council Mr. Robert Hammond was appointed consulting engineer to carry out the Council's electric light scheme at the usual fee of 5 per cent. on the executed works.

Bristol.—The telephone trunk-line system has been extended to Chippenham and Swindon, and conversations by telephone may now be had with those towns between the hours of 8 a.m. and 9 p.m. on weekdays only.

Eastbourne.—The Council have voted £100 to the town clerk for his services in connection with the negotiations for and acquisition of the Eastbourne Electric Light Company's undertaking, which has now been taken over.

Removal.—Messrs. O'Gorman and Cozen-Hardy's address will be, after 12th inst., 82, Victoria-street, Westminster. The telephone number will remain unchanged (734, Westminster), and also the telegraphic address ("Cosmogony").

Bradford.—The Electricity Committee of the Corporation on Wednesday appointed Mr. R. A. Chattock, superintendent engineer, City of London Electric Lighting Company, in place of Mr. Gibbings, subject to the approval of the Council.

Grimsby.—The prevailing tightness of money has so far interfered with the successful floating of the electric lighting loan. It is proposed to issue further stock, probably at £97. 10s. The subject is now being dealt with by a special committee.

Orsett.—A canvass is being made to see whether there are sufficient consumers to take the electric light, and it is stated that in the event of their not being enough the Council might be influenced to change the site of the proposed destructor.

Grantham.—The Town Council have consented to the Urban Electric Supply Company's application for a provisional electric lighting order. Major-General Webber has been authorised by the Council to apply on their behalf for a telephone license.

London Gazette.—Notice is given of dissolution of partnership between Messrs. Mason, Wathes, and Brown, Birkdale Cycle and Engineering Works, and Messrs. MacBryan and Co. An adjudication order has been made *re* Fred King, 22, Windsor-road, Cardiff.

Halifax. — The Gasworks and Electricity Committee have resolved to give a bonus to the engineers and drivers at the electricity works on the total works and management cost when these are brought below 1·5d. per unit. The total cost per unit last year was 1·65.

Accident.—Last week a linesman in the employment of the National Telephone Company fell from the roof of a four-storey building at Glasgow. He was removed to the Royal Infirmary, where it was found that he had fractured his right thigh and sustained other serious injuries.

Leith.—The Public Loan Commissioners having been unable to advance the additional loan of £10,000 for electric lighting recently sanctioned, steps are being taken to obtain the amount from private parties. The salary of the electrical engineer, Mr. W. A. Bryson, has been increased by £100 per annum.

Appointments Vacant.—The Portsmouth Electric Lighting Committee invite applications for a third assistant engineer to take charge of a shift. The Tramways Committee of the Manchester Corporation invite applications for the position of assistant permanent-way engineer. Particulars of these and other vacancies appear in our advertisement columns. We remind our readers that the appointment of chief electrical assistant at Glasgow is open until the 24th inst.

Stock Exchange. — The Stock Exchange Committee have appointed Feb. 14 as a special settling day for the Chelsea Electricity Supply Company's further issue of £50,000 4½ per cent. debenture stock. The following securities are ordered to be quoted in the official list: Buenos Ayres and Belgrano Electric Tramways Company, Limited, further issue of £54,415 5 per cent. debenture stock; Chelsea Electricity Supply Company, Limited, further issue of £50,000 4½ per cent. debenture stock; Western Telegraph Company, Limited, further issue of 1,937 shares of £10 each fully paid, Nos. 205 994 to 207,930.

Leeds.—Additional electric mains for lighting purposes are to be laid in the Burmantofts district at a cost of £4,600. It has been decided to light the crypt of the town hall by electricity, and the city engineer has been requested to prepare the necessary specification. The Council have authorised the Lighting Committee to proceed with the development of the Britannia Mills site by the erection of buildings thereon, and the provision of machinery necessary for the supply of electric current on the two-phase system at 50 alternations, in accordance with the recommendation contained in the report of Messrs. Hopkinson and Talbot. The appointment of Mr. France, architect for the existing buildings, is recommended. It was stated that he would be willing to serve the Corporation upon the terms on which he acted for the House-to-House Electricity Company.

Hammersmith.—The Electricity and Lighting Committee have reported to the Vestry that they have obtained tenders for wiring the works extensions, but as the Vestry's engineer's estimate of £275 was well below the lowest tender, they recommended that he be entrusted with the carrying out of the work at this figure. The Vestry agreed. The Vestry have just decided to make another important extension in the street-lighting. The Electricity and Lighting Committee recommended that, as an experiment, the whole of The Grove be lighted by alternating-current arc lamps, at an estimated cost of £941, so that the effect might be judged before proceeding further with the street electric lighting. The recommendation was adopted. The following figures were given as showing the effect of the recent reduction in the price to consumers. The figures indicate the saving so far as the town hall is concerned: for the December quarter, 1898, 4,016 units cost £87. 19s. 8d.; for the December quarter, 1899, 4,230 units cost £69. 6s. 3d.—making a net saving of £18. 13s. 5d.

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Lancaster.—Mr. W. Alan Fraser, electrical engineer, a member of the Middlesex Yeomanry, who has volunteered for service in South Africa, has been granted leave of absence for an indefinite period and an allowance of one-quarter of his salary during his absence, £25 to be paid at once.

Bournemouth.—The Town Council have replied to the Association of Municipal Corporations that they desire to consider the question of the establishment of a municipal telephone service, and would be glad to send representatives to attend a conference of municipalities on the subject.

New Firm.—The electrical engineering business formerly carried on by Messrs. Calvert and Co., of Manchester, has been taken over by Mr. J. Collier, lately assistant engineer with Messrs. Lacey, Clirehugh, and Sillar, and is now being carried on under the style of John Collier and Co.

Annual Dinner.—The Leeds branch of the Postal Telegraph Clerks' Association held its thirteenth annual dinner on Saturday last at the Grand Restaurant, Boar-lane. Mr. R. Tuke occupied the chair. Visitors were present from London, Manchester, Huddersfield, Batley, and other towns.

Electric "Tested Lamp" Co.—We are informed that owing to the large amount of general electric testing sent to them beyond their lamp-testing work this Company have instituted a general testing and inspection department, and have retained the services of Mr. Haydn T. Harrison, M.I.E.E., to superintend same.

Acetylene.—The *London Gazette* on Tuesday announced that at the expiration of 40 days it is proposed to submit to her Majesty in Council the draft of an order providing that acetylene, when in admixture with atmospheric air or oxygen, shall be deemed to be an explosive, and shall not be manufactured, imported, kept, conveyed, or sold.

Liversedge.—A letter has been received by the District Council from the British Electric Traction Company stating that they fully appreciated the efforts which the Council had made in their favour, and that they would agree to the Council's request not to press further for a certain clause to be inserted in the Council's electric lighting order.

Morley.—A resolution adopted at the last meeting of the Council with regard to the promotion of a Bill in Parliament for extending the limit of borrowing powers in connection with the construction of waterworks and electrical works, etc., and for further provision in regard to the water, gas, and electrical undertakings of the Corporation, has been confirmed.

Limehouse.—The County of London and Brush Provincial Electric Light Company have lodged objections to the District Board's order. As the application by the Board is the outcome of the conference held at the Whitechapel Board-room, and the deputation to the Board of Trade, another conference of the parishes interested is to be called to consider the objections.

Thirsk.—The Northern Counties Electric Supply Company and the Parish Council are not at all agreed upon the point that the latter is a "local authority," whose consent to their application for provisional order is necessary under the rules of the Board of Trade or the terms of the Electric Lighting Acts. The company are seeking powers to lay mains throughout the entire parish.

Darlington.—Arc lamps are to be placed in the following streets—viz.: from the junction of Coniscliffe-road and Grange-road to the junction of the Market-place with Feethams, four; from High-row along Northgate to Corporation-road, nine; from Bondgate to Greenbank-road, five; from Tubwell-row to St. John's Church, ten; in the Market-place, two; in Skinnergate, three.

Stockton.—The Corporation have approved of a scale of charges for the supply of electrical energy, and rental of meters, based on the maximum-demand system. The charges will be at the rate of 6d. per unit for 100 hours' use per quarter of the greatest number of lamps the consumer has in use at one time, and 2½d. per unit for all electricity over such amount. It is expected that the works will be ready in August.

Ramsgate.—The Town Council have resolved to offer strenuous opposition to the application of the light railway company for an electric lighting order for the borough, and to proceed with the Council's application for similar powers; also, if necessary, to obtain the insertion of a clause in the order under which the Corporation may, if desirable, purchase the electricity in bulk from the light railway or other company.

Walker.—At the last meeting of the District Council the Electric Lighting Committee reported favourably upon the offers made by the Newcastle-on-Tyne Electric Supply Company and the Tyneside Electric Company. The committee have appointed a sub-committee to consider the terms offered and any alteration that should be made, and to recommend which company the Council should arrange with, and the terms agreed upon.

Explosions.—Several explosions caused by faults in the electric cables have occurred in Manchester during the past few months. Last week an explosion took place in an underground chamber in Market-street. Smoke poured out of the manhole, the iron-bound concrete cover of which was completely shattered. The flags of the pavement around were lifted, but beyond a more or less severe shaking no injury was done to those who happened to be near the spot.

Cardiff.—Another failure of the electric light at Cardiff has to be recorded. It went out in St. Mary-street about one o'clock on the 2nd inst. It was about half an hour before the street lights were restored, but the ball in the town hall was still carried on by candle-light when enquiry was made at two o'clock. The Lighting Committee's enquiry into the defects of the supply has resulted in a decision, endorsed by the Council last Monday, by which Mr. Appelbee is given sole control.

Charing Cross and Strand Electricity Supply Co.—The directors, after providing £8,000 for depreciation and carrying forward £4,400, have decided to recommend a dividend for the half-year ended Dec. 31, 1899, at the rate of £10 per cent. per annum, making with the interim dividend distributed for the half-year ended June 30, 1899, at the rate of 8 per cent. per annum, a dividend payable for the year 1899 of £9 per cent. on the ordinary share capital as against 8 per cent. for the year 1898.

Hackney.—The Town Hall Committee of the Vestry have reported to the Vestry that they have had under their consideration the question of the ventilation of the Board room, and are of opinion that the three outlets in the ceiling of the Board-room should be connected with tubes to a centre shaft, which is to be continued up to and through the roof, and finished with a cowl to prevent down draught, and that a ventilating direct-driven electric exhaust fan of sufficient capacity be fixed in the centre shaft above the connection, at an estimated cost of £80.

Yeomanry Hospital.—The medical staff of this hospital, which is being prepared for the front, will include 19 fully-qualified medical men. Mr. J. F. Hall-Edwards, the surgical radiographer to the general hospital, who is to be attached to the staff, has been presented with a dynamo by Messrs. Thomas Parker, Limited. Messrs. Mawson and Swan, of Newcastle-on-Tyne, have contributed a large amount of photographic plates. Electrical fittings also are partly promised. Having secured so much, we learn that Mr. Hall Edwards would like to get a 2½-h.p. engine on the same easy conditions.

Liverpool Chamber of Commerce.—At the last meeting of the council of the Liverpool Chamber of Commerce, it was reported that copies of the resolutions passed at the meeting held on Dec. 11, when Sir E. A. Sassoon, Bart., M.P., addressed the Chamber on the subject of Imperial telegraphic communication, had been sent to members of the Cabinet, members of Parliament for Lancashire and Cheshire, and all the chambers of commerce in the United Kingdom. Acknowledgments had been received from the Cabinet, and promises of support from many of the members of Parliament and chambers of commerce.

Malton.—The Northern Counties Electricity Supply Company, who are about to seek a provisional order for supplying electricity at Malton, has, according to the *Leeds Mercury*, declined to accept the further conditions sent in by the Urban Council to extend the lighting area to that at present lit by gas. The compulsory area to which they primarily agreed is a very limited one, but they say they got the consent of the Council to this, and are prepared loyally to carry it out. The Council at their last meeting decided to send further representations to the Board of Trade, but not to be represented before that body by counsel.

Glasgow.—At the last meeting of the Town Council the license as now adjusted by the Postmaster-General was accepted, and it was remitted to a committee to prepare a scheme with estimates for carrying it into effect. The yearly charges for a complete service have been fixed at a maximum of £10, and a minimum of £4; and alternately, for telephonic communication only, a maximum of £4 and a minimum of 30s., with a maximum of 1d. and a minimum of ½d. per message from a subscriber, and a maximum of 2d., and a minimum of ½d. per message from a call office. The license runs from now till the end of 1913.

Gloucester.—Mr. Hammond, consulting electrical engineer, in his general report states that very good progress had been made at the electricity works during the past month. Applications to the number of 113 had already been received, representing a total equivalent to 10,024 incandescent lamps of 8 c.p., and that in 62 cases the necessary connections had already been made with the mains. Mr. Trevor Duesbury, of Clerkenwell, London, has been appointed assistant engineer out of 50 applications. There were 10 applications for the appointment of jointer and trimmer, and Mr. Charles Stephens, of Bradford, has been appointed to the post.

Edmundsons' Electricity Co.—An extraordinary general meeting of this Company was held on Monday last at the Company's offices at Westminster. Mr. Gripper presided in the absence of the chairman, and stated that the meeting was called for the purpose of receiving a report of the proceedings at an extraordinary general meeting held on Jan. 19 to confirm the following resolution: "That Article 84, Section (E), of the articles of association of the Company be altered by omitting the words 'one half' in the sixteenth line of the said section of the said article." On the motion of the Chairman the resolution was unanimously confirmed.

Oban.—At a special meeting of the Town Council in committee last week Mr. Craven laid sundry proposals and details before the members. He said that a supply of electricity by water power was not to be obtained, there not being a sufficiency of water in the near neighbourhood. A duplicate steam-engine would be necessary in order to cope with any breakdown in the plant, and while the upkeep would be somewhat expensive Mr. Craven indicated that electricity could be supplied in this way at a moderate cost and yield a profit to the Commissioners. Nothing definite will be done till the Council obtains the requisite powers under a provisional order from Parliament.

Hereford.—The Electric Lighting Committee's report states that lights have been connected with the installation equal to 2,283 8-c.p. lamps, 1,413 lights are ready for connection, and it is thought that another 1,252 will be added before the end of the current half-year. The estimated cost of the works—£20,000—has not been exceeded. The committee have been considering the

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advisability of providing another engine and dynamo, but have decided to go on with the present plant as long as possible, and then provide a much larger engine and dynamo than they would if the work were carried out now. The lighting of the butter and poultry markets by electricity has been deferred.

Edison and Swan Electric Light Co.—We have received from this company two new leaflets which they have issued to be added to their large catalogue. The first of these deals with a small electric motor to be worked by a primary battery, and to be used to drive by worm gearing a slowly-revolving stand in shop windows. The apparatus is exceedingly neat, and is produced at a price which should commend itself to the purchaser. Another neat thing in the leaflet is a rapid detector, which consists of a dry battery and indicating galvanometer fixed complete in an ebonite case. Only two brass terminals are required for this set, which is handy when looking for a short-circuit or broken wire in either electric lighting or bell work.

Kendal.—Messrs. Handcock and Dykes, in their report on the proposed scheme of electric lighting, estimate the capital outlay for 2,500 8-c.p. lamps connected at £8,568, and for extensions £990. The cost of the mains for 30 arc lamps down the main street, if placed while the other mains were being laid, would be about £280, while the additional cost, if put in later, would be £260. The report was confirmed last week, and the Town Council agreed that until the Council should have had the opportunity of considering the question of arranging for the supply of power to a company for a service of electric tramways in the borough, the preparation of specifications and the obtaining of tenders in connection with the proposed electric installation be deferred.

Malvern.—Mr. Robert Hammond, who has been consulted by the Urban District Council in connection with their electric lighting scheme, lectured upon municipal electric lighting, at the Assembly Rooms, last week. Mr. Hammond recommended Malvern to adopt the light, and said the limit of expenditure might go up to £40,000. There appears to be considerable opposition to the scheme. The Council on Tuesday resolved to ask the Board of Trade to extend the provisional order for electric lighting for a further term of three years, or failing this, to allow the Council to transfer the order to a company on the best terms obtainable. The Chairman reported that the Council had received from two companies offers to treat with regard to supplying the town with the electric light.

Norwich.—After considering a report which concluded with the following statement, "We are of opinion that the present terms of the National Telephone Company, Limited, are not of the nature required by this city, and are not satisfactory to the Corporation or the citizens generally," the Town Council have passed the following resolution: "That this Council is prepared to approve of the application for a license of the Norwich Mutual Telephone Company in the Norwich exchange area, and hereby refers the matter to the Executive Committee to further consider the details of the company's proposals, and to bring up a report and recommendations thereon as to the terms and conditions upon which this Council should give its consent to the applications for a license to be granted by the Postmaster-General."

New Companies.—A company has been registered by Messrs. Jordan and Sons, Limited, of 120, Chancery-lane, Landon, under the title of the Volt Electrical Company, Limited, to carry on the business of electrical engineers, etc. The nominal capital of the company is £3,000 and the registered office is at 63, Lionel-street, Birmingham.—Thomson-Davis Telephone System, Limited, is the name of a company registered by Mr. A. H. Holmes, 32, King-street, Cheapside, with a capital of £6,000, the object being to adopt an agreement between Messrs. A. T. M. Thomson and P. W. Davis and the General Electric Company, Limited, and Mr. H. Holmes for the acquisition of certain patents relating to improvements in telephones, to develop and turn to account the same, and as electricians and electrical engineers generally.

Transformer Fuse Blocks.—We have received from the British Westinghouse Electric Company their pamphlet No. 1,015, which deals with transformer fuse blocks. These are both single and double pole. The single-pole block is constructed of porcelain and is entirely waterproof. It is designed so that it can be mounted on a cross-arm or placed anywhere near a transformer. The fuse is threaded through a porcelain tube, and acts on the same principle as a plunger switch. It is constructed so that the fuse cannot blow into the linesmen's hands, the vent being at the bottom of the block. The double-pole fuse blocks are of the type which has been manufactured by the company for several years. They are in two styles, the first of which may be used for 1,000-volt service in connection with transformers not exceeding a capacity of 10 kw., and for 2,000-volt service with transformers with a capacity not exceeding 4 kw. For all other cases with certain limits the second style can be used.

Whitechapel.—The District Board are about to present a petition to Parliament against the Bills of the Charing Cross and Strand Electricity Supply Corporation, Limited, and the County of London and Brush Company, by which the companies seek power to lay electric mains through the district in order to connect certain other areas outside the district. The Electrical Committee have recommended that Messrs. Mather and Platt, having explained their inability to accept the proposal made by the Board, in accordance with a resolution passed on Dec. 4 last, to supply three new engines and dynamos of 275 kw. capacity at the total cost of £7,395, in consequence of the increased price of materials, but offering to supply them at the price of £7,500 and certain spare parts specified in addition for the sum of £257. 10s., making a total of £7,757. 10s., such offer be accepted by the Board, and that a contract with Messrs. Mather and Platt be entered into for the purpose, and that the seal of the Board be affixed to such contract when prepared. This has been agreed to.

Poplar.—The District Board have decided that, pending the acquisition by local authorities of powers to wire consumers' premises, advertisements be issued inviting schemes from companies or persons for the work referred to, such schemes to be alternative in the following respects—viz: No. 1, continuous hiring; No 2, hire-purchase by easy payments; No. 3, supply for cash, and the proposed charges under No. 1; also to be alternative as follows: at per unit consumed and at per lamp installed per annum. It has also been decided that 500 yards of mains be laid in Devon's-road in accordance with the plan and report of the electrical engineer, and that six arc lamps be provided along the route of the new main, the estimated cost of the main and lamps being £544 4s.; and that the electrical engineer be authorised to lay one mile of main in short lengths in different parts of the district, as may be required, at an estimated cost of £1,175, the engineer to report when the mile has been laid, with full particulars as to how it has been utilised, and this authority to be subject to the condition that extensions shall not be more than 75 yards without the consent of the committee.

Kidderminster.—The British Electric Traction Company, who have obtained a transfer of the electric lighting order held by the Corporation, are now proceeding with the work of putting down the mains and distributing cables. The company have already gone beyond the compulsory area over which the new light will be carried. The electrical generating station for the tramcars is situated in the New-road. In putting in the plant two years ago arrangements were made for considerable extensions when necessary. Two combined engines and dynamos were at first erected, a third combined engine and dynamo was laid down recently, and an additional boiler is now in course of construction. A sub-station for distribution purposes is about to be erected near the post office. The main cables have already been laid from the generating station to the site, and cables have been put in along the New-road in the direction of Oxford and Worcester-street. As the men proceed manholes are constructed and the boxes put in. The work will be continued up Comberton-hill and as far as Chester-road in that direction; along Oxford-street, Worcester-street, Exchange-street, Vicar-street, High-street, Coventry-street, Blackwell-street, Church-street, through the Bull Ring, up Mill-street as far as Park Butts and all the intersecting roads, so that practically the whole of the centre of the town will be covered by the electric light cables.

Spiral Globe Co.—We have received from the Spiral Globe Company, of 28, Bush-lane, Cannon-street, E.C., their price-list and description of the globes manufactured by them for giving an improved distribution of light with incandescent lamps. We are not concerned at the present time with the price of these globes, but note that up to the present the spiral globe is only suitable for a lamp with a round bulb. In the list some interesting tests made by Mr. Hugh Erat Harrison, of Faraday House, are given to show the effect of these reflectors on the distribution of light from an incandescent lamp. The great fault we have to find with the extracts given from this report is that, while the polar diagram of candle-power is given, no figure is given of the mean spherical candle-power of the lamp with and without the globe. For instance, while the spiral globe largely increased the light thrown vertically downwards from the lamp, we can hardly credit the small variation it makes in the horizontal rays. In fact, from a casual glance at the curve we should say that the mean spherical candle-power of the globe as applied was more than that with the naked lamp. This is obviously impossible, as any reflection of the light such as takes place is always accompanied by a loss. We notice also that the makers of the lamp are content to deal with the light given in a vertical direction, and hence they claim that with the same consumption of current 100 per cent. more light is obtained by means of their special type of globe. We think it would be wise for them to take a more modest view of the case, as while we admit that the globes, from Mr. Harrison's tests, will give a somewhat better distribution of light in the downward direction, their claim for a 100 per cent. increase is obviously absurd. A table is given in the list which shows that if 500 spiral globes are only used for 1,000 hours each, £260. 8s. 4d. will be saved by their owner. Any figures like these require a good deal more explanation than is given in the list.

Newington.—The Vestry have adopted a report of the Electric Lighting Committee, in which they stated that as soon as all the orders for connections had been carried out there would be 11,839 8-c.p. lamps in use, or 1 239 in excess of the original installation. In addition, negotiations were in progress for a further supply of current equivalent to 5,220 8-c.p. lamps. The growth of the undertaking was shown by the fact that the consumers' accounts for the quarter ending June 24 amounted to £36. 16s. 2d., whilst those for the quarter ending Dec. 25 reached the high total of £1.126. 11s. 2d. The units supplied each month were: July, 3.086; August, 6,961; September, 12,418; October, 18 857; November, 27,000; December, 34 030. Within a period of one year from the opening of the station there would be connected to the mains 2,703 lamps in excess of the original installation of 10.000, irrespective of the 3,756 municipal installations. This result had been attained without canvassing the consumers of the competitive corporation. The committee, with the assistance of the consulting engineers, would do their best to have the new boilers and generators fixed in the station for running by Michaelmas next, but even with that additional plant it was more than probable that by the end of the year the station would again

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be under full load. They recommended that a circular letter be addressed to the consumers thanking them for the support they have accorded to the Vestry's undertaking, and explaining that with the additional plant decided to be provided for the station rendered necessary by such support, the Vestry would by Michaelmas next be enabled to meet an increased demand upon the station during next winter equivalent to 11,000 8 c.p. lamps. The committee further stated that the deferred system for the repayment of capital would enable the Vestry by the end of 1902 to provide such a sinking fund out of profits towards the maintenance of machinery and the station as would ensure the ratepayers from ever being called upon to contribute towards its support.

Tunbridge Wells.—The following scheme for municipal telephones is before the Town Council in the shape of a report from the Telephone Committee affirming the need of a competitive service at a lower tariff than that charged by the National Telephone Company, and the committee recommend the Council to proceed at once with the application for a license to the Postmaster-General and to make the following suggestions to him: (1) that such license should be for 25 years; (2) that the area to be served by the Council be the whole of the National Telephone Company's local area, together with the parishes of Withyham, Mayfield, Ticehurst, Goudhurst, Horsmonden, and so much of the parishes of Brenchley, Lamberhurst, Wadhurst, Frant, Retherfield, and Speldhurst, as are not included in the National Telephone Company's local area; (3) that the maximum charge for telephone service be as follows: Tariff No. 1, an annual payment (in advance) of £5. 17s. 6d. to cover an unlimited number of calls. Tariff No. 2, an annual payment (in advance) of £3. 10s., with a toll of ½d. per call payable quarterly or half-yearly; 1,140 ½d. calls (about 3½ per working day), would mean a payment of £3. 10s. + £2. 7s. 6d = £5. 17s. 6d., the same as under tariff No. 1. Calls in excess of 1,140 in the year to be charged ½d. each. Tariff No. 3, an annual payment (in advance) of £2. 10s., with a toll of 1d. per call, payable quarterly or half-yearly; 810 1d. calls (about 2½ per working day) would mean a payment of £2 10s. + £3. 7s. 6d. = £5. 17s. 6d., the same as under tariff No. 1. Calls in excess of 810 in the year to be charged ½d. each. The above rates to cover lines up to one mile in actual length from the nearest switch-room. Any excess distance over the mile to be charged at 10s per annum per quarter mile or fraction thereof, no addition being made to the toll charges. The committee also recommend the Council to authorise them to proceed in anticipation of the grant of the license, and to obtain specifications and tenders for the necessary works, the committee laying the same before the Council in due course.

Brighton.—A report of the Lighting Committee has been adopted on the wiring and fitting of houses and other premises, and the hiring out of electric motors and other apparatus in return for annual payments on the part of the hirers. The committee commented upon a report of the electrical engineer upon Messrs. Page and Miles's proposal on this subject. According to the *Sussex Daily News*, they were of opinion that the scheme proposed by Messrs. Page and Miles, with one or two slight modifications, was a practicable one, and that the electricity undertaking of the Corporation would derive sufficient benefit from it were it carried into effect to justify the Council in undertaking, on behalf of the contractors, the collection of the charges made by the contractors in respect of the use of electric wiring and fittings. The committee recommended that the Council should offer to all electric wiring contractors in the borough to collect, on their behalf, during a period of seven years from the commencement of the collection, the rents or charges which might be agreed to be paid to such wiring contractors by the owner or occupier of any premises in which electric wiring is actually installed or fittings supplied on the hire system, the charges due to the contractors in respect of the hiring of such wiring or fittings upon the following terms: (1) the charges made shall not exceed the sum of 3s. per lamp per annum (the lamp to be 8 c.p., 16 c.p., or 25 c.p., as desired. Where additional lights are required on the same fitting or at the same "point," the rate shall not exceed 1s. per annum for each additional lamp); (2) the consumer shall have the right to purchase the installation at any time after its completion on terms to be agreed previous to the execution of the agreement for the hiring of the wiring or fittings; (3) the Council will undertake the collection of the charges agreed to be paid by the consumer to the wiring contractor, and to account for the same less 2½ per cent. deduction for the cost of collection; (4) the collection to be quarterly, and all accounts of sums to be collected on behalf of the wiring contractor to be left at the rate office before the last day of each quarter; (5) the Corporation not to be required to make more than one demand in respect of any account, or to sue or take any steps to compel payment of the account if not paid, nor shall their collector be called upon to prove delivery of any such account; (6) if the same sum or a less sum than the amount of the Corporation account for electricity is obtained from a consumer, the whole of the payment made to go in discharge of the Corporation account; (7) the wiring contractors to furnish the Corporation with a copy of every agreement between themselves and any consumer in respect of which the Corporation are requested to collect hiring charges. These were the principal terms which the committee thought should be insisted on, but there might be other matters of detail which would require to be provided for. Mr. Cecil C. Fowler, of the Corporation electricity staff, and member of the Hants Carabineers, has been allowed leave of absence in order to volunteer for service in South Africa with the Imperial Yeomanry. The committee's recommendation to pay him half his salary during the time was defeated at last week's Council meeting.

PROVISIONAL PATENTS, 1900.

JAN. 29.

1813. Improvements in filaments for electric incandescence lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Riccardo Arno, Italy.)

1825. Improvements in dynamo-electric machines. Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, June 30, 1899, being date of application in United States.)

JAN. 30.

1842. Improvements in or connected with incandescent electric lamps. George Davis, 38, Margravine-gardens, West Kensington, London.

1844. Improvements in the concentration and separation of complex ores. Sherard Osborn Cowper-Coles, Grosvenor-mansions, Victoria-street, Westminster, London.

1864. Improvements in and relating to the method of winding coils or helices for electrical purposes. William George Heys, 70, Market-street, Manchester. (John Scott, Richard Varley, and James Chris Anderson, United States.) (Complete specification.)

1869. Improvements relating to electric arc lamps. Herbert Arthur Couchman, 18, Southampton-buildings, Chancery-lane, London.

1886. An improved arrangement of switching appliances for use with telephones. Henry Edward Newton, 6, Bream's-buildings, Chancery-lane, London. (Parnell Rabbidge, New South Wales.) (Complete specification.)

1906. An improved electric pendulum clock. Friedrich Haenichen and Otto Albert Haenichen, 31, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JAN. 31.

1937. Improvements in or connected with overhead collectors for electrically-propelled railway vehicles. Ridley James Urquhart and Henry Goodwin, 5, Clayton-square, Liverpool.

1990. Improvements in means for producing and detecting or observing electrical waves or oscillations. James Yate Johnson, 47, Lincoln's-inn-fields, London. (George Frederic Hatton, France.)

FEB. 1.

2022. Improvements in the insulation of electric cables. George Edward Heyl-Dia, 55, Market-street, Manchester.

2040. Improvements in the system of electrical distribution. Bertram Hopkinson, 26, Victoria-street, Westminster, London.

2050. Improvements in controlling electrically-propelled vehicles. Edward Henry Tyler, 15, Kirkstall-road, Streatham Hill, London.

2062. Improvements in arc lamps. Horace Bourne, Lancaster Lodge, Wandsworth Common, London.

2077. An improved accumulator battery. Victor Cheval and Joseph Lindeman, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2079. Improvements in electrical condensers. George Frederick Mansbridge, 322, High Holborn, London.

2085. Improvements in the generating apparatus of searchlights. Mark Mayhew and Morden Euart Carthew-Yorstoun, 24, Southampton-buildings, Chancery-lane, London.

FEB. 2.

2104. Magnetic electrical surface contacts for electrical trams and light railways. William Frederick Stamp, The Willows, Sunderland.

2109. Improvements in or relating to electric cables. George Edward Heyl-Dia, 55, Market-street, Manchester.

2119. Improvements in or relating to junction-boxes for electric conductors. Lawrence Maxwell Waterhouse and the Simplex Steel Conduit Company, Limited, 34, Castle-street, Liverpool. (Complete specification.)

2120. Improvements relating to electric switches. Lawrence Maxwell Waterhouse and the Simplex Steel Conduit Company, Limited, 34, Castle-street, Liverpool. (Complete specification.)

2142. Improved means for controlling and regulating the consumption of electric current on light and power circuits. Isaac Alexander and Charles Bannister, 82, Canfield-gardens, West Hampstead, London.

2150. Improvements in telephone transmitters. Gaudiose Dallaire, 111, Hatton-garden, London. (Complete specification.)

FEB. 3.

2173. Improvements in electric stopping mechanism for drawing or slubbing frames. Frank Arrowsmith and Howard and Bullough, Limited, Globe Works, Accrington.

2197. Improved magnetic holding table specially adapted to hold flat articles down upon it. William Henry Lock and Mark Barr, 188, Fleet-street, London.

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2191. Improvements in electric brakes. Claude William Hill, Broad-street House, New Broad-street, London.

2212. Improvements in electric arc lamps. Willi Peritz, 46, Lincoln's-inn-fields, London.

2219. Improvements relating to the measurement of electric power and energy. Riccardo Arno, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 5, 1899, being date of application in Italy.)

2222. Improvements in electricity meters. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published Feb. 24.

1899.

2268. Cord-grip for electric lampholders, fittings, and the like. Brown.

2482. Means or apparatus for recording and repeating and retransmitting Morse characters for use with telegraphic instruments. Stevens, Vyle, and Milner.

3177. Electrically-illuminated advertising mediums or the like. Bell.

3412. Electrical apparatus for recording the time of working of machines and for like purposes. Barker.

4725. Electric incandescent lamps of glowing refractory substances. Howard.

5229. Method of and apparatus for making and breaking or varying high-potential electric currents, British Thomson-Houston Company, Limited. (Hewlett.)

6335. Device for producing electric current at sea by the action of the waves. Gehre.

6685. Voltaic cells. Heinrich.

6829. Trolley or like current collectors for electric railways and tramways. Magrini. (Villa.)

6864. Electrical measuring instruments. Townsend, Wilson, and McClelland.

9269. Electric arc lamps. Upton.

10134. Controlling devices for electric motors. British Thomson-Houston Company, Limited. (Case.)

20287. Method and apparatus for the manufacture by electro-deposition of articles plated with platinum, gold, and silver. Bourdillon.

20363. Electric meters. British Thomson-Houston Company, Limited. (Thomson.)

21669. Electric meters. British Thomson-Houston Company, Limited. (Thomson.)

23287. Producing high vacua. British Thomson-Houston Company, Limited. (Howell.)

23292. Electric locomotives or motorcars for adhesion and rack railways. British Thomson-Houston Company, Limited. (Union Elektricitäts Gesellschaft.)

23696. Electric alarm systems for the protection of buildings or for like use. Brookes. (Woodman and Fiske.)

24717. Fire-alarm telegraph apparatus. Mills. (Gamewell Fire-Alarm Telegraph Company.)

25449. Means for controlling electric motors. British Thomson-Houston Company, Limited. (Davis and Potter.)

25721. Plates for storage batteries. Pallavicini.

25750. Controlling electric motors. British Thomson-Houston Company, Limited. (Day.)

1900.

27. Electric arc lamps. Lyon and Talbot-Crosbie.

45. Electrical incandescence lamps of the newest type. Fenny. (Allgemeine Elektricitäts-Gesellchaft.)

176. Current receiver for electric railways. Lachenmeyer.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Feb. 3	3 822	3,552	+ 270	19,825	18,593
Blackpool-Fleetwood	,, 5	167	172	- 5	740	737
Bradford City Trams	,, 4	349	248	+ 101	25,352c	—
Bristol Tramways Co.	,, 2	2,476	2 274	+ 201	—	—
City & South London	,, 4	1,119	1,135	- 16	5,590	5,652
Dover Tramways	,, 3	150	125	+ 25	756	711
Dublin U.T., elec. cars	,, 2	2,789	824	+1,965	—	—
Dublin S.D. Electric	,, 2	569	545	+ 24	—	—
Halifax Corporation	,, 4	520	273	+ 247	26,014a	8,462b
Hull Corporat'n E.S.	Jan. 13	682	—	—	—	17 711c
Liverpool Corporat'n	,, 27d	6,598	5,503	+1,095	26 626	23 311
Liverpool Overhead	Feb. 4	1,527	1,273	+ 254	7,553	6,533
Sheffield Corporation	,, 5	1,779	—	—	—	—
South Staffordshire	,, 2	660	587	+ 13	3,010	2,895

a Since April 1, 1899. *b* Since June 29, 1898.
c Total receipts. *d* Partly electrical. *e* Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Tuesday.
Commercial and Industrial.—		
Aron Electricity Meter, 6 p c. Cum. Pref. Shares, 1-125,000	1 ..	⅜-½
British Insulated Wire, Ord., 1-40,000	5 ..	12-14
—— 6 per cent. Cum. Pref., 1-27,500	5 ..	6 6½
—— 5 per cent. Mortgage Debentures	100 ..	100-102
British Electric Works, Ordinary, 50,001-95 000	1 ..	½-1
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	½-1
—— 4½ per cent. First Mortgage Debentures	108 ..	97-99
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4½-5½
Brush Electrical Engineering, Ordinary	2 ..	1½-2
—— Non. Cum., 6 per cent. Pref.	2 ..	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100 ..	110-115
—— 4½ per cent. 2nd Debenture Stock	100 ..	102-105
Callender's Cable, Debentures	100 ..	110-115
—— Ordinary	5 ..	13½-14½
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	5 ..	3½ 4
—— 5 per cent. Debentures	— ..	98-101
Edison and Swan United, Ordinary	5 ..	2-2½
—— 5 per cent. Debentures	5 ..	3½-4½
—— 4 per cent. Deb. Stock, Red.	100 ..	93-95
Electric Construction	2 ..	2½-2⅝ xd
—— 7 per cent. Cumulative Pref.	2 ..	2⅝-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	103-106
Giffre Electro-Chemical and Power, Ordinary	1 ..	½-1½
W. T. Henley's Telegraph Works, Ordinary	5 ..	13½-14½
—— 4½ per cent. Preference	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	111-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	100-104
Telegraph Construction and Maintenance	12 ..	37-41
—— 5 per cent. Bonds	100 ..	103-105
Telegraph Manufacturing, Ordinary	5 ..	9-10
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	7½-7⅞
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	104-106
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅛-¼
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	10-11
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	8½-9½
Charing Cross and Strand	5 ..	10½-11⅛
—— 50,001-50,000	5 ..	10½-11⅛
—— 4½ per cent. Cum. Pref.	5 ..	5½ 6½
Chelsea Electricity Supply	5 ..	7½-8½
—— 4½ per cent. Debentures	100 ..	109-111
City of London, Ordinary	10 ..	10½-11½
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-127
County of London and Brush Provincial, Ordinary	10 ..	9½-10½
—— 6 per cent. Cum. Pref.	10 ..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	— ..	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	4½-5½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	8 ..	8-8½
London Electric, Ordinary	8 ..	1½-2½
—— 6 per cent. Pref.	5 ..	4½-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	101-103
Metropolitan, Ordinary	10 ..	14½-15½
—— 62,501-85,000	10 ..	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	115-117
—— 3½ per cent. Mortgage Debenture, Red	100 ..	96-97
Notting Hill Electric Lighting	10 ..	15½-16½
Oriental, 1879	1 ..	1½-1⅝
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6½-6⅝
Oxford Electric, Ordinary, 1-96 and 407-10,810	5 ..	6½-7½
River Plate Electric Light and Traction, Deb.	100 ..	75-85
Royal Electrical Company of Montreal	10 ..	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
South London, Ordinary	3 ..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 40,081-52,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	9-9½
Westminster, Ordinary	5 ..	14½ 15½
Electric Railways.—		
Central London, Ordinary	10 ..	9½-10
—— Pref. Half-Shares	5 ..	4½-5
—— ,, ,, deferred	5 ..	4½-5
City and South London, Consolidated Ordinary	100 ..	58-61
—— ,,	5½ ..	4-5
—— 4 per cent. Debenture Stock	100 ..	125-130
—— 5 per cent. Pref. Stock '91	100 ..	143-148
—— ,, ,, ,, '96	100 ..	135-140
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
Waterloo and City, Ordinary	100 ..	101-104
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10 ..	17½-18½
Brisbane Tramway	100 ..	104-106
British Electric Traction, Ordinary, 1-30,000	10 ..	16-17
—— 60,001-75,000	10 ..	15½-16½
—— 6 per cent. Cm. Pf. 30,001-60,000	10 ..	13½-13⅝
—— 5 per cent. Perpetual Debenture Stock	100 ..	125-128
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4-4½
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
Costa Rica Electric Light and Traction, 5 per cent. First Deb., 1-1,000 of £100 and 1,001-1,600 of £50 each	— ..	75-85
Isle of Man Electric Power, 1-95,000	1 ..	1 3/16-1 5/16
—— 6 per cent. Preference, 100,001-170,000	1 ..	1 3/16-1 5/16
Kidderminster and District Lighting and Traction, Pref.	8 ..	8-8½
New General Traction, Ordinary	5 ..	3½-4
—— 6 per cent. Cum. Pref.	5 ..	5-5½
North Staffordshire Trams	6 ..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	18-19
—— Preference	10 ..	10½-10⅞
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11½-12⅜
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11
Telephones.—		
Consolidated Telephone Construction and Maintenance	½ ..	½-½
National Telephone, Ordinary	a ..	5½-5⅝
—— 6 per cent. Cum. First Pref.	10 ..	14-15
—— 6 per cent. Cum. Second Pref.	10 ..	14-15
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅛-5⅜
—— 3½ per cent. Deb. Stock, Red.	100 ..	98-100
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

Personal.—We gather that Prof. Röntgen, who has just accepted a call to the University of Munich, has been appointed director of the State Institute of Physics and Meteorology.

Telegraphs in Baluchistan.—We learn that a combined post and telegraph office has been opened at Panjpai, the mid-stage between Quetta and Mishki, on the newly-opened Kafila and trade route, the system being rapidly pushed on to eventually terminate at the border of British territory, three hundred odd miles from Quetta.

London Telephone Tariffs.—On Friday last in the House of Commons, Mr. Hanbury, in replying to Mr. Provand, stated that the tariff and regulations for the Post Office London telephone exchange system were practically complete, but until the work of constructing the main system was also complete it had been thought better not to publish the details of the scheme.

Birkbeck Institute.—The annual conversazione of Birkbeck students was held on Saturday last, when Mr. Alderman Treloar received the guests. An excellent programme was arranged, which included X-ray demonstrations and connection by electrophone to the various entertainments in London. During the evening Dr. W. Hampson carried out some interesting experiments with liquid air.

Italy.—We learn that remarkable activity is being displayed in electrical matters in Italy at the present moment. Amongst the various projects for electric lighting installations we note that the specifications for the lighting of the town of Frosinone may shortly be obtained from the municipal authority. A central power station is projected at Bassignana, which is to serve an electric railway which will connect Allessandria, Bassignana, and Vallenza. The electric railway from Milan to Varese has also been approved of by the Government.

Gilchrist Lecture.—Dr. A. P. Laurie delivered a Gilchrist lecture at Wrexham on Friday last on the "Electric Current: Its Application and Use." Sir Robt. Cuncliffe presided, and, in introducing the lecturer, said that they would soon have the electric light in Wrexham. The lecture itself was a most practical one, as the lecturer did not confine himself to ancient history. He finally predicted that whatever the future source of power might be—coal, wind, or water—he was quite sure that the twentieth century was to be a century of electricity.

Institution of Electrical Engineers.—We have received the January issue of the *Journal* of the Institution of Electrical Engineers. It contains the presidential address of Prof. Thompson, and also the papers read since the opening of the session, with the discussion on each, the last paper given being that by Mr. Hope-Jones on "Electrical Time Service." In addition to these papers there is an original communication by Mr. A. Russel on "How Condenser and Choking Coil Currents Vary with the Shape of the Applied E.M.F." The last part of the volume is taken up by the "Report of the Committee on Copper Conductors."

Magnetic Disturbances.—The technical institutions in Berlin have laid a memorandum before the Reichstag respecting the electric and magnetic disturbances due to the electric tramways and railways in Berlin. In this memorandum it is pointed out that as soon as electric traction was first started on the circular railway the disturbances were felt in the Imperial Institute, 2½ miles away. These disturbances have rendered impracticable the making of observations on the earth's field, and special precautions have also to be made in order that the ordinary magnetic instruments for measuring small currents should not be affected.

"Science Abstracts."—The January number of *Science Abstracts* just to hand contains an immense amount of condensed information collected from scientific and technical journals all over the world. The abstracts are divided into 10 different classes, such as physics, chemistry, electricity, heat, etc. With this number we have also received the index to vol. ii., this giving, in addition, some errors in the past volume, and also a list of the journals from which the abstracts are taken. In the January volume of *Science Abstracts* we also notice that a section on steam plant, gas and oil engines has now been introduced, and abstracts dealing with motorcars in general are also included.

Steam-Engine Developments.—Mr. A. Saxon on Saturday last read a paper before the Manchester Association of Engineers on the "Future Development of the Steam-Engine." Amongst the predictions in this paper was one to the effect that the standard pressures will be increased to as much as 500lb. per square inch in the future. The author considered that this would lead to increased engine speeds, but in the report of his paper before us we do not see the question of lubrication referred to. We note, however, that he predicts that the design of engines to drive electric lighting plants will play a large part in the perfection of steam-engines. Mr. Saxon also predicted that England will hold her own in engine-building.

Rare Metals.—In view of the ever-recurring rumours as to the discovery of platinum, iridium, and osmium in different regions more or less inaccessible, enquiries have been made by the State Department at Washington as to the truth of the so-called discoveries. These enquiries were carried out with the help of consuls connected with the Department, and their reports show that the metals in question did not exist in paying quantities in districts in the United States and South America where they have been stated to have been found in considerable quantities; but reliable information as to the amount of deposit in any one place is not to hand. The Department, however, says that there is a general impression that payable deposits exist in British Columbia.

Manchester Tramways.—The Permanent-Way Sub-Committee of the Tramways Committee at Manchester have after serious consideration come to the conclusion that they cannot adopt the side-running trolley in their city. The mechanical and other difficulties in erecting a system of side-running trolleys have been found to be too great to allow it to be used. The committee therefore recommend that the central-pole system of suspension be used, with flexible supports, wherever the streets are wide enough. In other places the span-wire construction is to be used, the trolley wires being kept as central as possible over the track. These conclusions have been definitely fixed, and the electrical engineer of Manchester having this work in hand has been instructed to proceed on the above lines.

Burmese Telegraphs.—We gather from *Indian Engineering* that the total length of telegraph lines in the province of Burma had during the last official year increased from 5,177 to 5,296 miles, the total length of wire increasing in proportion from 11,838 to 12,148 miles. The messages between Rangoon and Calcutta took an average time of 41 minutes. This is a distinct improvement when compared with last year, when the time taken was 53 minutes. We gather that the Moulmein-Bangkok line was interrupted during the year for 19 days, and the line to China for

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about 70 days. Owing to a severe storm about half a mile of the line between Rangoon and Prome was wrecked in April, 1898. A most peculiar cause is attributed to the destruction of about 1½ miles of line on the Rangoon-Moulmein section, this damage being effected by wild elephants.

A Bonus System.—The Electricity Committee of the Halifax Town Council had decided, subject to the approval of the Council, to grant a bonus to members of the staff employed at the electricity works on any reduction of the total works and management costs when these are brought below 1·5d. per unit. Last year the total cost per unit was 1·65d. The committee propose that for every $\frac{1}{10}$d., and *pro rata* for every $\frac{1}{100}$d., a bonus of £130 be given to the staff in the following proportions: to the chief engineer, £50; to the assistant engineer, £40; to each charge engineer (now numbering three), £10; and to each driver (at present four), £2. 10s. It was suggested that the scheme be in operation for the two years ending March 31, 1901, after which it should be subject to revision. The scheme was a good one, but as it has been withdrawn comment is unnecessary.

An Armature Disc Press.—The *Electrical World* illustrates in its first issue for February an improved armature disc punch which contains several novel features. The first of these is an arrangement by which the whole press can be inclined, so that, instead of the plates being laid on a horizontal surface to be punched, they are placed on an inclined plane. The discs then automatically slide out of the way when they have been punched to shape, thus saving a considerable amount of hand labour. The machine is so designed, however, that it can be inclined at any angle, or can be placed with the dies horizontal. Another feature in this machine is a knock-out for the lower disc for removing the iron plates when punched, which is worked from a crank in such a way that the space for inserting the iron plates is in no way impeded. The machine is designed for punching plates up to 12in. in diameter.

Telephones at the War.—From the news received from South Africa it is clear that telephones are being largely employed for communication purposes by the British forces on active services. At Ladysmith the outlying positions are connected by telephone with headquarters, and this connection proved of great service when the town was attacked last month. At Mafeking also, Colonel Baden-Powell has a telephone service arranged with all his outposts so that he receives quickly the information of any move on the part of the surrounding forces. The latest news, however, is from a letter from a private soldier in the Grenadier Guards to the effect that a Boer spy has been found to be using telephone communication from a house within the English lines at Modder River, presumably to the Boer position. The end of that spy is said to have been as sudden as the switching-off operation in a telephone exchange.

Machine-Shop Practice.—Mr. Henry Roland continues in the *Engineering Magazine* his series of articles on the revolution of machine-shop practice. The article at present before us deals with the application of automatic mechanical production to heavy work. In this article the author illustrates some new machine tools, used at the works of the Westinghouse Company of America, for manufacturing the Parsons steam-turbines in quantity, and also a number of tools used in the Westinghouse Company's works and in those of the General Electric Company at Schenectady for making electric motors for street railway working. In the heavier work the tendency to bring the tools to the work rather than the work to the tools is seen. The author comments on the fact that the use of milling machines appears to have increased very little during the past four or five years, and that for certain classes of work the older types of planing machines have not been replaced by milling heads, as was expected.

Electrical Cabs in Berlin.—We are glad to note that in Berlin electrical accumulator cabs are being tried, and we trust that the experience gained in England may be of service in Berlin showing the designers of these cabs what to avoid. Two independent motors are provided on each of these vehicles, each capable of developing 2 h.p. at a speed of 1,200 revolutions per minute. These motors are independently geared on to the rear wheels of the cab, thus rendering differential gearing unnecessary. Arrangements are also made so that in the event of one motor breaking down, the others can be used to drive the cab home at a slow speed. The accumulator used is carried in the vehicles much in the same way as in theEnglish cabs. The accumulators have a capacity of from 60 to 70 ampere-hours, and consist of four cells of the Hagen type. The vehicle is provided with wooden wheels, and weighs complete about 2,500lb. Solid rubber tyres are used on the wheels. The maximum speed of the cab is just over 11 miles per hour.

Sterilisation of Wine.—Until recently the experiments made to sterilise liquids by means of electricity have failed because the application of continuous current decomposes the liquid and thus renders it useless, while alternating currents of the frequency usually employed are not sufficient to destroy the microbes which are the cause of the fermentation against which a remedy is sought. From a note in *El Telegrafista Español* we gather that, according to Meritens, all microbes in wine can be killed in a few seconds by the application of alternating currents of high frequency and low potential, which at the same time conduces to conserve the wines. Mr. Meritens has made an apparatus which consists of a narrow glass tube through which the wine to be treated passes. Inside the tube there is a series of metal discs. These are insulated, and each is in communication with one of the terminals of an alternating-current dynamo. The speed of the liquid is regulated by a valve so that it can be subjected to the action of the current for any given time. It is said that the invention has proved of considerable commercial value.

Society of Model Engineers.—A very interesting paper on "High-Tension Electricity" was read by Mr. Stanley J. Harding at the ordinary monthly meeting of the Society of Model Engineers, held at the Memorial Hall, Farringdon-street, E.C., on Feb. 7. The paper was illustrated by a number of experiments with induction and Tesla coils, vacuum tubes, and X-ray apparatus. Some interesting lantern slides illustrating the subjects described were also projected on the screen. The society's model railway track was used during the latter portion of the evening, and several of the members' models were tested under steam. We note that the next meeting of the society is to be held on March 8, when there will be an exhibition of the models entered for the society's competition, and for which gold and silver medals are offered. Some very fine engineering models have been entered for this competition, and the exhibition will naturally be of much interest. Visitors will be admitted on this occasion by complimentary tickets, which can be obtained on application to the hon. secretary, Mr. Frank E. Powell, 6, Farringdon-avenue, E.C.

The Solenoid Gun.—The inventor of an electric gun which is to propel its shells by means of the magnetic force generated in a solenoid, first hailed from Washington. We referred to his invention and showed the futility of

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his claims in a note appearing at the beginning of 1898. The gun in question was described in our American contemporary *Electricity*, which now states that the electric gun has been reinvented in New Orleans. The gun which hails from this towns has all the advantages of the one described previously, and one great point still further in its favour. This is that the inventor proposes to construct at once a large service model with a view to testing the practicability of his ideas. We regret that he thinks it worth while to make a trial on a large scale, but are sure that he will save the technical editors of electrical papers a considerable amount of ink by so doing. As the range of the gun is to be from five to six miles, the inventor will want a considerable estate on which to erect his solenoid in order that the necessary speed when leaving the muzzle of the gun may be obtained. The local electric lighting company will no doubt find a profitable consumer when the inventor has his model ready for working.

Concentric Cables.—The use of concentric and triple-concentric cables for street mains in England is now so common that it seems strange to us to hear of these mains being introduced into New York. We learn from the *American Electrician* that the Edison Company have adopted a concentric cable for their three-wire network. In this case they have not used triple-concentric cables, but have run a single uninsulated conductor for the third wire. We are surprised to find our contemporary advocating that this wire should be laid bare and be earthed at various parts along its length. It is suggested also that the sheathing of the cable could in that case serve as the centre wire, and we are told that there would be no danger of electrolysis because the drop of the neutral is slight and varies in direction on a well-balanced system. This argument seems to us to be faulty, because although the voltage drop may not reach such a high value as that in the earth return of the tramways in the United States, yet the proximity of the electric light mains to water-pipes, etc., would tend to greatly increase the leakage and electrolytic trouble. The Board of Trade regulation, that such systems should only have their central wire earthed at one point at the central station, is the only real safeguard in such circumstances.

Electric Lighting Profits.—One of the town councillors at Liverpool is doing his best to withdraw from the reserve fund the money which the electric light undertaking has been able to lay by during the past year. At a recent meeting of the Corporation he was informed by the town clerk that he could not use the £30,000 now standing at reserve, for the benefit of the ratepayers. His next move was to get the profits for the past year from the electric lighting undertaking used for current expenses in other departments, rather than that they should be laid by or absorbed by a reduction in the price of electrical energy. This proposal to make the consumers at the municipal lighting station pay more than their due share of the rates is not a new one, and it is difficult to get the Radical members, who usually bring such propositions forward, to understand that they cannot eat their cake and have it too. We have always maintained that an electric lighting undertaking equipped by a municipality should supply at cost price, making, of course, allowance for reserve and contingencies. The main bulk of the ratepayers then only gain an indirect advantage, but owing to the reduction in the price this indirect advantage is a very considerable one. We are glad to note that at Liverpool the effort to use electric lighting profits in the way suggested has not been favourably received.

Parallel Running.—Mr. F. G. Sykes, of Brooklyn, writing to the *Electrical World*, describes his experience in central-station work when running a 1,500-h.p. horizontal cross-compound Corliss engine and a 3,000-h.p. horizontal double-tandem compound MacIntosh and Seymour engine. The first of these engines was direct coupled to a General Electric 750-kw. three-phase alternator, and was fitted with a centrifugal ball governor, while the MacIntosh and Seymour engine was provided with a shaft governor and was connected to a 1,500-kw. alternator. The speeds of the engines were approximately the same. The first engine had a 50-ton flywheel. It was found that when running on artificial load no difficulty was experienced in synchronising, but as soon as the attempt was made to shift the load from one unit to another, large synchronising currents were set up. This was met by using a more viscous oil in the dash-pot of the first engine, and afterwards by arranging a means to vary the speed of this engine by an adjustable weight on the governor. When this was done, almost all troubles in parallel running ceased. When it was required to change the load from one unit to the other the speed-changing device on the governor was employed, the field excitation being only varied to keep down the cross currents. The writer concludes that, in order to run successfully in parallel with direct-connected alternators, it is necessary to have the governors of the engine made sluggish to sudden variations of speed, while the speed control on these governors should be worked from the switchboard.

Alternating-Current Arc Lamps.—Mr. R. Fleming strongly supported the series alternating current arcs with constant-current transformers in a paper read before the North-Western Electrical Association last month. The system which he advocates has been described in our columns before, and is practically the same as that adopted in England with the rectifier omitted. We are surprised to note, however, that he claims the alternating current to be equal, if not superior, to the direct, especially for street-lighting, owing to the improved distribution of light from the alternating current arc. This point was borne out to a certain extent in the discussion, but from the remarks we gather that inside a zone of some 30 yards from the lamp column the direct-current lamp gave better results. The author of the paper estimated that the saving in cost by using the series alternating system with enclosed lamps instead of the open arc lamp was from £1. 5s. to £2 per lamp per annum. One man only was employed to take care of some 600 lamps, whereas it required six men to look after a similar number of open direct-current arc lamps. He advocated the use of a current of 6·6 amperes with 70 volts across the arc as most satisfactory. Some of the speakers on this paper gave interesting figures as to the use of 32-c.p. five-ampere series incandescent electric lamps on the series system. It was stated that these lamps had exceptionally long lives owing to the substantial carbon rod used, and that the candle-power after 10,000 hours did not drop to more than 25 in a special case. The average life of the lamp was said to be from 4,000 to 5,000 hours. Two kinds of cut-outs had been tried with these lamps, one being the ordinary paper film cut-out and the other a shunt coil across the lamp.

Electromagnets.—It is a curious fact that, in spite of the great amount of literature devoted to the design of electromagnets, erroneous impressions as to first principles should still exist. Thus we notice in the *Scientific American* an article on an improved electromagnetic apparatus designed by Francisco de Borja Pavon, of Caribarien, Cuba. The idea of the inventor is that having obtained the maximum density of magnetic field with an iron core and exciting coil, this maximum could be still further increased if the whole arrangement is surrounded

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by a second field-magnet system with an independent exciting coil which is concentric with the first. In carrying out this arrangement the author has actually made models, photos of which are reproduced in our contemporary. Three such systems of concentric field-magnet poles are used in both the bipolar dynamo and the multipolar. The two inner poles of the bipolar machine are made circular in shape, while the outer pole which surrounds the two inner is made to embrace the system in the usual way with extended pole-pieces. The exciting coils round the two inner poles are practically enclosed. In the multipolar machine the same construction is used, except that it becomes considerably more complicated, and also the surfaces exposed to magnetic leakage are considerably greater. The inventor's idea evidently is that while the outer poles will be as strongly magnetised as in the ordinary machine, the intermediate pole will be much more strongly magnetised and the inner pole even more strongly still. An elementary knowledge of the permeability of iron would have saved in this case some expensive experiments, and we wonder that our contemporary has not pointed out the futility of the device.

Pacific Cable Details.—We take from the *Electrical World* a few extracts from the official reports received from Lieut.-Commander H. M. Hodges, who commanded the "Nero" during the last part of the voyage undertaken to investigate the feasibility of a cable route across the Pacific. The report of the first part of the voyage is referred to in our issue of Jan. 26: "The "Nero" surveyed between Guam and Luzon, and then ran back to Guam, pursuing a zigzag course, in order to sound along the route selected with a view to obtaining the best possible location for the cable. Then she ran a straight course to Yokohama. She returned zigzagging to Guam, and will zigzag across the line to the Midway Islands and to Honolulu, when her work will be completed. The "Nero" has found a depth of less than 3,000 fathoms between Yokohama and Guam and Luzon and Guam. Three thousand fathoms is the extreme depth the authorities were willing to lay the cable. The cable between Honolulu and Dongala Bay, which is the Luzon terminus of the cable line, will be 4,812 knots long. Only two offsets from the projected great circle route between the Midway Islands and Guam were found necessary to avoid obstacles to successful laying and operation of the cable. The first was a submarine mountain a short distance west of the Midway Islands, and the second an abyss more than 4,900 fathoms deep, found about 500 miles east of Guam. Our contemporary also contains some remarks of the vice-president of the Commercial Cable Company on a paper read before the American Institution of Electrical Engineers by Captain G. O. Squier. He pointed out that Captain Squier has not allowed for a duplicate cable as part of the Government system, in spite of the fact that a cable system cannot be deemed to be successful without a second line. He goes on to criticise the figures in the paper as they would be altered by the additional capital outlay which would have to be incurred by laying a duplicate cable.

British Tramway Development.—The February number of *Cassier's Magazine* contains an article by Mr. J. Clifton Robinson on "British Tramway Development," in which the progress of British tramway engineering is traced. The author draws attention to the fact that as early as 1837 there was a successful tramway in the city of New York. It consisted of tracks laid down on which the wheels of the vehicles could run more smoothly. The roads in America at that date were exceedingly primitive, being covered with mud in winter and deep with ruts and dust in summer. Hence a well-defined wheel track was an advantage. Mr. Robinson then refers to the pioneering work of Mr. G. F. Train, the designer of the Birkenhead tramway, who also did a large amount of work at other places throughout the country. From this the present systems of traction are traced, and Mr. Robinson gives some figures as to the costs of working which he obtained from the Bristol, Dublin, and Stockton lines. Thus he considers that, speaking broadly, the cost of operating a first-class electric line amounts to 5d. per car mile. Of this the power-house expenses, including coal, stores, wages, and salaries, account for 0·773d.; the traffic expenses, including wages, uniforms, superintendent's salary, stores, and compensation account for 2·503d.; the maintenance and renewal of the power-house plants, line equipment, and permanent way, 1·009d.; while local rates and taxes account for the balance of ·0715d. per car mile. These figures are, of course, varied by local circumstances. The author also states that on the lines mentioned about 1·046 Board of Trade units are used per car mile. Mr. Robinson concludes that while giving the public a cheap service electric traction ensures that the cost shall not exceed 50 per cent. of the revenue. This result has been nearly approached even on lines recently opened in Bristol and Dublin, and the revenue obtained in such cases not only yields a substantial return on the original capital, but also on the extra cost of re-equipment.

Labour Clauses.—Mr. Benjamin Taylor, F.R.G.S., contributes to the February number of *Cassier's Magazine* an article on "Labour Clauses in Public Contracts," which is pointed by a number of examples of the interference experienced from these clauses by electrical manufacturers. These cases are of recent date and have been referred to individually in our columns. The collection of them together into one place is, however, most valuable, and the author has also added the exact terms of the resolutions in which the various municipal authorities have inserted in order to interfere with the relations between employer and employé. He points out that in nearly all the resolutions the workmen's union is made the sole arbitrator as to what is the fair wage in the district, and that in certain cases firms have been objected to who actually paid, in piecework prices, higher than the union rate. We are glad to find that some electrical firms have withstood these clauses most successfully, although, in the case of Sheffield, the contract was only confirmed to Messrs. Ferranti by a majority of 3 in 49 votes. The author concludes that by a common agreement of employers in all trades it should be possible to compel the deletion from all contracts of clauses giving the purchaser the right to lay down the wages to be paid or the hours of labour to be observed. They should also be enabled to enforce the principle that fair wages are not what the trades union representatives choose or specify, but the rates agreed between employer and employé. We cordially agree with the author in this, and are glad to see that the employers are resisting these labour clauses, which tend to wreck the industry of the country. It is interesting to note that the last attempt at Manchester to upset a contract placed with Messrs. Ferranti, Limited, for two large engines was not successful, in spite of the fact that the labour clauses were kept in the background, and a subsidiary point made the main point at issue.

Electrolysis.—At the meeting of the Manchester City Council last week Sir John Harwood, in moving the adoption of the report of the Waterworks Committee, referred to the alleged injury to the water-pipes by electrolysis. He stated that the committee had *primâ facie*

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evidence from the condition of their small pipes that there was considerable damage going on, and that they were led to believe that electricity escaping from the mains was responsible for this damage. This danger from electrolysis might be expected to increase when the electric tramways were working. As, however, no one present could give an absolute statement as to the damage done already by electrolysis, the committee suggested that the chairman of the Technical Instruction Committee should be requested to afford the technical schools the facilities necessary in order to make a full investigation into the matter. This question was naturally taken up by Alderman Higginbottom as chairman of the Electric Lighting Committee. He pointed out that the whole of the work being done by the Electricity Committee was under the most strict Board of Trade requirements, which had been compiled to prevent damage by electrolysis. He admitted that some few years ago a few water-pipes had been damaged owing to faulty cables, but these had been replaced, and there was no possibility of leakage from them. While his committee had no objection to the investigation being made at the present time, it should be only after a joint conference of the committees interested. In consequence of the opposition brought against the report, it was amended by the suggestion that the chairmen and deputy-chairmen of the committees should meet together and employ such experts as they thought fit to investigate the matter, and to arrange what should be done in the future. Without seeing the *primâ facie* evidence which the chairman of the Waterworks Committee referred to, we cannot give an opinion one way or the other, but there is ample proof that where the Board of Trade requirements are complied with, as they are in Manchester, trouble from electrolysis will not be felt.

Telephone Cable Laying. — We referred some months ago to the laying of the telephone cable across the Mackinaw Straits from a town named St. Ignace. This cable is being used by the Erie Telephone Company, and permits of direct communication between the upper and lower peninsulas of Michigan. The cable is composed of 10 pairs of wires, two pairs being of No. 14 B. & S. and eight pairs of No. 16 B. & S. gauge. Each conductor contains seven strands, and is insulated to $\frac{4}{33}$in. diameter with rubber compound of special high quality for submarine work. Over the cable conductors two heavy friction tapes are put on in reverse directions, then follow two servings of tarred jute also in reverse, and finally the cable is armoured with No. 6 B.W.G galvanised steel wire. The specifications called for an insulation resistance of 500 megohms per mile, and a maximum copper resistance of 14 ohms per mile for the No. 14 wires and 24 ohms per mile for the No. 16 wires. The finished cable measures about 2¼in. in diameter, and weighs 15 tons to the mile. The *Electrical World*, in describing the laying of this cable across the straits, for which some six miles of cable were required, makes it clear that the usual survey of the bottom to receive the cable was not made. The cable was jointed up into a continuous length on shore and then coiled in the hold of a scow. This scow being divided lengthways by a bulkhead, the cable had to be coiled on each side of the bulkhead. The coiling was done in the figure of 8 form, with the cross very near one end. The succeeding layers were divided by strips of wood, in order to prevent any catching up or kinking when paying out. The scow was towed across the straits by two steam-tugs, and the shore end landed on the Mackinaw City side of the water. The last 1,000ft. had to be hauled ashore, owing to the shallow water not having sufficient depth for the tugs. The tugs started, and the cable was paid out at the rate of about two miles per hour, until when near the St. Ignace shore a reef of rocks not shown on the Government chart and not revealed by previous soundings on the cable-laying expedition stopped the tugs. It was eventually found that the reef was comparatively short, and a detour was made. The delay, however, prevented the work being finished on the same day as it was started, and the remaining end of the cable was dropped on the bottom of the lake and was then picked up again the next day and the cable completed. From tests made after the work was done an insulation resistance of over 1,000 meghoms per mile was found on all the cable.

An Internal-Combustion Engine.—The presidential address of Mr. Henry O'Connor to the Society of Engineers contained much of interest to gas engineers, and one point in particular which is of interest to electricians. This is a description of an internal-combustion engine invented by Mr. P. F. MacCallum, of Helensburgh. This engine is designed to burn coal dust in the working cylinder, and has been tried experimentally in Edinburgh. In working the experimental engine, a volume of air is compressed by the up-stroke of the piston into the upper part of the combustion cylinder. The proper quantity of coal dust is then injected by a jet of high-pressure air on to a wrought-iron plate attached by a stud to the piston, and maintained at a high temperature by the successive combustions. Immediately the first portion of the coal dust strikes the plate, ignition takes place, and a working down-stroke is made. When the piston reaches the bottom of its stroke, the exhaust valve opens, allowing the combustion products and suspended ash to escape. A fresh charge of air then ascends through automatic valves from the crank chamber, and is compressed into the upper part of the cylinder in readiness for another combustion stroke, and so on. As the fuel never comes into contact with any but dry surfaces, and is always kept in a state of suspension and motion, no accumulation of ash or dirt takes place within the engine; the force of the exhaust being amply sufficient to sweep out any solid matter which can possibly enter the engine through the fuel feeder. The engine is equally satisfactory when employed with oil. The engine working with coal dust gives diagrams of good and regular form, showing about 15 h.p. at a speed of 150 revolutions per minute, with a fuel consumption of about 1½lb. of coal dust per horse-power per hour. The consumption of fuel would be much less but for several defects in the design of the experimental motor—in fact, from one cause and another, nearly one-half of the fuel injected at each stroke is exhausted without having done any useful work. Notwithstanding the defects alluded to, inseparable perhaps from a first motor presenting so many points of absolute departure from previous practice, the engine has been pronounced a practical success by many well-known experts who have examined it in operation. Prof. Stanfield predicts that a larger engine of improved design will give a horse-power for a consumption of about ½lb. of coal per hour. Almost any kind of coal can be used, and the cost of pulverising is stated to be from 6d. to 9d. per ton. The inventor is said to be now engaged in forming a company to fully demonstrate his system by building a larger engine on improved lines. The difficulties to be expected with such an engine are many, and the lubrication of the cylinder is by no means the least of these. We are told, however, by Mr. O'Connor that this has been overcome in a most ingenious way, but the exact details are not given.

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THE NIAGARA POWER SYSTEM UP TO DATE.

In the January issue of the *American Electrician*, Mr. J. E. Woodbridge gives some most interesting information as to the development and extensions of the Niagara power system of electrical generation and distribution. He explains that when the station was first laid down three 5,000-h.p. machines were provided, and that this number has now been increased to 10. The largest of the new local electro-chemical factories started near to the power works are those of the Union Carbide Company, which already absorbs some 15,000 h.p. The long-distance transmission of power from the station has also been continually on the increase. Thus the Buffalo General Electric Company takes some 3,000 h.p. over lines which are about 27 miles long and transmits it to meet the requirements of its consumers. The International Traction Company, which operates in Buffalo and the surrounding district, also takes its supply from the Niagara. Mr. Woodbridge goes on to state that although it was originally contemplated that 16 of these 5,000-h.p. machines should be placed in the power-house, it is now probable that extensions will be made by constructing a new wheel-pit and power-house so as to keep down the maximum amount of machinery in any one station. After that the next development is expected to take place on the Canadian side, where the tunnel to take away the tail-water can be constructed more cheaply than on the American side. The new 50,000-h.p. capacity power-house on the American side of the Falls will be situated nearer the river than the present power-house, and will draw its water from the same canal. The new generating units added after the experience obtained from the first three machines are practically all alike in detail. Mr. Woodbridge has, however, illustrated the improvements made in these machines over the earlier type by the combined section, which we give in Fig. 1. The general design of the outside field, which is the revolving part of the machine, is practically the same as in the first three dynamos. The changes in detail on the armature and field have been made in order to reduce the internal losses, and to provide for the better carrying off of the heat generated. These machines have an extremely high efficiency, which is said to be 90 per cent at full load, but even then the loss amounts to some 100 h.p., which corresponds to a considerable amount of heat to be carried off from the machines. Coming to the mechanical details, which have been altered in the more recent types, one of these is the method of supporting the bearings

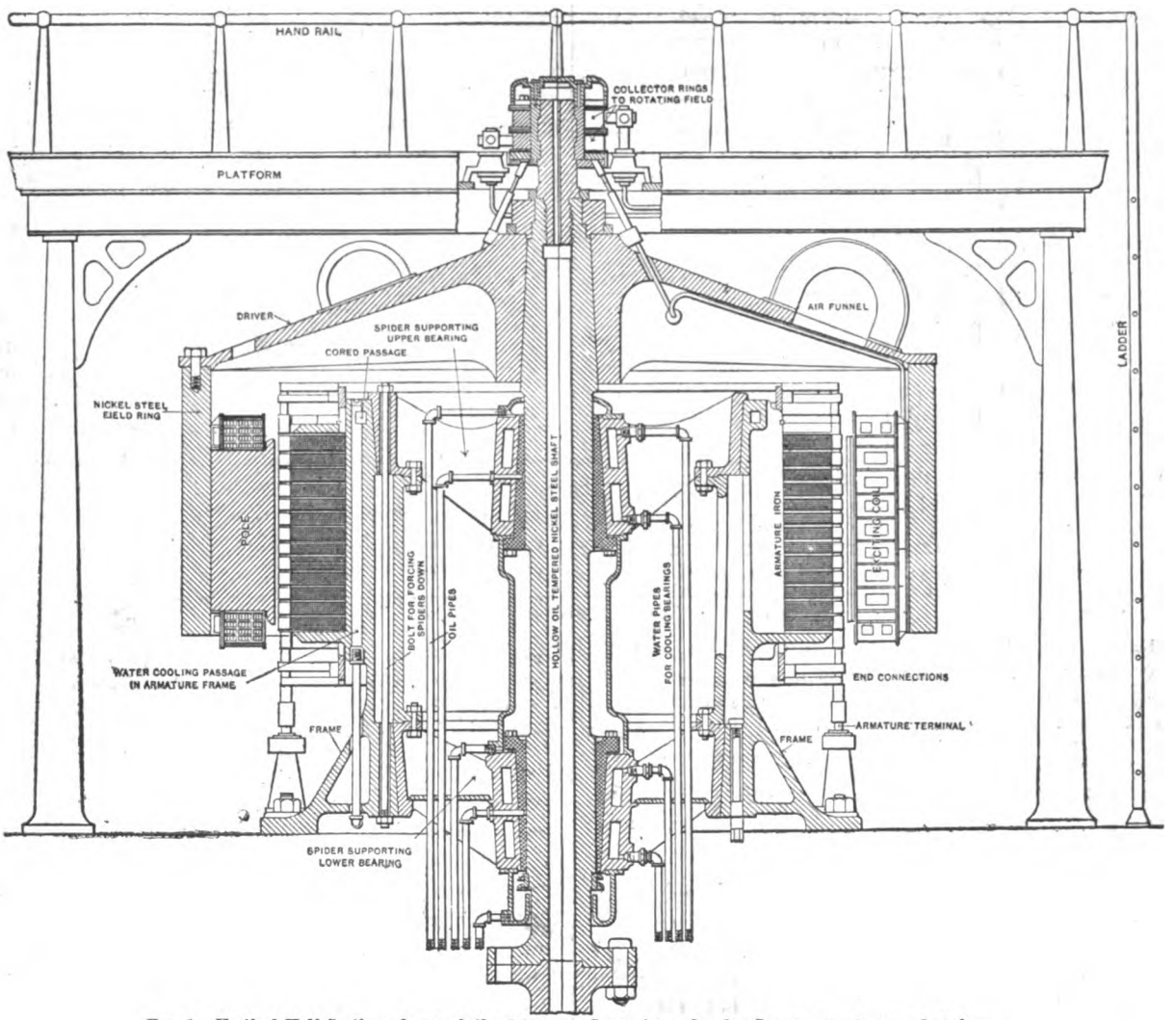

FIG. 1.—Vertical Half Section of one of the 5,000-h.p. Generators, showing Improvements over first form.

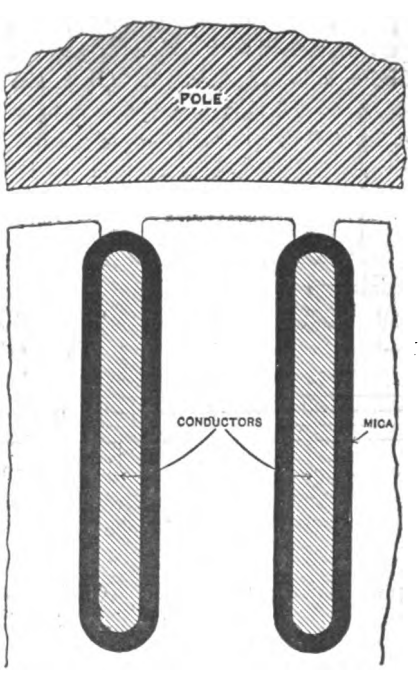

FIG. 2.—Full-size Cross-Section through Two Armature Slots of New Generators.

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in accurate concentric alignment with the frame, and the other is the cooling arrangement. The spiders holding the two bearings are forced downwards by means of bolts shown into tapered seats bored in the interior of the frame. The bearings themselves are also forced to a tight fit in the spiders. These bearings are piped to an oil-circulating system, as shown in the left-hand section, and chambers cored in them are piped for the circulation of water for cooling purposes, as shown in the right-hand section. The frame itself has vertical ribs, in which the armature laminations are dovetailed, and through these ribs run vertical passages, as shown in the left-hand section, through which passages water is circulated for the purpose of cooling the iron.

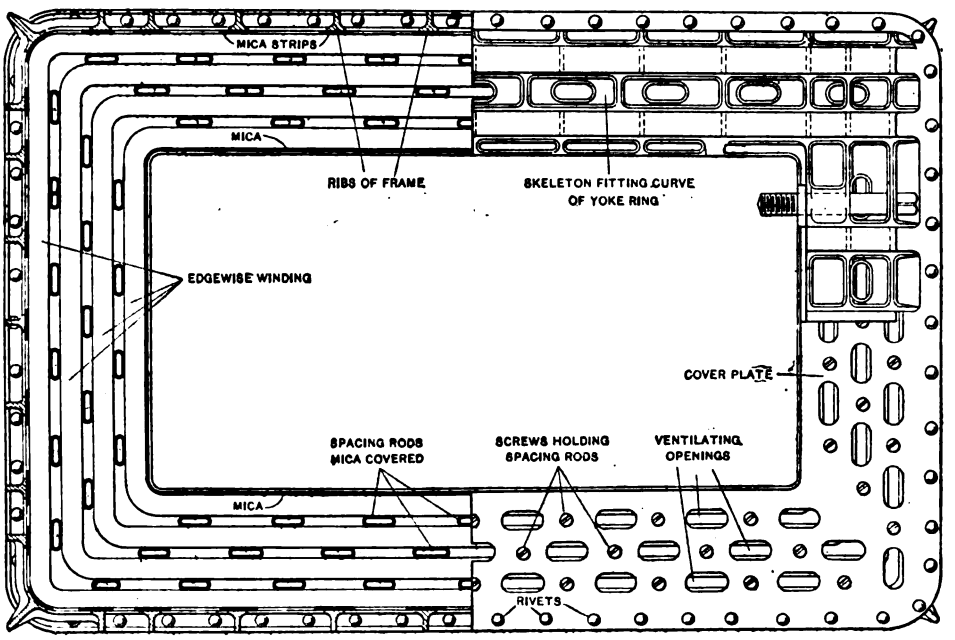

FIG. 3.—Construction of the Four-layer Edgewise Winding of the New Generators.

Pipes connect the lower ends of these passages, while the upper ends are capped and connected together by means of small square cross-passages cored in the casting. The connections are such that the water must flow up one passage and down the next, and so on throughout the whole series around the frame. In addition to this, there are the usual ventilating spaces in the armature iron through which air is drawn by the centrifugal action of the fields and air

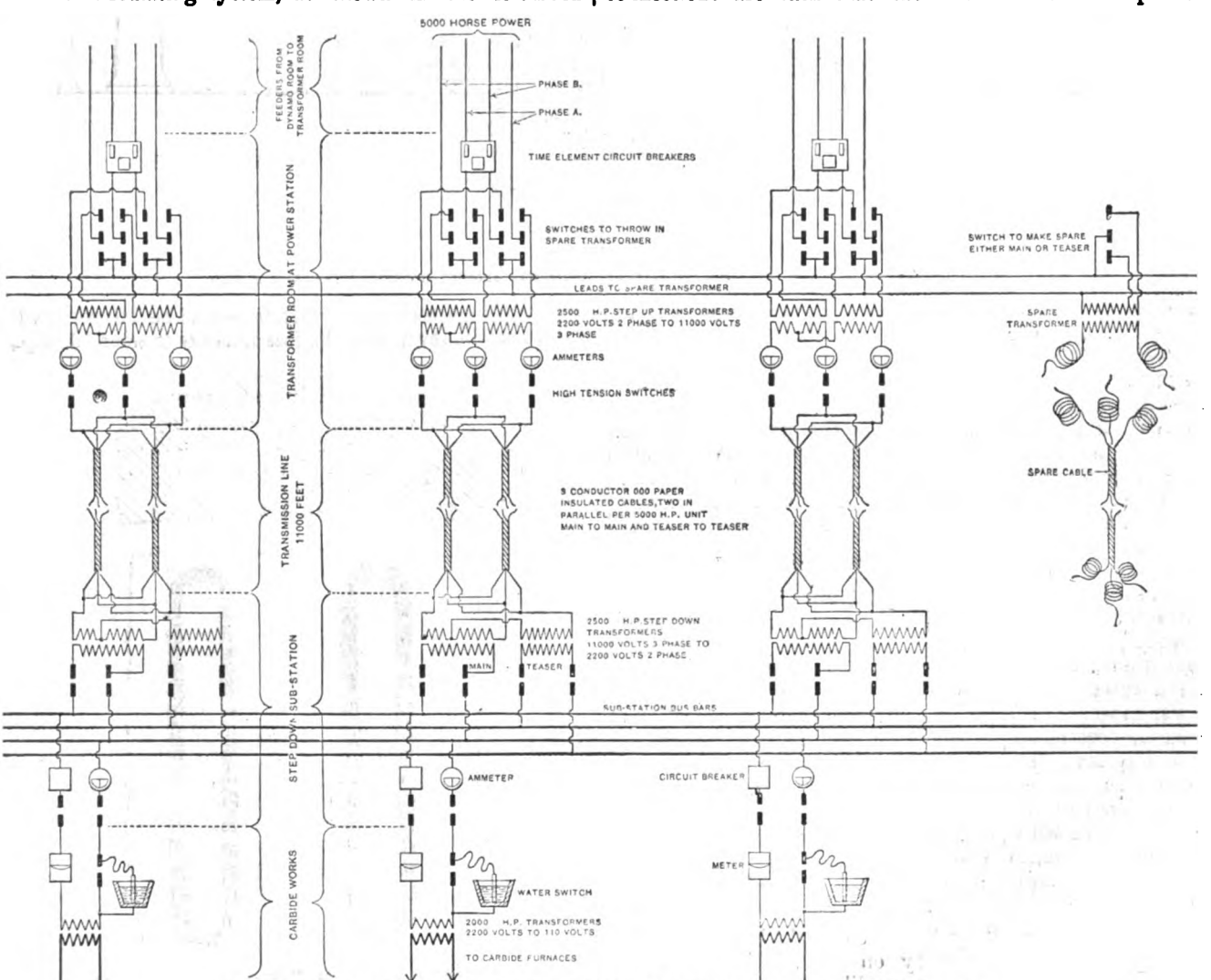
5000 HORSE POWER
FEEDERS FROM DYNAMO ROOM TO TRANSFORMER ROOM
PHASE B.
PHASE A.
TIME ELEMENT CIRCUIT BREAKERS
SWITCHES TO THROW IN SPARE TRANSFORMER
SWITCH TO MAKE SPARE EITHER MAIN OR TEASER
LEADS TO SPARE TRANSFORMER
2500 H.P. STEP UP TRANSFORMERS 2200 VOLTS 2 PHASE TO 11000 VOLTS 3 PHASE
SPARE TRANSFORMER
AMMETERS
HIGH TENSION SWITCHES
TRANSFORMER ROOM AT POWER STATION
3 CONDUCTOR 000 PAPER INSULATED CABLES, TWO IN PARALLEL PER 5000 H.P. UNIT MAIN TO MAIN AND TEASER TO TEASER
SPARE CABLE
TRANSMISSION LINE 11000 FEET
2500 H.P. STEP DOWN TRANSFORMERS 11000 VOLTS 3 PHASE TO 2200 VOLTS 2 PHASE
MAIN
TEASER
SUB-STATION BUS BARS
STEP DOWN SUB-STATION
AMMETER
CIRCUIT BREAKER
METER
WATER SWITCH
2000 H.P. TRANSFORMERS 2200 VOLTS TO 110 VOLTS
TO CARBIDE FURNACES
CARBIDE WORKS

FIG. 4.—Diagram of Carbide Transmission Circuits from Generator Switchboard to Carbide Furnaces.

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funnels mounted on the drivers. The field coils are made up of bare copper strip, but differ from the usual edgewise coils, in that there are four layers. Fig. 2 shows a full-size cross-section of two of the armature slots, while Fig. 3 shows a plan and partial section of one coil. The four layers are separated from each other, and rigidly held in place by means of metal spacing rods covered with mica and shellac insulation. Between these spacing rods there is ample room for the ventilation of each layer, the circulation of air being permitted by means of ventilating openings in the casing. This casing consists of a brass framework of skeleton ribs and perforated plates riveted together, the spacing rods being fastened to the plates by screws. The edgewise turns of each layer are insulated from each other by strips of built-up mica and shellac insulation inserted between them. After describing the machines, Mr. Woodbridge gives full details of the governing arrangements now being used for controlling the large turbines. He also gives some most interesting information of the transforming plant required both for the local distribution of power and for its transmission over long-distance lines. The illustration (Fig. 4) gives a diagram of the circuits used in transmitting the power to the calcium carbide factory which is mentioned above, and to which we referred in a previous issue. It will be remembered that in this case it was advantageous to transform up to 11,000 volts, as it was found that the distribution at 2,200 volts involved much too heavy copper mains, and also there would be trouble in the conduits due to the heating of the same. In this case, however, as mentioned above, some 15,000 h.p. are being used. The length of the conductors, however, is only about 11,000ft. The transformers used in connection with this power supply are of 2,500 h.p., and are cooled by means of oil in which water-pipes are placed to assist in getting the heat away from the oil.

THE FUNCTIONS OF THE ENGINEER.*

BY SIR WILLIAM HENRY PREECE, K.C.B., F.R.S., PAST-PRESIDENT INST.C.E., PAST-PRESIDENT I.NSTE.E.

The success of the modern engineer is due to the fact that he has buried in the depths of oblivion the much-vaunted empirical rule of thumb, and that he has elevated to the heights of science the observations of exact practice and the exercise of pure reason. The principle of doubt, which is the root of all scientific enquiry, forces him to consider every phase of weakness in the materials that he employs in his structures, to examine every possible cause of error in his designs, to anticipate every source of failure in his work. The principle of faith, which is the outcome of the growth of his experience, must be continually illuminated by the light of progress and controlled by the patient development and consideration of the too-long-hidden laws of Nature. The engineer must maintain his acquaintance with ever-growing science so as to be able to fulfil promptly and accurately his duty, which is the application of the great principle of energy and the utilisation of the marvellous properties of matter to the wants, comfort, and happiness of man.

In considering the functions of the engineer we have to consider his practice and his making. His practice—what has he got to do? The practice of engineering can be divided into three branches: civil, military, and naval. The term civil was originally introduced to distinguish the practical man of peace from the practical man of war. Engineering applied to our wants and comforts is a very different thing to that applied to the destruction of our foes or to protect ourselves from their wish to destroy us. War is waged both on land and sea, and as the conditions involved in attack and defence in modern times have become so totally different in these two cases, the term military has been gradually confined to the operations of our army on land, while the term naval is applicable to the warlike operations of our fleets. England owes her present position as the centre of a great empire to her naval supremacy, and she has acquired this supremacy as much by the inventive, constructive, and maintaining powers of her working engineers as by the mighty deeds of her fearless fighting sailors. Civil engineering aids us not only to build that haven of rest and comfort that we call "home," but to surround it with the elements of health—pure air, pure water, pure food, pure light. If we aggregate together in towns, or scatter ourselves in country districts, it supplies us with all possible means of transport by road, river, and rail, and of means of intercommunication by post, telegraph, and telephone. These means of annihilating time and space are not only interurban in our own country, but international in our continents, and in a wider sense imperial, cosmical, and universal, over the whole earth. The world is knit in one, connected whole by wire. We know to-day from that triumph of art, science, and culture—the intelligent and free British daily public Press—the history of nearly all that took place yesterday over the whole globe.

The engineer fears not the infinitely great, for the stars in their courses aid him to survey the land and to cross the deep with safety. He spurns not the infinitely little, for the molecules in their mutual actions and reactions supply him with those metals and those elements of purity and strength which give him the means to resist the forces of Nature so as to span the broad channel, laugh at the foaming river, build the palace of glass at Sydenham, cover acres of ground so as to display this year in Paris the goods, manufactures, and works of art, industry, and utility of the whole world. The engineer utilises matter wherever it can be found; he delves into the crust of the earth for ores and minerals which give him wealth, currency, protection, and strength; he dives into the sea to survey the bottom as a bed for his cables, and to see that he has secured proper foundations for his moles, piers, and breakwaters; he explores the surface of the earth for articles of necessity, of use, and luxury. He irrigates the land, to prepare it for the growth of pure and wholesome food, for the supply of cheering and sustaining drinks, for the maintenance of the stores on the shelves of the doctor, and for those articles of pure clothing that add so much to the comfort, cleanliness, and health of man. He utilises for his purposes the great principle of energy so as to transform it at his will into its various forms of heat, light, electricity, sound, chemism, and material motion. By these agencies he transforms crude matter into its various elements, compounds, and states so as to secure permanence, strength, and value. Life is not free from his grasp. He has developed the empire of bacteria, and has encouraged the minute microbe in countless armies—to liquefy and purify our sewage, and to become the scavenger of our homes and our cities. He has by defensive measures freed the soil and the river from those ruthless bacterial enemies who invade our frames, and bring disease and death in their train.

Engineering is divided into various sections, many of them having their own institutions and their own publications. The definition of a civil engineer, as given in the charter of the institution, is very comprehensive. This institution is "a society for the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in Nature for the use and convenience of man, as the means of production and of traffic in states both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange, and in the construction of ports, harbours, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns." It is difficult to classify the sections of engineers into any logical order; but I have attempted in the accompanying table to arrange methodically the various branches upon the same principle as we draw up a genealogical tree, for every branch emanates by direct descent from the one root, engineering, which is applied science. [This tree is subdivided as follows,—ED. *E. E.*]

* Address delivered on Feb. 8, 1900, to the Glasgow Association of Students of Institution of Civil Engineers.

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ENGINEERING.

NAVAL.—Artillery, gun mountings, explosives—Shipbuilding—Marine engineering — Hydrography — Application of steam, hydraulics, and electricity to the auxiliary machinery of ships—Torpedoes and submarine mining.

MILITARY.—Fortification—Artillery and explosives—Surveying and reconnaissance—Submarine mining—Signalling and telegraphy—Barracks construction—Traction, road, and railway making—Searchlights—Ballooning.

CIVIL.—*Domestic.*—Bells and signals—Buildings (architecture)—Drainage — Lifts — Lighting — Ventilation — Warming — Water supply.

Municipal.—Electrical energy—Gas—Housing the working classes—Hydraulic power—Hygiene—Markets—Overcrowding—Parks and recreation grounds—Public buildings—Public lighting—Refuse destruction—Sewerage and drainage—Slaughter-houses—Smoke prevention—Streets—Tramways.

Interurban. — Bicycles — Canals — Motors — Railways — River navigation—Roads—Telegraphs—Telephones—Surveying.

National.—Breakwaters — Ceramics — Chemical industries — Coinage — Construction of machinery and engines — Docks — Harbours—Irrigation and agriculture—Lighthouses—Management of estates—Manufacturing processes—Metallurgy—Mining and quarrying — Refrigeration — Signal stations — Trigonometrical survey.

International.—Connection of national surveys—Lighthouses—Posts (letter carriage—Steam navigation—Submarine telegraphy.

Cosmical (or Universal).—Astronomical mensuration—Geodesy—Hydrography—Manufactures.

The growth of invention in early ages was very slow. Man sheltered himself in caves. How long did it take him to devise a tent, or a hut, or a house? How long to protect himself with clothing? How long to construct weapons of offence and defence, not only to protect himself from wild beasts, and from his neighbours, but to secure for himself food and raiment. The first protection from weather was probably the skins of the animals he hunted, killed, and ate, and the first art acquired—the making of leather. How long did it take him to obtain a knowledge of the use of fire, and of the means of producing it artificially so as to cook his food, and to bake the plastic clay into pots and pans for drinking and eating purposes?

We have no record of these early stages of the evolution of the human being. The first known picture depicts him as a hunter. Ages elapsed before the conception of a record "engraved upon the rock for ever" seems to have occurred to him, and though stone, papyrus, clay, skin, and wax gave him material upon which he could record in elementary pictures his victories, his virtues, and his commands, many centuries passed before the greatest invention the world has ever acquired—the alphabet—occurred to some smart Phœnician, probably in the land of Egypt, where picture writing, hieroglyphy, had reached its acme. It has taken 3,000 years to mature this invention. The alphabet we use to-day is a direct descendent of that first Phœnician attempt to indicate the elementary sounds of speech by letters. But what a change has occurred since the next great invention in this direction—printing! The brain is now excited by the publication of every new fact extracted from Nature's storehouse. Inventions spring up like mushrooms. They are published by the Press to the whole world at once. Innumerable minds of all nations are thus set to work to utilise, develop, and improve them. Advance is rapid, and progress proceeds at a compound interest rate. I said it took 3,000 years to mature the alphabet. It has taken 450 years to perfect printing, but 60 years in our days have matured telegraphy and photography, and only 60 months have been sufficient to apply Röntgen rays to assist the physician to apply his gentle art to restore to health the maimed and wounded. Such is the advantage of publicity!

Why such marvellous constructive skill and scientific progress should have been developed on the banks of the Euphrates and the Nile on the Old, and in Mexico and Peru on the New Continent, so early in the history of the world, is a mystery of the development of the mind that remains to be satisfactorily explained as much as the persistent conservatism of the negro and the gipsy of the present day. The wicker hut depicted on Egyptian bas-reliefs 3,000 years ago is the same dwelling-place of the same race in the present day.

The luxurious, roomy, and well-warmed southern villa of their Roman conquerors failed to commend itself permanently to the mind of the unrefined ancient Briton. Nevertheless, the Roman left us the arch, showed us how to build a bridge, and left us his straight and admirable road. The words arch, pont, and street remain in our languages historical memorials of those early colonists.

The rapid progress of modern engineering is phenomenal. Practice grows by leaps and bounds. Take any form of energy and examine its utilisation in any field of industry. Take only one instance of the application of electricity. See how it comes to the aid of the sailor! It controls the rudder, it ventilates the interior and the living space of the ship, it forces the draught and assists the raising of steam, it revolves the turrets, it trains and controls the guns, it handles the ammunition, it purifies the drinking water, it lights up the ship internally, it enables the captain to sweep the horizon with the brilliant rays of the searchlight, and to communicate with his tender, or with his commanding officer across space independent of weather, night, season, fog, or rain. It would lengthen this address too much to illustrate this point further. Light, sound, heat, chemism, and mechanics have been equally active in the service of man, and have helped to specialise in many directions the functions of the engineer.

The Making of the Engineer.—It is idle to ignore the fact that the modern engineer is the outcome of high-class and long-sustained education, either imparted or self-acquired. Education means generally the training of the intellectual, moral, and physical faculties of youth, but the education of the engineer never ceases as long as he remains in active practice. I am still in school, and rarely fail to acquire some new fact each day of my life. The first foundation is clearly a broad, solid, general education, not specialised in any way until the pupil has reached the stage when he can work and think for himself. But from the very earliest years—in fact, from infancy—I advocate the cultivation of the powers of observation, a systematic training of the memory, and an encouragement of the exercise of thought. This is, in reality, the scientific method. Many people advocate the early teaching of science, but I do not. I advocate the collection and naming of plants, the love of animals and knowledge of their habits, the observation and explanation of the daily occurrences in the house, the air, and the ground. The fire, a candle, the teapot, cooking, blacking boots, the dewdrop, clouds, rain, wind, and storm, the ebb and flow of the tide, the performances of tops and bicycles, familiarly explained, excite a love of nature and of science, and train the mind to observe, to think, and to remember. Cramming the young mind with ill-digested text-book science, illustrated by experiments that generally fail, excites ridicule—the common accompaniment of ignorance.

The engineer must be a scientific man. Science deals with the facts of Nature, their laws and their theory. The engineer applies this knowledge to the uses of mankind. His practice means the correct design and due execution of works. The present president of the British Association, in his inaugural address delivered at Dover, drew no distinction between natural knowledge (science) and applied science (engineering). His illustrations to glorify the former were drawn from the triumphs of the latter. Sciences are experimental, such as chemistry, mechanics, and physics, and observational, such as botany, zoology, geology, geography, astronomy, biology, etc. They are very numerous, and, as engineering, is only another term for applied science, it is clear that an engineer would waste his time in acquiring abstruse sciences that would be of no subsequent use to him. He must confine himself to those branches of science which will be of service to him in his future career, so as to enable him to apply them to living, industry, and commerce. Mathematics, the shorthand of thought and the purest form of logic, experiment, the handmaid of observation, measurement, the instigator of accuracy and precision, and reasoning, the organ of common-sense, are the tools that shape his store of knowledge which memory brings to his help when he has to practise what he has learnt. The boy who has passed well through the ordinary curriculum of school, and proceeds thence into a university, from which he emerges as a young man, not only well imbued with the refining influences of literature and art, but with a well-earned

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degree of science, is fully prepared to commence his engineering training and to enter the workshop or the drawing office, where alone he can acquire that combination of knowledge and skill, and that training of the brain and the hand for mutual aid which is called technical education.

The Institution of Civil Engineers will now admit into their body only those who can produce the certificate of such an educational career as I have indicated above, or who can pass an examination which will give evidence of his possessing similar qualifications. A scientific man can become an engineer only when he has become an expert through practice and experience.

It is not a question between science and practice; it is a question between science and rule of thumb. Practice is always there, but rule of thumb means rule of error, until by repeated failures rule of thumb becomes rule of right, which means the victory of organised common-sense. Organised common-sense is a very good term for science. Scientific men talk nonsense when they observe differences between science and practice, and so-called practical men act foolishly when they ignore science and assert that an ounce of practice is worth a ton of theory. Practice based on true science means immediate success and economy; practice based on rule of thumb means error, delay, and excess of estimates. The engineer cannot neglect the laws of Nature any more than the scientific man can ignore the success of practice. The science of the chair has, however, often been obsolete or behind the day. The professor is not sufficiently in touch with the industrial and economical interests of the country. It happens that in my own special branch of the profession practice has always been in advance of theory. The progress of telegraphy and telephony owes nothing to the abstract scientific man. The fundamental principles and natural facts that underlie the practice of electrical engineering are the teachings of actual experience, and not the results of laboratory research or professorial teaching. The science is, however, now established, and those who are academic students have the advantage of acquiring a knowledge of facts and principles in the classroom before they commence their practical career. Their path is thus much cleared, and their progress expedited. They start well equipped mentally to grasp and comprehend the art of their profession.

Smeaton, Watt, Telford, Stephenson, Fairbairn, Whitworth, and all our early engineers had to acquire their own natural knowledge by their own individual investigations. They had to seek out and determine first principles for themselves. All that is now changed. The science of to-day is the science of the Victorian era. The engineer is not now required to research as much as his predecessors. There are now physical laboratories where it can be done for him, but this must not tempt him to lessen his enthusiasm in verifying the facts of Nature by experiment. Doubt must always be transformed to faith.

The civil engineer of eminence has not only to know thoroughly the science, but to conduct the practical operations of his profession. The lives of human beings are entrusted to his designs. People have faith in the safety of his ships, long tunnels, bridges, and railway trains. He is called upon to advise on policy, to deal with commercial management, to act as arbitrator or judge in many important intricate judicial cases, and to appear in courts of law and committee-rooms of Parliament as an expert witness. The mental qualities of the engineer must, therefore, be of the very highest order. His scientific training and his world-wide practice have broadened his views and enlarged his mind. Above all, his character must be above all reproach. The honour of the engineer is the honour of his profession. The Lord Chief Justice's Bill was welcomed by every member of the Institution of Civil Engineers. The evil it is desired to suppress is very great and very wide, but it is not the characteristic of the engineer.

Let me, in conclusion, impress on you the antiquity and the universality of the functions of the engineer. Tubal Cain was an instructor of every artificer in brass and iron, and this before the Flood. The very earliest remains of Egyptian, Babylonian, and Assyrian temples and monuments indicate a wonderful knowledge of the strength of materials. The Cloaca Maxima of the early Latin King Tarquinius Priscus exists still, though built 2,600 years ago. In the track of war and diplomacy in the earliest days of history went trade and commerce. The general became the engineer. Western Asia was covered with roads not only to facilitate the transport of troops and chariots, but to assist the merchant in the distribution of his wares. Intercourse of all kinds has always been the outcome of civilisation. The balance of power falls to the strong. In days of old it was to the strong physically. In modern days it is more to the strong mentally and financially. The greatest political gift that mind can give to man, the greatest security for peace and comfort, is the ability to wield the great powers of Nature so as to destroy human life with the greatest rapidity and at the greatest distance. An overpowering fleet and an efficient army are our insurance for security at home. There is not a habitable spot on the face of the earth that does not bear traces of the presence of the engineer. He is the great civiliser. He not only immediately follows, but he sometimes even precedes the military conqueror. He distributes peace and goodwill without the accompaniments of fire, blood, and famine. Mr. Cecil Rhodes is opening up Africa with the "wonder-working wire." Khartoum has been brought within 70 hours of Cairo by train, and ere long, when peace is restored in that self-disturbed country South Africa, Cairo and Cape Town will be in direct and immediate communication by telegraph, and eventually by rail.

The engineer is not only a benefactor to his race, but he is a necessity of the age.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on Thursday, the 8th inst., before the reading of Mr. P. Sellon's paper, the PRESIDENT announced that Prof. Hughes had kept the Institution in mind even to the last. A letter had been received from the executors of the deceased gentleman, who had left a bequest in his will to the Institution of £2,000, free of legacy duty. The will had not then been submitted to probate, but steps were being taken for that purpose. In the will the testator desired that the money should be invested by the Institution for the purpose of founding a scholarship, which was to be called the David Hughes Scholarship. The scholarship was to be awarded to a student of the Institution in exactly the same way as the Sir David Salomons Scholarship. The Council had suitably acknowledged the receipt of the letter. A portrait of the late Prof. Hughes which was exhibited on the table, had been lent to the Institution by Mr. Spooner, of Regent-street.

The SECRETARY proceeded to read the names of the officers elected at the Newcastle branch of the Institution. They were as follows:—chairman: Mr. A. W. Heaviside; vice-chairman: Mr. W. D. Hunter; hon. secretary: Mr. J. F. Snell; and committee: Messrs. C. Burnett, H. F. Friedrichs, J. Holmes, J. A. Jeckell, W. C. Mountain, and the Hon. C. A. Parsons.

Mr. P. SELLON then read his paper on "The Standardisation of Electrical Engineering Plant," the first part of which was given in our last issue.

The Standardisation of Electrical Engineering Plant.

BY R. PERCY SELLON, MEMBER.

(Concluded from page 202.)

5. If, then, the principle be accepted that standardisation, with the qualification named, is for the advantage alike of producer and user, we may pass on to consider how far, and by what means, it is capable of beneficial extension. Standardisation presupposes such a substantial and sufficiently enduring demand for an article as to make it worth the while of manufacturers to incur the requisite outlay in time and money to achieve it. Hence, as already mentioned, in the early and experimental stages of an industry it is neither possible nor desirable. The period at which it becomes practicable is largely one for the judgment of producers. But from the preceding argument it is evident

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that the user plays an influential part in hastening or retarding its advent: as is proved by the fact that standardisation is much further advanced for the same character of products abroad than in Great Britain. This clearly indicates that it is the system in this country, and not the infancy of the industry, that is responsible for this condition of affairs. Standardisation, to be enduring, must proceed on lines which shall be beneficial alike to the producer and user. It follows that any attempt to stereotype detail of design or construction must ultimately fail in its object, because such a course will not be adapted to the varying manufacturing facilities of different producers, nor will be acceptable to the user, since it must prove restrictive of constructional improvement and involve the buyer in paying a higher price for an article which the producer will decline to effectively guarantee. In other words, enduring mutual advantage to producer and buyer will only result if standardisation be confined to ends or performance, and not to means or constructional detail. Under the term "ends" or "performance" as opposed to "means" or "constructional detail" would fall the following: (*a*) steam pressure; (*b*) electrical pressure of generation; (*c*) electrical pressure of distribution; (*d*) periodicity of alternate-current generation; (*e*) sizes of generating steam units (say in convenient fractions or multiples of horse-power or kilowatts); (*f*) sizes of mains (say in convenient fractions or multiples of a square inch or other unit); (*g*) sizes of motors; and similarly as regards transformers, arc and incandescence lamps, and essential fittings and accessories. That much can be done in this direction is evidenced by the ease and rapidity with which, as regards electric traction, we have acquiesced in the standards of pressure, general construction, and types of motors, trucks, and accessories, prevalent in America. There can be little doubt that had practical electric traction originated with us, instead of being an imported art from the United States, we would still be in the stage in which buyers' engineers would be creating different "standards" of their own composing, while every producer would be expected to manufacture and guarantee a corresponding variety of designs. The author understands that most of the leading electric cable manufacturers in this country have already adopted, by agreement among themselves, certain standards in their own department of production. The question of standardisation has also for some time received attention at the hands of the Electrical Engineering Plant Manufacturers' Association. Again, the Municipal Electrical Association, a body thoroughly representative of the municipal users' interests, has given evidence of its readiness to co-operate with manufacturers in the direction of standardisation of the commercial conditions of contracts for electrical plant. Its representatives have met in conference representatives of the Electrical Engineering Plant Manufacturers' Association and have agreed upon certain general conditions as a basis for specifications of plant required by local authorities; and the outcome has undoubtedly been beneficial. It is evident, therefore, that the whole subject is ripe for consideration on the broader basis of harmonising, by adequate representation and discussion, all sections of users' interests with those of producers.

6. It is not possible to enter in this paper upon the consideration of the actual formulæ which might constitute standards for the future. This is a very large and important question demanding much careful thought and discussion. The machinery for this purpose already exists, at any rate as a nucleus, in the Uniformity Committee of this Institution, appointed shortly after the submission of a highly suggestive paper on "Uniformity of Plant," by Mr. C. H. Wordingham before the Municipal Electrical Association in the summer of 1898. But beyond a word of advice on the subject of standard periodicities, nothing has so far issued publicly from the deliberations of this committee extending over 18 months. At this rate we may become irretrievably committed to many steps which all may live to regret, before effective results are obtained; for an unexampled expansion in every department of electrical engineering, notably those of electric traction and of power distribution over extensive areas, appears about to take place in this country. The author ventures to suggest that additional weight and acceleration to the work of the committee of the Institution would be given if it were strengthened by the addition of representatives of all interests concerned—viz., those of the manufacturer, user, consulting engineer, and user's engineer. The Institution might also encourage the submission of papers suggestive of standards for various classes of electrical engineering plant and accessories. These, together with the views which would be brought out in discussion, would serve as a valuable guide to a representative committee. In conclusion, the propositions which the author has endeavoured to establish may be briefly recapitulated as follows:

(*a*) Standardisation, to a greater degree than at present exists, is in the interest of the manufacturer, as a means of facilitating repetition production and of meeting the competition of standardised foreign manufactures.

(*b*) Standardisation of "ends" or "performance" as distinct from "means" or "constructional details" is equally in the interest of the user, by securing for him low purchase cost, prompt delivery, freedom from the risks of experimental design, and full manufacturer's guarantees.

(*c*) The relative absence of standardisation in Great Britain, in contrast with other countries, is mainly traceable to the prevailing system wherein the user's engineer specifies "means" or constructional details," instead of confining himself to "ends" or "performance."

(*d*) The determination of standards by organised effort rather than by the slow and costly process of "trial and error" is desirable, and should be undertaken under the auspices of the Institution of Electrical Engineers, as representing the interests of both producer and user.

P.S.—The accompanying table of central stations in Great Britain, with particulars of system, periodicity, generating pressure, and distributing pressure employed, is adduced for the convenience of members.

TABLE SHOWING SYSTEM IN PERIODICITY, GENERATING PRESSURE, AND DISTRIBUTING PRESSURE IN THE CENTRAL STATIONS OF GREAT BRITAIN.

Name of Station.	System.	Periods.	Generating pressure. Volts.	Pressure at lamps. Volts.
Aberdeen	Direct three-wire	—	448	220
Aberystwyth	Alternating	100	2,050	100 & 200
Alderley Edge	Direct three-wire	—	420 460	210
Altrincham	Alternating	80	2,000	100
Ashton-under-Lyne	Direct three-wire	—	440 Traction 550	200
Ayr	Alternating	60	2,100	100 & 200
Barking	Direct three-wire	—	460-500	230
Barnsley	Direct three-wire	—	450	230
Barrow	H.T. continuous	—	1,100	220
Bath	Alternating	100	2,000	100
Bedford	Alternating	60	2,000	100
Belfast	Direct three wire	—	440-500	220
Bexhill	Direct three-wire	—	440	—
Birkenhead	Direct three-wire	—	460	230
Birmingham	Direct three-wire	—	—	110 & 220
Blackburn	Alternating	50	2,000	110 & 220
,,	Direct three-wire	—	230-250	110 & 220
Blackpool	Alternating	83	2,000	200
Bolton	Alternating	83	2,000	100
Bournemouth	Alternating	100	2,200	100 & 200
Bradford	Direct three-wire	—	250 & 500	230
Bray	Alternating	60	1,000	100
Brighton	Direct three-wire	—	300	115 & 230
,,	Alternating	70	2,400	115 & 230
Bristol	Alternating	93	2,050	105 or 210
Burnley	Direct three-wire	—	220-240	220
Burton-on-Trent	Alternating	75	2,000	100
Bury	Direct three wire	—	230	220
Cambridge	Alternating	90	2,000	100 & 200
Canterbury	Direct three-wire	—	440	200
Cardiff	Alternating	40	2,500	100 & 200
Carlisle	Direct three-wire	—	460	230
Charing Cross Co.	Direct three-wire	—	100 & 1,000	100 & 200
Chatham	Alternating	100	2,400	100
Chelmsford	Alternating	100	2,100	100
Chelsea	Direct three-wire	—	—	100 & 200
Cheltenham	Alternating	93	2,200	100 & 200
Chester	Direct three-wire	—	440	210
Chislehurst	Direct three-wire using motor-altr. and buying H.T. energy	—	420	210
City of London	Alternating	100	2,000	100 & 200
Coatbridge	Alternating	100	2,080	100

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Name of Station.	System.	Periods. ⌒⌣	Generating pressure. Volts.	Pressure at lamps. Volts.
Colchester	Direct three-wire	—	220	105
Cork	Direct three-wire	—	500	230
County of London.	Alternating	100	2,100-2,200	100
,,	Direct	—	530	Power 510
,,	Alternating (two-phase)	50	2,100-2,200	200
Coventry	Alternating	87	2,000	200
Croydon	Alternating	60	2,000	200
Crystal Palace Co.	H.T. direct	—	1,000-1,100	100
Darwen	Direct three-wire	—	460 500	230
Derby	Alternating	40	2,000	102 & 205
Dewsbury	Direct three-wire	—	250	110 & 220
Dover	Alternating	100	2,000	100
,,	Direct (tramway)	—	500	500
Dublin	Alternating	83	2,100	100
Dundee	Direct three-wire	—	220	200
Ealing	Alternating	40	2,000	102
,,	Series D.C. arc lighting	—	1,800	100
Eastbourne	Alternating	83	1,800	100
,,	Series D.C. arc lighting	—	—	—
Eccles	Alternating	50	2,000	200
Edinburgh	Direct three-wire	—	—	115 & 230
,,	Alternating	50	2,100	—
Exeter	Alternating	100	2,000	100
,,	Series D.C. arc lighting	—	1,600	—
Folkestone	Direct three-wire	—	460	210
Galway	Direct	—	130	110
Glasgow	Direct	—	500 & 600	250
Gloucester	Direct three-wire	—	250	—
Guildford	Direct	—	400	200
Halifax	Alternating	80	2,000	200
,,	Direct for tramways and power	—	—	—
Hammersmith	Alternating	50	2,200	110
Hampstead	Alternating	90	2,000	100 105
,,	Series D.C. arc lighting	—	1,300	—
Hanley	Alternating	100	2,000	200 & 100
,,	Series D.C. arc lighting	—	1,500	—
Harrogate	Alternating	50	2,000	200 & 100
Harrow	Direct three-wire	—	470	220
Hastings	Alternating	100	2,000	100 & 200
Hove	Direct three-wire	—	220	220
Huddersfield	Alternating	100	2,000	100 & 200
Hull	H.T. & L.T. direct	—	2,250, 450 & 225	110 & 220
Islington	Alternating	50	2,000	100 & 200
Kelvinside	Direct	—	150	100
Kensington and Brompton	Alternating	—	2,000	100
Kensington and Knightsbridge	Direct three-wire	—	110 & 220	100 & 200
Keswick	Alternating	75	2,000	—
Killarney	Alternating	100	2,000	100
Kingston-on-Thames	Alternating	77	2,100	105
,,	D.C. arc lighting	—	1,000	—
Lambeth	Alternating	—	—	—
Lancaster	Direct three-wire	—	240 & 120	200 & 100
Larne	Alternating	100	2,200	100
Leamington	Direct	—	113	—
Leeds	Alternating	83	2 000	100 & 200
Leicester	Alternating	50	2,000	100 & 200
Leith	Direct three-wire	—	460	230
Leyton	Direct three-wire	—	—	150
Lincoln	Direct three-wire	—	460	230
Liverpool	Direct	—	—	230
Llandudno	Direct three-wire	—	440	220
London (part)	Alternating	83	10,000	—
Londonderry	Continuous arc lighting	—	3,000	—
Manchester	Direct multi-wire	—	400	100, 200 300, or 400
Metropolitan Co.	Alternating	—	—	200 & 100
,,	Direct three-wire	—	—	200 & 100
Middlesbrough	Direct	—	440	—
Monmouth	Alternating	60	3,000	120
Morecambe	Direct	—	1,400	220
Morley	Alternating	60	2,000	200
Nelson	Direct	—	120	112
Newcastle-on-Tyne (part)	Alternating	100	2,000	100
,,	Alternating	80	1,000	100
Newington	Direct three-wire	—	450 500	220
Newmarket	Direct three-wire	—	420-460	210
Newport	Alternating	87·5	2,000	100
Northampton	Direct three-wire	—	220	105 & 210
Norwich	Direct three-wire	—	250	110 & 220
Nottingham	Direct three wire	—	220	100 & 200
Notting Hill	Direct three-wire	—	200	100 & 200
Oldham	Direct	—	—	210
Oswestry	Direct	—	230	220
Oxford	Direct	—	1,000	100
Paisley	Alternating	50	2 000	200
Pembroke	Direct three-wire	—	250	—
Plymouth	Alternating	50	2,000	200 & 109
,,	Direct for tramways	—	520	500
Pontypool	Direct	—	135	100
Poplar	Direct	—	450-570	—
Portsmouth	Alternating	50	2,000	100
Prescot	Alternating	100	2,000	100
Preston	Direct three-wire	—	120 & 250	110 & 220
,,	Alternating	50	2,000	220
Rathmines	Direct three-wire	—	250	—
Reading	Alternating	67	2,000	100 & 200
,,	Direct three-wire	—	400 450	100 & 200
Richmond	Direct three-wire	—	115 230	110 & 220
Rochdale	Direct three-wire	—	460 480	—
St. Helens	Alternating	60	2,000	100 & 200
,,	Direct three-wire	—	460	230
St. James's, Westminster	Direct three-wire	—	—	107
St. Pancras	Direct three-wire	—	—	110 & 220
Salford	Direct three-wire	—	—	—
,,	Alternating	75	3,000	—
Salisbury	Direct three-wire	—	450	210
Scarborough	Alternating	80	2,000	100 & 200
Sheffield	Alternating	100	2,050	100 & 200
Shoreditch	Direct	—	1,100	—
Shrewsbury	Direct three-wire	—	420	210
Southampton	Direct three-wire	—	230	100 & 200
,,	Alternating	50	2,200	100 & 200
Southport	Alternating	50	2,100	100 & 200
South Shields	Alternating	50	2,000	110 & 220
Stafford	Direct three-wire	—	108 & 216	105 & 210
Stockport	Direct three-wire	—	460	230
Sunderland	Direct three-wire	—	440	110 & 220
Swansea	Direct three-wire	—	440	—
Taunton	Alternating	—	2,000	100 & 200
Torquay	Alternating	50	2,100	200
Tunbridge Wells	Alternating	68	2,100	220
Ventnor	Direct three-wire	—	420-460	210
Wakefield	Alternating	60	2 000	200
Wallasey	Alternating	50	2,000	100
Walsall	Direct	—	2,000	105
Watford	Alternating	50	2,100	200
West Ham	Alternating	50	2,000	100
Westminster	Direct three-wire	—	225	100 & 200
Whitehaven	Direct three-wire	—	210-240	100
Wimbledon	Alternating	50	2,200	—
Winchester	Direct three-wire	—	420-460	210
Woking	Alternating	100	2,000	100
Wolverhampton	Direct	—	2,000 & 460	110, 220, & 440
Woolwich	Direct three-wire	—	420	—
Worcester	Alternating	100	2,200	100
Wycombe	Direct three-wire	—	420	210
Yarmouth	Alternating	83·5	2,000	100

Number of direct-current three-wire stations = 73
,, ,, direct-current high-tension ,, = 9
,, ,, alternating-current ,, = 62
,, ,, combined A.C. and D.C. ,, = 16

Periodicities:

⌒⌣ = 100, 93, 90, 87, 83, 80, 77, 75, 70, 67, 60, 50, 40

Number of stations } 20, 2, 2, 2, 7, 4, 1, 3, 1, 2, 8, 20, 3

Alternating-Current Generating Voltages:

10,000 V., 1 — 3,000 V., 2 — 2,600-2,400 V., 2

2,200-2 000 V., 66 — 1,800-1,600 V., 1 — 1,000 V. 1

Discussion.

Mr. R. E. B. Crompton said they must thank Mr. Sellon for bringing forward a subject of such great importance. It was a paper of arguments, and they were so thoroughly in agreement with the author is nearly every argument that it was not easy for the paper to be criticised properly. They all agreed with him, and they should all help him to carry out the suggestion in the last paragraph—namely, "That the determination of standards by organised effort was desirable, and should be undertaken under the auspices of the Institution of Electrical Engineers as representing the interests of both producer and user." Mr. Sellon started by pointing out that there were disadvantages in introducing standardisation into any industry at an early stage, and this was the case. Up to the present the manufacturers were the people who had suffered from the vagaries of the consulting engineer in not being allowed to standardise more than was the case in their work. Still, no large harm had been done, and a great deal of harm, he thought, would have resulted if standardisation had been carried out earlier. The list of central stations which Mr. Sellon gave, however, proved that the consulting engineers who had been responsible for the stations had not varied the standards very much. The 100-volt for continuous current had been fixed upon by lamp manufacturers, as it

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was supposed to be the most suitable for their lamps, and it never varied by more than 10 per cent. After several years of the use of lamps of this voltage it was discovered that manufacturers could make lamps of much higher voltage, but the tendency to make lamps for "twixt and between" voltages was wisely resisted by the engineers. It was only when the lamp manufacture had so far improved that was possible to get lamps at double voltages, that the corresponding voltages of 200 and 220 instead of 100 and 110 began to be used. As far as that was concerned, the consulting engineers did not behave at all badly. On the question of periodicity others could speak better than he, but they all remembered the strong arguments used on the matter, that the great variety of periodicity pressed hardly on the manufacturers. Only those who had to make motors and lamps, etc., knew what troubles came from the great number of periodicities required. He thought they all agreed with the author that standardisation would be of as much use to the user as to the producer. Small machines in ordinary use, such as sewing machines, were standardised, and motors should be also. It was only after standardisation that the small user could obtain them at the price he was prepared to pay. He was glad to say that quite recently developments had taken place in the standardisation of small electric motors which would increase their use very much indeed. He referred to the motors of ¼ h.p. and ⅛ h.p., such as would be used in houses for ventilating and cooling purposes. The next step should be the standardisation of motors for driving tools for use in workshops. This was likely to become general almost at once. Thus by small steps they could lead up to the standardisation of large motors and dynamos. There was no doubt that the producer could assist the coming of standardisation by calling the attention of the user to the enormous advantages gained by the user by using the manufacturers' standards.

Mr. A. B. Blackburn said he took it as a matter of course that they all agreed with Mr. Sellon as to the desirability of standardisation. The chief thing was to consider the limit to which they could go. Each manufacturer must begin at home and standardise his own types, and try to convince the user that he has good reasons for doing so. If each manufacturer did that, he thought they might come to some common understanding amongst themselves as to what were the best types of machines. The user could assist them very much if he would just point out the conditions under which the machines were to work. If he stated what he wanted, the manufacturer would find the means to supply the want. As regarded alternate-current machinery, he thought they were already arriving at something like standardisation. Instead of the previous varied periodicities they were getting to use very similar periodicities. He hoped that the engine-makers would help them in obtaining standardisation. At present, in tendering they generally found considerable diversities of engine speed. They then had to get out tenders for three or four different dynamos to accommodate different types of engines. As regarded American standardisation this had arisen very much from the quantity of machines required, and not from the conditions of quality. If manufacturers here could obtain a larger amount of work of one type, they would also rapidly be able to standardise.

Mr. J. Slater Lewis said he would make a few remarks from the manufacturer's point of view. The first question they ought to ask was how they were to meet the foreign competition. There was no doubt that this country was being invaded by the Americans and Germans, and it was giving the manufacturers great trouble to meet the competition. If they imagined a manufacturer who made a dynamo of one size only, his establishment and fixed charges would fall enormously. If the establishment was arranged with the tools in proportion to the work, it would save considerably. By standardisation on these lines the establishment charges would fall at least 60 per cent., these charges now being higher than in any other trade—this was because they kept large machines going when a large proportion of the work only required small ones. If the manufacturing electrical industry was to do very much good in this country, standardisation was necessary. His own idea was that if a committee could be formed with the view of suggesting certain sizes of motors and dynamos, they would come to some definite conclusion on the subject. He thought Mr. Crompton was wrong in saying that the matter would automatically right itself. The subject of standardisation wanted attacking very vigorously. In his own case they were commencing to standardise motors, and these had been satisfactory. They hoped in a short time to only sell standard sizes of motors. In this way only could the difficulty of foreign competition be met. Those dynamo makers who supplied local authorities to consulting engineers' specifications were handicapped by the different types demanded. Until the number of drawings and plans for plants of similar output could be reduced, they would not be able to compete with the foreign manufacturer.

Mr. E. Johnson said he had had considerable experience in the standardisation of electrical plant in America, but not exactly in the direction which Mr. Sellon took. His work had been to standardise as far as possible in constructional detail. He thought the subject was one which engineers in this country should give their attention to, as it applied in every direction. The great thing was the standardisation of what they wanted, and let the manufacturer supply that, and not having in each particular case a different engineer to specify how things should be constructed. That was the weak point of the matter. In America this was not done, but the user gave his order for such-and-such a thing, and the things were supplied from stock, so to speak, and no time was lost.

Mr. J. S. Raworth said he noticed that Mr. Sellon had done what most experienced writers did—namely, to throw down the bone of contention straight away. It did not matter what the bone was as long as two dogs got hold of it. He thought the title to Mr. Sellon's paper did not fit it. He used the word plant in a wrong sense. The word plant as accepted in legal matters meant not only the motors and engines, but also the different tools, etc., used with them. The charwoman who bought buckets and brushes at a shop immediately became possessed of plant, because they were used in her particular business, but a lady buying the same articles, they would only be domestic utensils. He thoroughly agreed with the author, however, in the subject matter in the body of the paper. He himself should divide the paper into two divisions—namely, the standardisation of governing factors and the standardisation of details. In railway work the governing factor was the gauge. When railway engineers first started they made the gauges not all alike, and there was much consequent trouble. The analogy of this in electric lighting was the periodicity and the pressure. If they looked in the author's list, they would find that some effort had been made to standardise in some respects. In 20 stations they would find that the periodicity was 100. They had, whether it was good or bad, to thank him and Mr. Mordey for this. It had been proved later that a periodicity of 50 gave gave better results, and in a very much shorter time, than with the 100. Twenty stations had been standardised with the 50 periodicity. Coming to the standardisation of details, this had a much greater effect on a station than most people were aware of, even more than the periodicity and pressure. He had been once with a company which greatly exerted itself to obtain standardisation, but they had not got it. The ordinary engineer's draughtsman could alter it all by altering small details in his drawing. He had recently come across a case of this kind. He had wanted a new valve spindle. When the spindle came to be tried it would not fit, and it was found that the draughtsman had altered the drawing by just $\frac{1}{32}$in. If they wanted to standardise, they should keep a cauldron of boiling oil and put the draughtsman in it, and put a placard round his neck stating "This is the man who altered our drawings."

Mr. E. K. Scott rose to protest against the last remarks of Mr. Raworth, but the President called on Mr. Robinson to continue the discussion.

Mr. Mark Robinson said that his firm some years ago determined to standardise their work. They started with launch engines, and when the first order came for a 4-h.p. launch engine five others were made exactly similar to it on the speculation of their being wanted. The buyers came very quickly, and the experiment was a success. Ever since that time they had gone on the same system, and he thought he was the representative of a firm who standardised in no less degree than any of the American firms. Very often a consulting engineer when ordering would just state whether he wanted high and low speed engines, and left a great deal to the discretion of the manufacturers. This helped standardisation considerably. If his electrical friends would attack the problem in the right way, they would soon get what they wished. A year or two ago an order came in for an engine of 1,200 h.p. from his works. Gauges were at once got out so that others could be made similar to it, although it was a very large size, but the wisdom of this course was soon shown, as before this one was out of the shops orders were received for 18 more. As to the standardisation of engine speeds, the dynamo makers had only to express the wish for it, and the engine-makers would do their best in that way. He thought the paper a very valuable one, and that it would call forth the interest of the whole country.

Mr. B. Hammond said there were some very interesting sentences in the paper, notably that which said: "Assuming, then, that the buyer's engineer has come to stay, it would appear that a condition precedent to the standardisation of plant is the standardisation of the buyer's engineer." He belonged to the class of gentlemen who had to be standardised, and as speaker had succeeded speaker he had felt the process going on. He was, however, quite in agreement with the writer that this subject was of interest to the community at large. The most important thing was to get the best plant, and the next to get it as economically as possible. Nothing would help the proper spending of capital as much as standardisation of plant. Of course, as Mr. Raworth had said, they all had had their ideas on periodicity. He himself was responsible for the periodicities of 83, 83·5, and others near this number, as found in the list. He thought the time had arrived to show that the consulting engineers were not so black as they were painted. Each manufacturer thought his own engine or dynamo the best, but the disadvantage was that he did not know other makers' results. The consulting engineer saw many types, and advised the user as to the best. Mr. Sellon had made a good suggestion in saying that the Institution should back up the Standardisation Committee. Of course, that committee had perpetrated one act, and that was to fix the standard periodicity at 50, after which they went on to say that there should be a periodicity of 100 for systems using transformers in people's houses. This only showed how difficult it was for even the Institution to do everything perfectly, and in not striking out the 100 periodicity he thought they had made a slip. He thought that the views of the manufacturers and users should be taken on the subject, and a standard might thereby be arrived at. One thing he had found it necessary to standardise, and that was the meaning of the word "plant" in his specifications. This he always made clear in the commencement of the specification as meaning all the plant and materials used in the specification.

Mr. S. Z. de Ferranti said the paper contained matter of value not only to the electrical industry, but to the engineering industry of the country at large. The paper was full of remarks of sound common-sense, and he was only sorry that the paper was not read 10 or 12 years ago, as to his mind a great deal of the evil of

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non-standardisation had now come to stay. This they could see in the numbers of different periodicities in generating stations all over the country, and also a great many different engine speeds. It was very difficult once a periodicity was fixed to get engineers to alter it. Lately he had arranged in one case to alter the periodicity from 100 to 50, but this was an exceptional case, and very few engineers would consent to change their plant once running. In America they had started with 120 periods, and had kept to that standard, until quite lately they had found that it was too high, and it was consequently halved, so that in America they had a common periodicity of 60. He had heard a very curious thing recently—namely, that standardisation of voltage was not the best thing in all cases. The argument to support this was that with a slightly higher voltage on one circuit than the surrounding ones this one could use use up the dim lamps from the others. But this was a policy of selfishness. He agreed thoroughly with what Mr. Sellon had said as to consulting engineers, but if he might do so he should suggest to the Institution that the true function of the consulting engineer was to fully appreciate the scheme he was carrying out, and to lay down the ends which he desired to accomplish, and to leave to the manufacturers the work of designing and supplying what was wanted to attain that end. He then should sit in judgment on the work of the manufacturers, and tell his clients what was the best thing to buy.

Major-General Webber moved the adjournment of the discussion till the next meeting.

The following is a list of the candidates balloted for at the meeting:

Members.—W. J. Birnie, P. and O. Terrace, Bombay; A. Colson, Corporation Gas and Electric Light Office, Leicester; J. P. Phibbs, 16, Wool-exchange, London, E.C.

Associate Members.—A. L. Cook, National Telephone Company, St. John's-street, Colchester; F. A. Greene, 93, Canfield-gardens, Hampstead; J. W. Papworth, 10, Park-place-villas, Maida-hill, W.; H. W. Warde, 24, Barrington-drive Glasgow; H. Williams, 5, Great George-street, Westminster, S.W.

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Students.—F. T. Chapman, 4, Whingate, Armley, Leeds; A. S. Cross, Faraday House, Charing Cross-road, W.C.; T. C. Evans, 248, Plymouth-grove, Manchester; C. R. Heron, Imperial-road, Huddersfield; T. A. Hill, Dilston House, Church-road, Norwood, S.E.; W. J. Line, 36, Essex-road, Acton, W.; W. McBretney, 65, Pontefract-road, Castleford, Yorks; R. W. Millstead, White Lodge, Streatham Common, S.W.; A. H. Midgley, 9, Bingfield-street, Caledonian-road, London; J. Palmer, 3, Glenluce-road, Westcombe Park, Blackheath, S.E.; E. P. Perkins, Luton House, Dunstable, Beds; J. E. Schofield, Green Villa, Marsden.

THE EVOY COMPASS.

On Tuesday last we were invited to inspect the Evoy patent adjustment compass at Victoria-street, S.W. We may mention, however, that the offices of the company are at 14, Queen Victoria-street. The object of this compass is to avoid the serious errors in compasses placed on iron ships, and which can only be partially corrected by frequent adjustments and careful observations on the part of the navigator of the ship. The means of correcting the readings of compasses on iron ships are now well understood, but the magnetic effects of the iron of the ship are continually varying, while at the same time the cargo of the vessel can often seriously affect the compass readings. The result of these errors has been the casting away of many ships and the loss of valuable lives. It was first pointed out by Dr. Scoresby, in 1854, that a standard compass placed aloft would be free from magnetic disturbances, which are serious on the deck level. From that date a number of experiments have been made in this direction, and on some ships compasses are placed up aloft, where they can be read by means of a telescope from the deck, and in some cases by a seaman sent aloft. The object of the Evoy compass is to make the reading of a mast-head compass possible on the bridge or on any point on the deck which may be selected. For this purpose the compass is suspended from the jumper stay between the

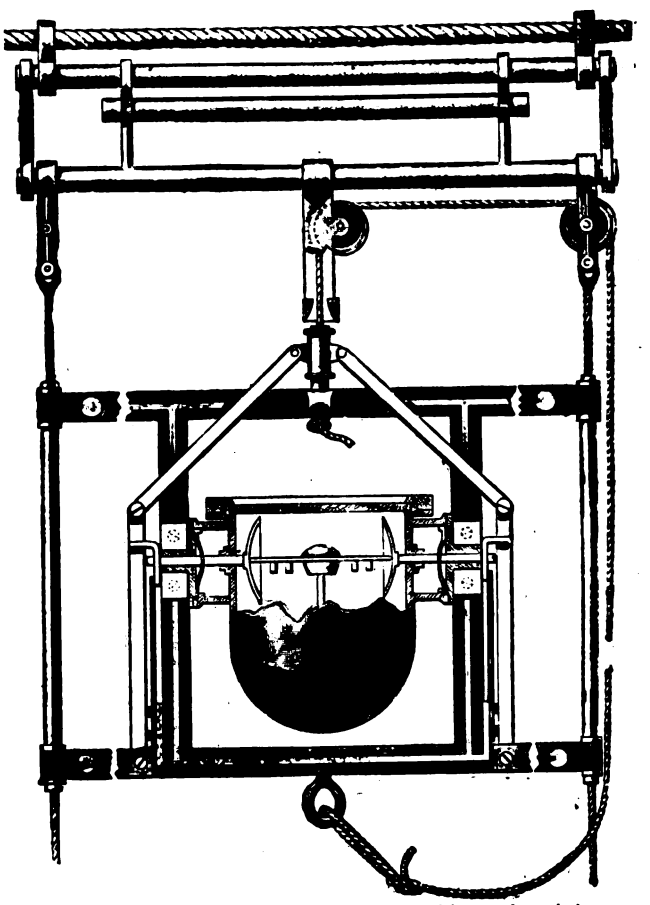

FIG. 1.—Sectional View of the Evoy Compass with Attachments to Jumper Stay.

two masts, being carried on two vertical stays accurately secured to the deck on the fore and aft line. Fig. 1 shows this compass when almost in its uppermost point of travel, while Fig. 2 is a view of the clip arrangement which secures the compass under the jumper stay. By means of

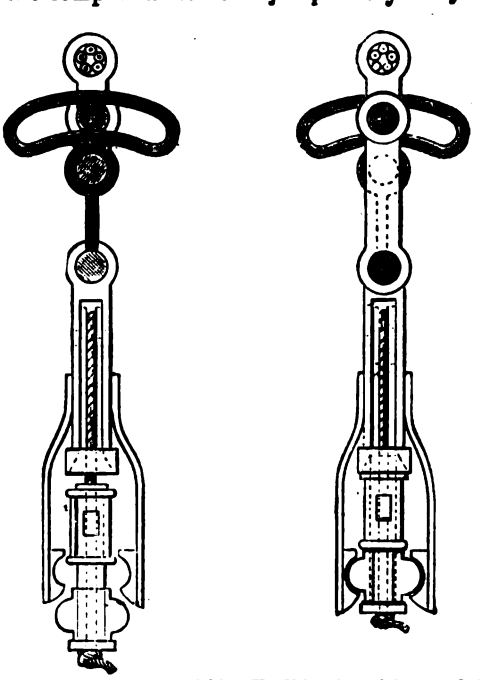

FIG. 2.—Appliances for Taking Up Vibration of Stay and for Unlocking Compass Card.

the lever arrangement seen in Fig. 1 these clips also release the compass card automatically. The process of taking a reading is then as follows: The compass is hauled up to just below the stay, where it is free from most of the magnetic influences of the ship. In fact, we

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were assured by a captain in the Royal Navy that at 50ft. above the deck the influence of the magnetism of the ship is practically negligible. The compass is then released automatically, so that the card soon takes up its correct position in the magnetic meridian. The compass is then pulled down, and immediately the upper portion leaves the clips the card is secured by means of the spherical cups at each side. When the compass reaches the deck, an accurate comparison can be made between its reading and that of the compass on the bridge. It is, of course, necessary that the ship should be held closely to its course while the observations are being taken. The compass used is made much in the same way as the Admiralty type, and is filled with liquid so as to leave the pivots free from the strains due to the weight of the card. The card has a sapphire set within the central float, and works upon a pivot of bell metal of special alloy, which with this compass is found to be more satisfactory than the iridium centre. The details of construction have been so carefully carried out that it is possible to shake the compass as hard as possible so as to give a rapid lateral movement without in the least causing the compass to "fly" round or even to vary

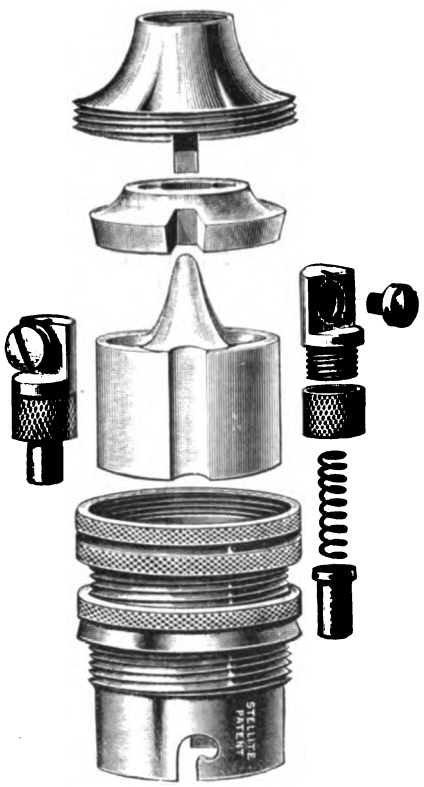

FIG. 1.—Parts of a Stellite Lampholder.

more than a degree at the most. The magnets, which consist of two groups of five in each, are made of very thin tungsten steel ¼in. in depth, and bound together after magnetisation to form two compound magnets of great directive force. The bowl is suspended on a carrying frame by trunnion-like form of axles, through which plunger rods pass, and have their inner ends provided with discs or stops. The plunger rods have liquid-tight diaphragms, and their outer ends are exposed to be pressed in by vertical levers pivoted to projections of the bowl-carrying frame, and the levers are governed by springs which tend to keep the levers inwards, so that the card is locked or held by the two cups until released, as mentioned above. The lubber line is inscribed on one of the cups.

The compass has been tried on a large number of ships, and we had the opportunity of conversing with certain captains who have used it. The company has also received testimonials, which were shown to us, and from which we gathered that the idea had been found to be of great service in actual use. One case is referred to in which the master of a Newcastle-owned ship found a variation of as much as 1½ points in his compass, due to a cargo of pig iron. It is needless to say that a deviation to this extent would have caused an unnecessarily long course to be steered, and might also have led to the wreck of the vessel if the weather had been thick when a coast line was near. Although the idea of the Evoy compass is simple, every detail seems to be most carefully worked out, and we see no reason why it should not in a large measure replace the costly adjustments of the compasses now enforced by the Board of Trade, and which at the best only give corrections of temporary value.

STELLITE FITTINGS.

The British Electric Works Company, Limited, of the Stellite Works, Aston, Birmingham, have laid themselves out for the production of electric lighting accessories in large quantities, and have designed the same so as to overcome numerous faults which have been proved to be defects in

FIG. 2.—Stellite Switch-holder.

the older types of apparatus. The most striking feature in connection with this company's wares, of which they have kindly sent us a selection, is the great use to which porcelain is put. One is also surprised to see the increasing accuracy with which small parts can be manufactured in porcelain. A typical example of this is seen in Fig. 1, which is a collection of the parts of a Stellite lampholder. The flexible cord is led down through the centre of the holder to the brass terminal

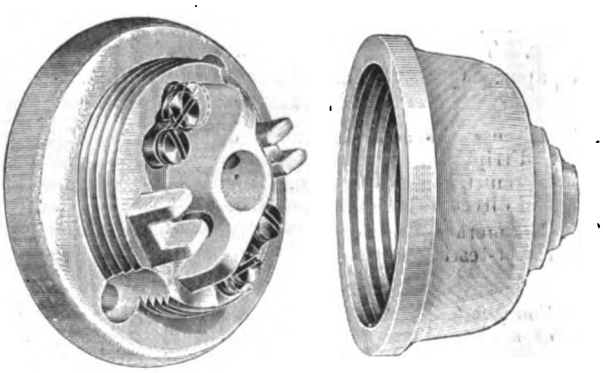

FIG. 3.—Stellite Ceiling Rose.

and spring contact, shown complete at the left-hand side of the illustration. In connecting up this holder the wires are secured to these terminals, and then the contact is placed inside a recess in the porcelain block. The porcelain cup just above the block forms an insulating packing to secure the spring contacts in place. The same class of holder is also made with a switch, as shown in Fig. 2. One useful feature in this switch-holder is the two small knobs seen at the right and left hand of the switch knob. These enable the lamp to be switched on or off easily with one hand, which cannot be done with most of the switch lampholders. Fig. 3 shows one of this company's ceiling roses with a special porcelain cord-grip. The cords pass down into the central hole and out and round the check blocks on the way to the connecting screw. With this device a heavy weight can be hung on the cord without bringing any strain on the connecting terminal. Fig. 4 shows a fuse with porcelain cover which is said to be

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suitable for high voltages. The fuse wire is placed round the nicks in the three projecting blocks of porcelain, which tend to cool the arc and to prevent damage to the cover. This cover is ventilated so that the temperature inside should not rise excessively. The British Electric Works Company have also standardised some balance-weight fittings with cord-guides, which make a good provision against the cord getting off the pulleys. Full details as to price, etc., of these accessories can be obtained from the company.

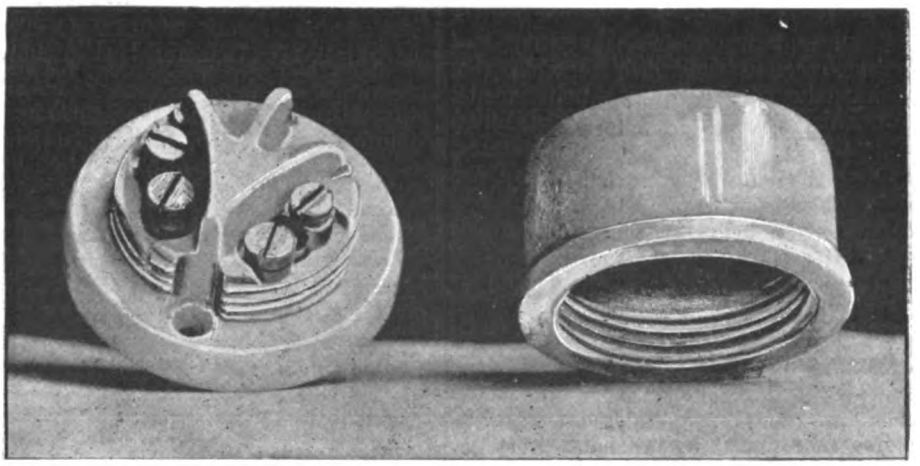


FIG. 4.—Fuse and Cover.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

245. Discuss the advantages and disadvantages of three-core and triple-concentric distributors for a low-tension direct-current three-wire system, the cables to be armoured and laid direct in the ground.—E. L.

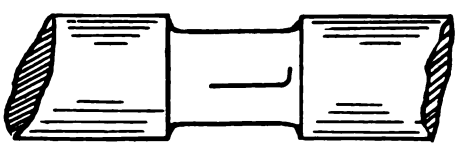
246. Enumerate the necessary fittings and accessories for a meter-testing room at an electric light station.—J. A. S.

ANSWERS.

Question No. 239.—A fracture having developed in the journal of a crankshaft, state how you would proceed to determine if it is sufficiently serious to necessitate the immediate replacement of the shaft.

Best Answer to No. 239 (*awarded* 10*s.*).—The proper solution of this question is often one of considerable practical importance, as the condemnation of a shaft not immediately dangerous may cause much inconvenience; whereas if it can be decided that the shaft is not immediately dangerous, a new one can be made to replace the old one with the minimum amount of inconvenience arising from the stoppage of the engine.

In approaching the question, it will be advisable first to consider the effect of the ordinary working stress upon a shaft. The primary object of a crankshaft is to transmit a rotary force, and the principal stresses to which a shaft is subjected are of a torsional character. There are of course bending stresses acting, but in considering the journal these may be neglected. The effect of submitting a shaft to a torsional stress is to cause shearing strains at right angles to the length of the shaft. Therefore, whilst a shaft is intact transversely, a fracture or fractures whose direction is not circumferential may not be serious. To illustrate this point we might construct a shaft of a number of wire rods bound together at intervals by circular hoops, and such a shaft, though containing a large number of longitudinal spaces, would transmit a torsional force satisfactorily. It will be seen, then, from this that a purely longitudinal fracture is not necessarily serious, even though it may be very open. As a matter of fact, such fractures are very common in shafts, and do not cause any trouble. It is advisable, nevertheless, to test and mark them by the method described below. If, however, the fracture turns in a circular direction, as shown in the figure, it may be serious, and requires



attention, as its resistance to torsional stresses is becoming impaired, and the ultimate failure of the shaft is only a question of time. In order to form a reliable opinion whether or not it is desirable to continue to run a shaft having a circular fracture in the journal, a test should be made as follows: Under the cheeks of the crank, blocks of wood should be firmly placed, so as to prevent the crank from moving. When in this position, the shaft should be stressed by exerting a pressure on a barring lever or other means as may be found most convenient. A rough calculation of the maximum pressure on the crank-pin should be made, and the barring moment regulated to at least equal the maximum working twisting moment on the shaft. By this method the shaft can be stressed to approach the actual conditions of working. The fracture, when the journal is stressed, should be observed, and if it is found to be very elastic and oil oozes out from it the probability is that the fracture is deep and therefore dangerous, as a large portion of the effective resistance of the shaft may be lost.

Should the fracture remain firm, it is probably only on the surface and does not extend into the shaft. A groove, however, should be made by a round-nosed chisel along the fracture to gauge its depth. If the fracture can be chipped out or is decided to be shallow, and there is a fair factor of safety at the journal, the shaft may be considered safe to continue to work. In the case of a loose and open fracture in a circular direction, the risk of continuing to run is very great, as the shaft may give way at any time. The ends of all fractures in a shaft that is running should be marked with a centre-punch mark so that any extension may be noted.

It may be observed that an iron shaft just before fracture at the journal gives warning by heating at the bearing, but a steel shaft does not, and for this reason some prefer iron shafts.—E. W. T.

Answer to No. 239 (*awarded* 5*s.*).—In such a case as this the replacement or otherwise of the shaft is a question of the area of metal unaffected by the developing fracture,

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the maximum load the shaft will have to transmit, and the possibility of the elimination of the fracture itself. First, let the torsional and bending stresses be determined as nearly as practicable from the known conditions under which the shaft works, or may be allowed to work, though it is not a safe policy to lose sight of normal load; then decide on a minimum area of shaft which it is judged will safely bear the strain. Data for this may be obtained in most engineering text-books. Now carefully examine the fracture—a strong magnifying glass will not be amiss here—mark the journal at the extreme ends of the fracture; now drill one or two radial holes centred on the line of fracture, according to its length round the circumference of the shaft, in order to find if its depth is fairly uniform and accurately represented by the external indications. Assuming this to be so, and that the unaffected area is not below the predetermined amount (if below, of course, it will be wise to put in a new shaft), either of two courses may be followed:

(*a*) Drill two holes in the shaft, one beyond each of the limit marks of the fracture (in the direction it would take if continued), of a diameter and depth which are arbitrary, say $\frac{3}{16}$in. or $\frac{1}{4}$in. diameter and 1in. depth for a 6in. shaft. If desired, the holes may be tapped and filled in with screw plugs. The area represented by the holes must be deducted from the effective area previously found. Although this treatment greatly arrests the development of a fracture, it cannot entirely prevent it.

(*b*) Since the presence of the fracture in any case constitutes a danger, owing to the inherent tendency to increase under strain, it is better to chip out altogether that portion of the shaft containing it, and dovetail, or otherwise fit in its place, a piece of metal of the same quality, if possible, as the shaft.—G. E.

Answer to No. 239 (*awarded* 5*s.*).—To determine extent of fracture in crankshaft journal, take a sharp round-nosed chisel and cut along fracture until you have got depth of it; you will find the cuttings come off in two pieces. Do not take over-deep a cut, so you will be able to follow the fracture. This is the surest method of finding extent of fractures in shafting. Of course I am assuming fracture to be a circumferential one; longitudinal fractures are not often serious. The way to treat a longitudinal fracture is to put opposite strain on shaft; then you may find fracture open a little if serious. While strain is on shaft you can put a few drops of paraffin oil on fracture; then you can determine extent by the quantity of paraffin oil it takes to fill fracture.—F. N.

Question No. 240.—What do you consider the largest area of copper which can well be insulated and laid as a low-tension feeder? How does the cost of several such feeders laid on the solid system compare with the cost of the equivalent conductors of bare copper laid on insulators in a conduit?

Best Answer to No. 240 (*awarded* 10*s.*).—It is not advisable to use a larger cable than about 1½ square inches cross-sectional area. If larger cables are used the cable drums must be very large and awkward to move about, or if the cable is coiled on smaller drums the insulation would be unnecessarily severely strained. It may be further observed that there is practically no advantage in using larger cables, as their cost would be almost the same as if smaller cables were used whose total cross-sectional area equalled that of the single cable. Large cables are very unmanageable feeders to lay, and the cost of laying the separate smaller cables will be found not to exceed that for the single large cable.

TABLE A.

	Approximate costs per yard run. Exclusive of street boxes.		
	A.	B.	C.
Cables or bare copper conductors	£2 19 0	£2 19 0	£1 12 0
Trench work, laying, and materials for troughing (including compound for filling), or insulators and conduit	0 8 6	0 13 0	1 1 9
Total costs per yard	3 7 6	3 12 0	2 13 9

A. Lead-covered cables laid on the solid system with wood troughing. B. Lead-covered cables laid on the solid system with iron or earthenware troughing. C. Bare copper conductors laid on insulators in a conduit.

To answer the second part of the question, let us assume that the feeders consist of two conductors of 1½ square inch area each, and another conductor of one square inch area. The approximate costs of the trench work, conduits or troughing filled with compound, and the conductors in the different cases will then be as shown in Table A.

When the cables are laid on the "solid system" the troughing should be of earthenware, or, preferably, of iron, if the cables are laid under a road over which heavy traffic passes, as otherwise trouble might be experienced through the compound covering being cracked if only protected by the wood casing. It is evident from the above figures that the conduit system is the cheaper to adopt where it is possible. The hindrance to its universal adoption, however, is the difficulty of finding space under the foot or road way, and it is rare to find this space continuously. And it is also found necessary to change from the conduit system to some other kind at crossings or places where difficulties arise. Changing from one system to another adds considerably to the cost. Mr. R. E. Crompton—who has had considerable experience with the conduit system—has stated that a length of feeders estimated to cost £4,000 to £4,500 on the plain, straightforward culvert system would probably cost £5,500 when an average allowance is made for the combined systems which are usually required. Mr. Crompton's experience has led him to estimate the cost of maintenance of the conduit system as being less than ½ per cent. per annum on its first cost. This is wherein the culvert system is so superior to the cables laid in troughing. Probably no cable manufacturer would like to guarantee the maintenance of cables much under 10 per cent. per annum.—D. P.

FORTHCOMING EVENTS.

FRIDAY, FEB. 16.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., at 38, Bath-street, first ordinary general meeting. Paper on "The Problem of Arc Lighting from 25-Volt Supply," by Mr. W. B. Sayers.

SATURDAY, FEB. 17.

Institution of Electrical Engineers.—At 11 a.m., students' visit to the Davis-street station of the Westminster Electric Supply Company. Meet at Davis-street station.

Institution of Mechanical Engineers.—At 2.30 p.m., students' visit to the Central London Railway depôt. Assemble at Caxton-road entrance.

TUESDAY, FEB. 20.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Further discussion on papers on "Moving Loads on Railway Underbridges," by Mr. W. B. Farr; and "Note on the Floor System of Girder Bridges," by Mr. C. F. Findlay, M.A.; and, time permitting, a paper on "Corrosion of Marine Boilers," by Mr. J. Dewrance.

THURSDAY, FEB. 22.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Papers on "Improvements in the Longworth Power Hammer," by Mr. E. Samuelson; and "Portable Pneumatic Tools," by Mr. E. C. Amos.

Institution of Electrical Engineers.—At 2 p.m., students' visit to the works of the Incandescent Electric Lamp Company, Hammersmith. Meet at works. At 8 p.m., ordinary meeting. Discussion on paper on "The Standardisation of Electrical Engineering Plant," by Mr. R. Percy Sellon.

FRIDAY, FEB. 23.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Bearing Springs," by Messrs. B. Humphrey and H. E. O'Brien.

Glasgow and West of Scotland Technical College Scientific Society.—At 7.30 p.m., ordinary meeting. Paper on "Some Points on Slow-Speed Engine Design," by Mr. A. Marshall Downie, B.Sc.

Royal Institution.—At 9 p.m., discourse on "Recent Studies in Gravitation," by Prof. J. H. Poynting, F.R.S.

Physical Society.—At 5 p.m., discussion on Prof. Lodge's presidential address on "The Controversy concerning Volta's Contact Force." Description and exhibits of photographs of Sound Waves and Kinematographical Demonstration of the Evolutions of Reflected Wave Fronts; a New Sendoscope; Diffraction Colour Photographs and Artificial Parhelia.

SATURDAY, FEB. 24.

Manchester Society of Junior Electrical Engineers.—At 7.30 p.m., ordinary meeting, at Manchester. Paper on "Destructors and their Application to Electric Light and Power Stations," by Mr. A. Rothwell.

North-East Coast Institution of Engineers and Shipbuilders.—At West Hartlepool, ordinary meeting.

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RUCKER v. LONDON ELECTRIC.

As will be seen from the report in another column, judgment has been given in this case in favour of the defendants. It is understood that the case will be taken into a higher court, so that it is difficult to say how far we are at liberty to criticise. However, we trust we shall not pass the bounds of permissible comment. We assume the object of a judge is to obtain the truth, and in this case the verdict seems to generally accord with the opinions expressed by the great body of the profession, so far, at any rate, as we have been able to gather such opinions. During the days of the trial a mass of intensely interesting, amusing, but utterly irrelevant matter to the eyes of a layman was gone through, but the most amusing, perhaps, was the attempt to define the state of electrical knowledge in 1885. One would have thought such a definition to have been a fairly easy matter, but, on the contrary, it seemed to be very difficult. There were grave doubts expressed as to the knowledge about a certain ratio, though the tracing back of the expression "ampere-turns" might have shown something definite. This ratio, we should say, must have been perfectly well known to every student who read Lenz's experiments as described in vol. i. of Taylor's "Scientific Memoirs." Even if he had not read Lenz's paper, the matter is clear enough in Cummings's "Introduction to the Theory of Electricity," a schoolbook used years before the time in question. A still wider circle of readers probably read J. T. Sprague's "Electricity," the second edition of which was published twelve months or so before the date of the patent under discussion. The term "ratio" may not have been applied to the windings of the primary and secondary on a transformer, or even on induction coils; but that the effect was determined by the ratio between them must have been well known. Similarly no one may have expressed in a certain form of words that the resistance of the secondary for certain purposes should be low, but whether it was stated in one way or in another the whole question of wasted energy due to internal resistance was well known, and is well expressed in Sprague's book, as indeed it is in other books. These and a host of other amusing topics came up during the trial; but really we have been led astray so far from the real object of this article. The difficulties of a judge are great, and not the least difficulty is at times to determine if any real knowledge has been brought into a patent which at the best only claims to be an improvement. A case was cited during the trial which shows clearly the care with which judges weigh evidence. The House of Lords sustained the validity of a patent in which the ostensible alteration over a prior article was simply the putting in a stronger door. The apparatus was in all other respects identical. It was intended for disinfecting purposes, and dry steam was to be used so as not to injure the materials disinfected. The Aberdeen apparatus consisted of a disinfecting chamber in which steam at four or five pounds pressure was used, and this chamber was surrounded by a steam-

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jacket. In the Aberdeen apparatus the door of the inner chamber blew out at the above pressure. Mr. Alliott patented an exactly similar apparatus, except with a stronger door, for steam to be used at fourteen or fifteen pounds pressure. The latter patent was held to be good, and we think justly. The facts seem to be that the patentee of the later apparatus knew that steam at fourteen or fifteen pounds pressure would be effective for the purpose required, while steam at four or five pounds pressure would be ineffective. The man in the street says, "What! Only a stronger door? Why, any fool mechanic could have done that." Just so. But the kernel was simply that any fool mechanic did not know the difference in effectiveness of the steam at five and the steam at fifteen pounds pressure, while the man possessed of that knowledge applied it to this common apparatus and secured a valid patent. Before the issue of the patent now held by the plaintiff, the value of generating at high pressure, feeding at high pressure, and transforming to low pressure for distribution to customers was well known. There was nothing new to be learnt about the value of series and parallel. The whole thing had been discussed *ad nauseam*. Thus far we may say, having regard to the question being carried to a higher court, without infringing any legal perogatives. In the Rucker case a complete system of distribution is claimed because the patentee is said to have made the system practical by the insertion of one link more perfect than any such link was before his time. The introduction of Joy's valve gear was surely an improvement in an engine, but Joy could not therefore patent all engines using his gear. What he could do, and what he did do, was to patent the gear and get a lump payment or a royalty when the gear was used. This seems a reasonable analogy to the real point in the case under consideration. The useful link might have been patented, but the introduction of that link into a system well known was hardly enough to make valid a claim for the system.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

DEPARTURE OF ELECTRICAL ENGINEER VOLUNTEERS FOR SERVICE IN SOUTH AFRICA.

SIR,—You will probably have seen a letter from Mr. McMillan, honorary secretary to the Dinner Committee who are arranging for a good "send-off" for the Electrical Engineers (R.E.) Volunteers leaving for South Africa. I would like to take this opportunity of saying that already a good response has been made to this appeal, and that many gentlemen from different parts of the country are sending their cheques, though frequently stating that they will not be able to be present at the dinner. Thinking that this may form a precedent with regard to other of your readers, I would intimate by your courtesy that we should like a good response from the entertainers of our friends who are going abroad, and shall be glad to receive cheques from those who also will not be able to attend the dinner.—Yours, etc.,

HENRY EDMUNDS, Honorary Treasurer.

[When going to press another note was received from Mr. Edmunds stating that Major R. E. Crompton had arranged for the dinner to be held on Saturday, March 3, 1900. It will probably take place at the Great Eastern Hotel, Great Eastern Station, Liverpool-street, E.C., at 6.30 p.m., but full particulars will be forwarded, together with tickets, to entertainers of the corps. It would very much facilitate matters if intending entertainers would send in their names at once.—ED. *E. E.*]

INSTITUTION OF CIVIL ENGINEERS.

SIR,—Would you kindly insert the enclosed in your valuable paper, as the same will, I trust, be of interest to a large number of your readers.

Several engineers having expressed the opinion that they are at a greater disadvantage than the members of other professions, in there being no existing library from which to obtain books for reference, and that, considering the wealth of the Institution of Civil Engineers, and the fact that a lending library need not necessarily be carried on at the institution buildings, should there be lack of accommodation in the same, there appears to be no reason why such a library should not be started by the above institution.

It is suggested that the accompanying petition should be sent to the president of the Institution of Civil Engineers on the subject.

As it is impossible to forward the petition to each member for signature, I should be glad if those belonging to the Institution of Civil Engineers who are in favour of the formation of such a library would send me a post-card authorising the addition of their names to the said petition.—Yours, etc.,

E. HAMILTON WHITEFORD, A.M.I.C.E.
Borough Engineer's Department, Municipal Offices, Plymouth.

COPY OF PETITION.

To the President and Council of the Institution of Civil Engineers.

We, the undermentioned members, associate members, and students of the Institution of Civil Engineers, desire to draw your attention to the serious inconvenience to which members of the civil engineering profession are subjected to by being unable at any time to borrow a technical book for reference.

We would suggest that the council should take into their earnest consideration the desirability of forming a lending library at or in connection with the Institute of Civil Engineers, similar to those worked by the Royal Institute of British Architects and numerous other professional bodies.

AN ELECTROLYTIC CENTRIFUGAL PROCESS FOR THE PRODUCTION OF COPPER TUBES.

SIR,—I have to request that you will kindly publish in your next issue the subjoined reclamation of the electrolytic centrifugal process described in the *Electrical Engineer* of the 9th inst. The reclamation is a copy of my contribution to the discussion on Mr. Cowper-Coles's paper read before the last meeting of the Institution of Electrical Engineers.—Yours, etc.,

HENRY WILDE.

Alderley Edge, Feb. 14, 1900.

MR. HENRY WILDE, F.R.S. (communicated): I have read with much interest the paper of Mr. Cowper-Coles on "An Electrolytic Centrifugal Process for Producing Copper Tubes." May I point out that the process described is identical with the one patented by me in 1875 (No. 4,515), which has been in successful operation in Manchester and elsewhere for more than 20 years. By the publication of his paper, Mr. Cowper-Coles has, however, rendered an important service to the electro-metallurgical industry in exposing the fallacy of submitting electro-deposited surfaces to the friction of foreign substances during the process of deposition. His paper also contains much valuable information on the electro-metallurgy of copper which is not available in other publications. Subjoined are extracts from the specification and claims of the patent referred to:

"Whereas attempts have been made from time to time to substitute iron rollers covered with a thin layer of

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copper by means of electricity, for the solid copper rollers used in calico printing and in other processes, but owing to the expense of the battery power and the slow rate at which the copper was deposited in the reguline state, such attempts have not hitherto been commercially successful.

"Now, my invention consists in giving to the electrolyte or depositing liquid in which the roller to be coated is immersed, or to the positive and negative electrodes themselves, a rapid motion of rotation in order that fresh particles of the electrolyte may be brought successively in contact with the metallic surfaces. By this means powerful currents of electricity may be brought to bear upon small surfaces of metal without detriment to the quality of the copper deposited, while the rate of the deposit is greatly accelerated (p. 4).

"Instead of producing the whirling motion of the electrolyte by the rotation of the roller, *b*, as above described, it may be produced by the rotation of the positive electrodes, *g*, mounted on a revolving frame, or by paddles revolving in the annular space between fixed electrodes and a fixed roller (p. 5).

"This invention may also be applied to the electrolytic method of refining copper described in the specification of letters patent granted to J. B. Elkington, November, 1865, No. 2,838 (p. 4).

"*Claims.*—First: Imparting a rapid whirling or rotating motion to a depositing solution in the manner and for the purposes described. . . .

"Lastly: The application of the whirling or rotatory motion of the electrolyte in the refining of copper and the apparatus for effecting the same, as shown and described."

WIRING RULES.

SIR,—I beg to reply to the letter which appeared in your paper of the 9th inst. Do I understand from your correspondent that the wiring rule—viz, "That no wiring should be allowed to be done out of sight unless run in iron or earthenware pipes" is unsuitable or unnecessary? As regards wires being run between floor and ceiling in *wooden structures*, if the above rule be strictly observed, there is less likelihood, in my opinion, of bad work being done, and, therefore, less risk, than in many of the existing modes of wiring installed in false roofs, etc.

Let us assume that a short-circuit should occur in an iron tube. The result would be that any arc so produced would be immediately checked by the blowing of the fuse in that particular circuit without any damage being done to surrounding woodwork, whereas in the case of wires being laid in wooden casing (which method in the majority of cases is adopted), the tendency would be (in case a short-circuit developed) to gradually char the wood, and this state of affairs would continue, without disturbing any working conditions, until perhaps some amount of damage had been done.

If, on the other hand, earthenware piping was used, fire risk would practically be brought to a minimum. The cost of adopting the above system of wiring would, no doubt, cause a greater *initial* outlay compared to the system described by General Webber.—Yours, etc.,

RUPERT H. WAITE, Stud.I.C.E.

Fountain House, Morley, Feb. 14, 1900.

LIVERPOOL TRAMWAYS.

Last Sunday the Corporation opened for traffic one of the main trunk routes into which the city will be divided when the comprehensive scheme of electric tramways, described in our issue of Jan. 5, has been completed. Cars will be run every four minutes right from Aintree on the north to the Garston boundary on the south. This covers a distance of something like 8½ miles, and as far as electric tramcars are concerned the new line furnishes a record in this country, certainly in respect of the length of the journey through densely-populated districts.

The *Liverpool Courier* publishes some facts and figures concerning the progress which has been made in Liverpool in the matter of the introduction of the electric system of tramways, and of the remarkable success with which up to the present time it has been attended. Our contemporary says not very long ago, when the Corporation acquired the undertaking of the tramways company, the finger of scorn was pointed at Liverpool, which was pictured as a city content to abide by ancient and obsolete conditions. To-day the picture is very different. Once the City Fathers decided upon electricity in preference to horse power there was no laggard policy, with the result that to-day Liverpool stands in the proud position of having a greater mileage of electric tramways than any other city in England or Scotland. At the end of 1898 there were in existence 6½ miles of experimental line to the Dingle and Prince's Park. During the past year upwards of 30 miles of lines have been reconstructed for electric traction, and at the present time there are something like 28 miles of tramlines over which electric cars are running. The apparent discrepancy in these figures can easily be explained. Some lines have been relaid which cannot yet be utilised. For instance, those from Lowhill to Old Swan, and from the necropolis to West Derby Village have been completed, but are for the time being useless on account of the absence of the electric power. Herein comes a point not without significance to those who opposed the erection of a power station in the vicinity of Lister-drive. The delay which was occasioned by those members of the City Council who were adverse to the selection of the site finally adopted has certainly had the effect of retarding the provision of electric trams for West Derby and Old Swan. However, it may be some consolation for residents of those districts to know that by October next they are almost certain to share in the benefits now enjoyed by other parts of the city. But apart from the mere reconstruction of lines, which in itself is a work involving an immense amount of forethought and engineering skill, the public and those people who are only too apt to make complaints during the process of conversion will be interested to note the simply astounding development which has attended the tramway concern since the late Sir Arthur B. Forwood carried into effect the acquisition of the old tramway company. Our contemporary is enabled to give publicity for the first time to some figures which are the most emphatic proof of the growth of the tramway undertaking under municipal auspices. In the year 1898 the traffic receipts amounted to £311,610, the passengers carried numbered 41,772,034, and the mileage was 4,789,300. A comparison of these figures with the results of the past year is nothing less than remarkable. The receipts were £356,265, the passengers carried 63,771,450, and the mileage 7,600,545. In one year, therefore, with the electric system by no means in full swing, there was an increase in receipts of £44,655, while the excess of passengers was 21,999,416, and of mileage 2,811,245. Figures in other directions may be dry, but they are not uninteresting. Of the passengers during 1899, the electric cars carried 15,853,160, the horse cars 39,321,946, and the omnibuses 8,596,344. During this period 2,861 horses were required, as against 3,150 in the preceding year. Now as to the vehicles actually running. At the end of 1898 they were as follows: electric cars, 12; horse cars, 187; omnibuses, 80—total, 279. When last year closed, the change had been so pronounced that the numbers were: electric cars, 70; horse cars, 180; and omnibuses, 40—total, 290. Yet another set of figures which convey their own lesson. The average fare per passenger for the year ending Dec. 31, 1898, was 1·80d., and for 1899 1·35d., or a decrease of 0·46d. The obvious inference is that the reduction of fares, coupled with the introduction of electric traction, has more than borne out the prophecies of the most pronounced advocates of the change. And the gilded pill for the ratepayers is that the receipts are bound to go up by leaps and bounds as new routes are opened. Even since the beginning of this year the corporate tramway purse shows an excess over the corresponding weeks of last year of about £1,000 a week, a very pleasant reflection for all who are anxiously looking for a relief of rates from the commercial undertakings of the Corporation.

Mr. John A. Brodie, the city engineer, upon whom the duty of superintending the laying of the new lines has

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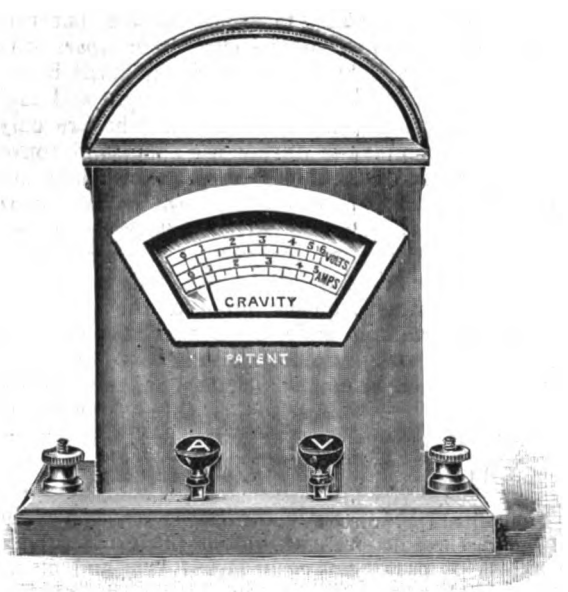
fallen, is performing his arduous task with a degree of skill which has extorted the admiration of all who are engaged in similar undertakings throughout the country. Roughly speaking, each week sees about a mile of tram-lines laid in the city. The work is undertaken by Corporation employés under the engineer's direction, and from 1,300 to 1,500 men are daily employed. The city engineer's department on Saturday entered upon the reconstruction of the Prince's Park horse-car route, and the opening of the lines from Bootle will take place as soon as the final agreement between the Liverpool and Bootle Corporations is concluded.

COMBINED GRAVITY AMMETER AND VOLTMETER.

The instrument we illustrate below at one-third actual size is a very useful and compact meter, introduced by Mr. W. R. Morris, of the Faraday Works, Birmingham. It is of the Gravity type, there being no permanent or electro-magnets used in its construction. The makers claim that in consequence it never requires re-calibrating; but it is not free from errors due to external magnetism.

It consists of a walnut case standing on a base, and has a leather handle to carry by. A brass bezell, with a glass to protect the pointer is fitted in the front of the case. There are two terminals on the base to connect with the source of power. It has also two contact keys. The one marked V is used for measuring the E.M.F.; the other, marked A, is for measuring the current. It has a silver-plated dial, and we notice that no printed dials are used.



The scale in each instrument is marked by hand during calibration, and afterwards engraved. This method prevents errors caused by the use of printed scales or dials. The scale being unusually large the readings can be easily seen. A novel feature about it is its double scale, the top part of which is used for volts, and the bottom for amperes.

To use the instrument, connect the cell or other source of power to the two terminals (no current passes until one of the keys are pressed). Press the key marked V, when the aluminium hand or pointer will show the E.M.F. in volts on the top line of the scale; when the key marked A is pressed the pointer will give the current in amperes on the bottom line of the scale. No calculations are necessary, as the readings are directly given.

It will be gathered from the above that the instrument is intended for primary battery testing chiefly, as with ordinary work a key in the main circuit would not be feasible.

INSTITUTION OF JUNIOR ENGINEERS.

At a meeting of this institution held at the Westminster Palace Hotel on Friday, Feb. 2, the chairman, Mr. Basil H. Joy, presiding, a paper on "Arc Lamps and Arc Lighting" was read by Mr. H. G. Cotsworth, member.

After briefly describing the more important phenomena of the electric arc, including the different formations of the carbon points working with direct, alternating, and enclosed arcs, the author reviewed the means available for actuating the striking and feeding mechanism. It was shown that the thermo-electric method offers decided advantages over the electromagnetic. For instance, with alternating currents, an alteration in the periodicity has no effect on the regulation, as would be the case with an electromagnetic control. The thermo-electric system would, in fact, equally work well with alternating or continuous currents; it had, however, not come into practical use to any extent. The majority of lamps have their mechanism controlled by both a series and shunt solenoid, but lamps in which the series coil is replaced by a spring or counter-weight are equally successful, and the current through a shunt lamp may be varied over a very wide range without affecting the feed. They are also simpler in construction, and therefore cheaper in first cost. Lamps of American origin are nearly all controlled by a clutch acting direct on the upper carbon guide rod, and are liable to give a spasmodic feed, owing to the wear of the clutch on the rod, but on the Continent a mechanism having a clockwork escapement finds most favour. In England the prevailing type has a wheel controlled by a brake, resulting in a very sensitive and accurate feed being obtained. In referring to the working of the lamps, the author remarked that arcs when run in series must be provided with an automatic cut-out, so that in the event of a lamp failing the circuit would not be broken. For street-lighting the cut-out is best placed in the plinth of the lamp-post. On a short series, however, the cut-out may be dispensed with, but means must be provided for breaking the circuit of the shunt coil, otherwise, on the failing of a lamp, this coil would be burnt out. Alternating arcs may be run in series across the primary mains, and if provided with a small choking coil across their terminals the extinction of one lamp does not affect the others. Another ingenious method provides a means of running alternating arcs in series with a constant current off constant-potential mains. This is accomplished by having a transformer so arranged that when the current in the secondary increases due to the cutting out of lamps, it reacts on the iron core of the transformer, causing more or less magnetic leakage across a short air-gap between the coils of the primary and secondary.

Alternating arcs do not give the same efficiency as direct, and attempts have therefore been made to rectify alternating currents into direct, resulting in an increased efficiency of the lamps, but introducing rather complicated apparatus at the station. The author, in dealing with enclosed arcs, mentioned that, although the actual efficiency was increased by their use, the necessity of having two dense opaloid globes more than counteracted any gain, and described a lamp which to some extent has the advantages of the enclosed lamp without its corresponding disadvantages. It has but one globe, works at about 80 volts across the arc, and burns for 70 hours with one trimming. Recently an enclosed lamp working at 160 volts across the arc has been placed on the market, which is intended for running singly in parallel on 200-volt mains.

In the discussion which ensued Messrs. A. S. Arundel, E. C. Roche, F. Arundel, A. F. Gatrill, A. W. Marshall, and others took part. A vote of thanks having been accorded the author, the proceedings terminated with the announcement of the ensuing meeting on March 2, when a paper on "Electrolytic Zinc as a Protective Metallic Coating for Iron and Steel" would be read by Mr. W. A. Paddon, member, of Wrexham.

THE UPKEEP OF ACCUMULATORS.

We have received a copy of Mr. Robert Hammond's report as consulting engineer, on the five tenders received by the Hackney Vestry for the supply of accumulators to their new electricity works. These accumulators were specified to be capable of maintaining 10,000 8-c.p. lamps burning for four hours, which is equivalent to an output of 600 amperes for that time. Owing to the voltage of the supply some 300 to 312 cells were required to meet the conditions of the specification. The prices

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of the five tenders, with the manufacturers' names, are given in the column of this issue devoted to contracts for electrical supplies. The lowest tender for the accumulators, stands, lifting tackle, and contingencies is £8,155, while the highest is £12,567. While Mr. Hammond leaves the selection of the tender to the Vestry, he analyses most carefully in the report the details of the five tenders, and these details are in many cases of general interest to the profession. In his specification Mr. Hammond provides that the 10,000 lamps should be supplied for four hours without the voltage in any of the cells dropping below 1·8 volts. In order to fulfil these conditions the lowest tenderer estimates for the supply of 310 cells, and another firm undertakes to do it with 304 cells. Again, the lowest tenderer provides 23 large plates in each of his cells, while as many as 61 plates are used by another manufacturer. It is clear from the figures given that the use of a few large plates is a distinct advantage, as it enables a battery of accumulators of a given capacity to be erected in a smaller accumulator-room than if more plates per cell are employed. Thus, in the present case, it was specified that the width of the battery-room should be 30ft. The lowest tenderer, the Tudor Accumulator Company, require this room to be 130ft. long to contain the cells in one tier on the floor level, while another maker requires as much as 228ft. The energy efficiency of the accumulators was left to the manufacturers to specify, and it is interesting to note that as high as 77 per cent. efficiency with 600 amperes discharge and 78½ per cent. efficiency with 300 amperes discharge is guaranteed by the Tudor Accumulator Company. The manufacturers were also asked to undertake the maintenance contract for a period of 14 years. For this the Tudor Company ask an annual sum of £405, which is hardly 5 per cent. on the capital outlay. One other firm offer to maintain at 4½ per cent. on the capital outlay, but as their tender was higher, the annual sum for maintenance came out larger. The maintenance rates with other makers went as high as 8½ per cent. As the output was specified at a four hours' discharge rate, practically all the tenders provided for accumulators to give 600 amperes over this period. There is, however, a considerable divergence in the alteration of the discharge or ampere-hour capacity with variations of the period of discharge. Thus the Tudor Company provide for a discharge rate of 1,450 amperes for one hour and for a discharge of 280 amperes for 10 hours. Another firm, while having the same discharge for four hours, guaranteed 1,400 amperes for one hour and as high as 360 amperes for 10 hours. Mr. Hammond, in his report, points out that as refuse destructors are to be used at Hackney, a high discharge rate is of the utmost importance. He also calls attention to the fact that since his original report was submitted to the Vestry the price of lead has risen from £13 to £16 per ton, and that this, with the increased cost of coal, is responsible for a considerable extra cost in accumulators. The report is most interesting as showing at what low rates accumulators will be maintained at the present time by makers, and also the influence of the form of the cells on the space occupied and indirectly, we believe, on the price.

ELECTRICITY WORKS AT LEYTON.

On Saturday last, Mr. C. G. Musgrave, the chairman of the Leyton Electric Lighting Committee, laid the memorial stone of the new buildings rendered necessary by the rapidly growing demand for electrical energy in the district. The stone in question forms part of the base of the octagonal chimney, which shaft will be 160ft. high. The snowstorm had rendered the site unpleasantly wet, so that most of the speeches in connection with the opening ceremony were deferred until after the dinner at the town hall at night. The trowel with which the stone was laid was presented by Mr. Coxhead, of Leytonstone, whose firm has secured the building contract. After the dinner in the evening the usual loyal toasts were honoured. In reply to the toast of "Success to the Electric Light Works," Mr. Musgrave gave a review of the progress made with the electric light in Leyton. The Council obtained their provisional order for this purpose in the year 1894. In the spring of 1895 the question of the lighting of the new town hall and technical institute, then in course of erection, came under the consideration of the Council, when it was decided at a meeting held on May 28 in that year that the buildings should be lighted by electricity and that Prof. Robinson was called in to advise the Council on the question. Prof. Robinson afterwards prepared a further report as to a scheme for lighting by electricity the whole of the district. He advised a central station in the neighbourhood of Grove Green-road to be worked by a gas plant. He further submitted two estimates, one for a central-station plant including four engines and dynamos of 55 b.h.p., and seven miles of mains, at an estimated cost of £21,725, and the alternative providing for two engines and dynamos and four miles of mains. The Council adopted the smaller scheme submitted, and gave instructions for the necessary plans to be prepared for submission to the Local Government Board to obtain their sanction to a loan of £16,850, being the final estimate as approved by the Council. Contracts were entered into for the purchase of the land and construction of the works, Messrs. Wells Bros. obtaining the contract for the engines and Siemens Bros. for the cables. The works being proceeded with, it became necessary to appoint a resident engineer, and accordingly on June 2, 1896, the Council authorised advertisements to be inserted for this purpose, when, from amongst 53 applicants for the appointment, Mr. Collings Bishop was selected by the Council at their meeting on July 28, 1896. The station was opened for the supply of electric current on Sept. 8, 1896, and shortly afterwards—viz., on Oct. 13—Prof. Robinson, in a report to the Council, stated that, owing to the rapidity with which the householders had connected up and the number of applicants that had been received, it was necessary for the Council to at once extend the plant at the central station, and recommended them to put down another gas producer and two more engines and dynamos at an estimated cost of over £3,000, which recommendation was adopted by the Council at their meeting on Oct. 20. Consequent on the extension of the generating plant, it became necessary to extend the mains, and at the Council meeting of March 2, 1897, it was resolved to apply to the Local Government Board for sanction to borrow £7,900, to cover the cost of the proposed extensions, which sanction was reported to the Council in the month of May. This practically carried out the larger of the two schemes proposed by Prof. Robinson in his report of July 1, 1895, but at a total cost of £24,750. The extensions having been carried out, the number of consumers so largely increased that a further sum of £1,880 for extension of mains was sanctioned by the Local Government Board, and in the month of November, 1897, a special report was made by Mr. Bishop to the Electric Lighting Committee, in which he advised that to cope with the business as it was then coming in it would be necessary to spend during the next five years the sum of £5,000, in order to make the necessary extensions to the station buildings, machinery, and mains, and that of that amount £17,931 should be spent in the year 1898 in extending the station buildings, putting in four more engines and dynamos, two generators, about six more miles of street mains, house connections, etc. This report was adopted by the committee, who were of the opinion that it was absolutely necessary that immediate extensions should be provided for, and they recommended the Council to apply to the Local Government Board to sanction a loan for £20,000 to cover the cost of the extensions required in 1898. The Council, however, at their meeting on Dec. 7, determined only to apply for sanction to borrow £15,000, and it therefore became necessary to reduce the engines and dynamos to two and the generator to one. Events, however, soon showed that the reduction was impracticable. Connections to the mains continued at a rapid rate, further numerous applications for current were received, and on May 26, 1898, the engineer reported that it was absolutely necessary that the two further engines and dynamos should be ordered together with the generator, and that an additional set of batteries should be erected with other works, at a further estimated cost of £5,000. This report was submitted to and approved by the Council at their meeting on June 7, 1898. The matter being extremely urgent, tenders were obtained for proceeding with the buildings, etc., without waiting for the sanction of the Local Government Board, but notwithstanding all the pressure put on by the Council, it was not until the end of the year 1899 that the last engine and dynamo was delivered and got into working order. The total capacity of the station when the works were finished was then 19,000 lights connected. The lamps connected on Dec. 31, 1898, were 11,876, and at the end of January, 1899, there were a further 2,814 applied for and waiting for connection. Hence the question of the further extension of the station again became a burning one, and the committee on Jan. 21, 1899, directed the engineer to prepare and submit to them a scheme for further extension to meet the growing demand. This matter was receiving his consideration when, on Feb. 3, he wrote tendering his resignation, having been appointed electrical engineer to the Corporation of Wigan. The Council thereupon advertised for an electrical engineer to take his place, and from among a large number of applicants Mr. Harman Lewis, the present engineer, was selected by the committee and appointed by the Council on March 7 last, and forthwith took up his position. By this time it had become manifest that in connection with any further extension of the machinery it would be necessary to have a steam generating plant. The vexatious delays in connection with the delivery of the gas generating plant, the comparatively small load which could be carried even by the larger of the gas-engines, the constant interruption caused by temporary breakdowns which, as the station was now worked to its utmost capacity, at once affected the quality of the light, all pointed to a change in the nature of the generating plant. Accordingly in the preliminary scheme which was being prepared by Mr. Bishop at the time of his resignation, he suggested the use of a steam plant. One of the first duties which Mr. Lewis had to turn his attention to was the development of this extension scheme, upon which he prepared a report in which he suggested a scheme

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which provided for the acquisition of four large steam-engines with dynamos and boilers, and a large additional service of mains and feeders. This scheme, which necessitated the purchase of additional land for the erection of the new buildings required, was estimated to cost a further sum of £30,000. This report was approved by the Electric Lighting Committee on March 22, and confirmed by the Council on April 6 last. Application was made to the Local Government Board for sanction to borrow the amount, which was granted as to £7,350 on June 28, and as to the balance of £22,550 on Oct. 26 last. The question of the additional land required was an awkward one. The only land suitable was the piece between the works and the railway belonging to the trustees of St. Patrick's Cemetery, who were quite disinclined to sell, but who, he was glad to say, as the result of an appeal on the ground of the public necessity, eventually agreed to do so, but at the rather heavy price of £4,000. Tenders were advertised for for the erection of the various works, and contracts were entered into with Mr. Coxhead for the buildings and chimney shafts, Messrs. Willans and Robinson for the four triple-compound steam-engines, Messrs. Mather and Platt for the dynamos, Messrs. Davey, Paxman, and Co. for the boilers, and Callender's Cable and Construction Company for the mains and feeders. He hoped that with the completion of these buildings and the installation of the plant the period of anxiety which the Electrical Committee and its officers had gone through would come to an end. Although for upwards of three months the Council had had to delay the connection of any new customers to the mains, it would have been quite impossible to have continued the working unless they had had fitted up one of the new engines in a temporary building, which, fortunately, they had been able to do. The cost of the station and works, therefore, when the present extensions are completed, would be about £80,000, with a capacity of upwards of 45,000 lights instead of the 6,000 lights allowed for by Prof. Robinson in the larger of his two estimates, which he estimated would be sufficient for five years. As regards the cost to the ratepayers, he was happy to say that notwithstanding all difficulties the working had shown a gross profit from the outset. From the returns to the Board of Trade there was a gross profit from the opening of the station in September, 1896, to March, 1897, of £4. 1s. 3d.; for the year ending March, 1898, £382. 1s. 8½d.; for the year ending March, 1899, £925. 12s. 9½d.; or a total to that date of £1,311. 15s. 9d. The net revenue account at that date showed a total deficit of £2,264. 13s. 6d., but out of that amount £1,847. 1s. 4d. was for repayment of capital, and they had paid the sum of £1,729. 7s. 1d. for interest on capital. These were figures which should inspire confidence in the ratepayers as to the future profitable working of the undertaking. As regards their treatment of consumers, they started with a charge of 6d. per unit. From Jan. 1, 1897, this was reduced to 5d. per unit, and in the case of large consumers to 4d. In March, 1898, the Brighton system was adopted, charging 5d. per unit for the first hour and a half, and 2d. per unit for all current used afterwards. An analysis of the last quarter's supply of current shows that during that quarter 145,575 units of electricity were sold, of which 97,149 were to private consumers and the remaining 46,426 were for the public lamps. Of these 97,149 units, 50,589 were sold at 5d. and 43,243 were sold at 2d., so that the average cost to the private consumer is just a trifle over 3½d. per unit. The analysis shows that during a winter nearly as many units are consumed on the 2d. scale as on the 5d. From these figures he considered that there was probably no district in the United Kingdom where the consumers had received such great advantages so soon after the opening of a new station. He predicted a great future for the Leyton electrical works, and looked forward to its being one of the largest in the metropolitan districts. For the first three months no consumers had been connected with the mains, but as soon as their new engine was working 4,000 lights, for which they already had applications, would be connected. The plant which that £30,000 would provide for would be capable of supplying from 45,000 to 47,000 lights. In November last they had 18,000 lights connected, and in a week or two that number would be increased to 22,000. In the past year they had nearly doubled the number of lights connected, and he believed that as soon as that additional plant was laid down the number of consumers would be such that it would be necessary for the Council to again extend the station. Of course, as they knew, the present extensions were being carried out so as to provide for these further extensions.

We are indebted to the *Leytonstone Express* for parts of the above report.

GENERAL ELECTRIC COMPANY'S STAFF DINNER.

"It was a cold day for Willie when the mercury went down," according to the epitaph which adorned the tombstone of the youth who had broken the thermometer and swallowed the contents. When winding our way to the Trocadero last Saturday through the sleet and snow, we heartily wished Willie had swallowed the only instrument of that designation left in the world, so that it would go down no more to belie its name of heat-meter and become a cold-meter. It speaks volumes for the popularity of the General Electric Company that on arriving we found an assembly of about 300 guests, amongst them a fair sprinkling of ladies, who were being received by Mr. Hugo Hirst. Soon afterwards dinner was announced, and the arrangements for position-finding being of the most efficient order, all were speedily and comfortably seated in the prettily-decorated Empire Room. After the sonorous grace of the toastmaster, Ashton's Blue Band "began to play," and all hands fell in to enjoy an entertainment excellent in quality, lavish in quantity, and, above all, made most pleasant by the cordiality of the hosts and stewards. It was, in fact, the thorough good-fellowship pervading all which made the evening so enjoyable. The same feeling afterwards manifested itself in the speeches, of which there were many. The Chairman (Mr. Hirst) read a letter from the absent chief of the company. Mr. G. Byng proposed the health of "The Army, Navy, and Auxiliary Forces," to which Major Crompton responded, saying that he hoped his corps, which is shortly leaving for the front, and which was accustomed to overcome the forces of Nature, would deal likewise with the other forces they were about to encounter. In proposing "The Staff," Mr. Max Byng gave some alarming statistics, from which we gathered that the General Electric Company has a staff of 3,000, including 200 technical men; 55 ledger clerks deal with 10,700 accounts, they had about 10,500 letters per week, and sent out 30,000 invoices in that time. If we understood rightly, they thus get a letter from each customer every week and send him three invoices in reply. Very active bis that! The staff made their reply through Messrs. Bevis, Ives, and Barrow, the latter giving some of his tropical experiences.

Then Mr. Hirst had something to say about expansion. Already, before the war, most firms were beginning to learn that in order to compete in the markets of the world the old-fashioned way of manufacturing in six-storey buildings, constructed with no other view than to hold large quantities of shafting and a great number of people, away from railway communication, and erected in crowded districts, preventing gradual extension, were unsuitable. The General Electric Company was one of them. As soon as this present crisis was over, the traders and manufacturers must be ready to follow up the victories of our soldiers; they must be ready to refill the depleted stores of the Empire. He then detailed the worries encountered in finding a suitable site. First, there was great trouble in finding a site at all, then arose the bother with ancient rights and ancient lights; railway companies stood in their own light by refusing to construct sidings; then the canal companies came and threw cold water over the scheme, and having once again got on swimmingly, another bugbear barred the way—i.e., the working-man. Mr. Hirst had much more to say on the point of workmen's dwellings, working-men's education, and so forth, which was very interesting, but which want of space prevents us dealing with any further.

A lengthy programme, under the direction of Mr. H. S. J. Booth, followed, in which musical recitals, songs, and comic sketches were admirably rendered by Mdlle. Cheron, Miss Kate James, and Messrs. Leffer, Thorne, Brockbank, Gatehouse, Arthur, and Roberts. They had a most appreciable and enthusiastic audience, who in the meantime sat about chatting and laughing and enjoying long cigars and the usual compliments to a smoking concert. Then out into the Christmas landscape again, a rush and a crush at the railway stations, a shivering journey home, and so to bed, as Mr. Pepys has it.

PHYSICAL SOCIETY.

The annual general meeting of this society was held on Feb. 9, Prof. Lodge, F.R.S., president, in the chair. The following officers were elected to form the council: president—Prof. Lodge; vice-presidents (who have filled the office of president)—Dr. Gladstone, Prof. Carey Foster, Prof. Adams, Lord Kelvin, Prof. Clifton, Prof. Reinold, Prof. Ayrton, Prof. Fitzgerald, Prof. Rücker, Sir W. Abney, Mr. Shelford Bidwell; vice-presidents—Mr. Blakesley, Mr. Boys, Prof. Everett, Mr. Griffith; secretaries—Messrs. H. M. Elder and W. Watson; foreign secretary—Prof. S. P. Thompson; librarian—Mr. W. Watson; treasurer—Prof. Callendar; other members of council—Prof. Armstrong, Dr. Atkinson, Mr. W. Baily, Prof. Glazebrook, Mr. E. H. Griffiths, Mr. S. Lupton, Prof. Perry, Mr. Swinburne, Prof. Threlfall, and Mr. J. Walker.

Mr. Addenbrooke asked if the *Proceedings* of the society could be published with less delay.

The Chairman promised to try and have them printed sooner.

Prof. Lodge then delivered his presidential address on "**The Controversy Concerning Volta's Contact Force.**" Those who take a metallic view of the Volta contact force are accustomed to deny that the Peltier evolution of heat measures the local E.M.F. existing at a junction; they assert that it measures the rate at which that same E.M.F. varies with temperature. In the thermo-

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dynamic equation connecting the Peltier effect with the variation of E with temperature, the E which varies is not necessarily that at the junction considered, but is the total E.M.F. of the circuit. The reversible heat at a specified junction is a measure of the metallic E.M.F. located there. Those who say it is a temperature variation of the E.M.F. beg the question by locating the whole E.M.F. of the circuit at the particular junction they are considering, usually an interface of zinc and copper. At a chemical junction the E.M.F. is not purely thermal, and hence is not measured by the Peltier effect; it is chiefly of chemical origin and is calculable from the energy of combination of the materials on either side of the boundary. At a metallic junction there is no such chemical potentiality. A strong current may be passed across a zinc-copper junction for years and no brass is formed. It is therefore improbable that the chemical affinity of zinc for copper is the propelling influence which causes the E.M.F. located at such a junction. In showing the Volta effect experimentally a trace of liquid can act detrimentally by forming a conducting bridge between the plates, across which the bulk of the electricity passes as the metals are being separated. The safest and clearest mode of expressing the Volta effect is that it consists in an opposite charge acquired by dry zinc and copper while in metallic contact, a charge which results from an E.M.F. of fixed value and is controlled solely by this E.M.F. and electrostatic capacity. It is undeniable that the order of the Volta force can be calculated from the differential heats of combination of the metals for oxygen, although it is doubtful whether it can be calculated from the heat of formation of brass. The opposing sides of the old controversy used to be called contact theorists and chemical theorists. Now the opposite sides are involved both in contact and both in chemical views. It is a question of which of several contacts is the effective one, and what kind of chemical action or affinity is the active cause. Is it the contact and chemical affinity across the metal-metal junctions, or across the metal-air junctions? The opposite sides are thus metallic and dielectric. The metal-air force is of the order volts, the metal-metal force is of the order milli-volts. When a piece of zinc is put in contact with a piece of copper the oxygen atoms which surround these bodies move slightly away from the copper and approach slightly nearer to the zinc. These slight motions produce the whole Volta effect. All that is necessary for the Volta effect is the inherent film on the surface; all the rest of the gas is mere dielectric, and might be substituted by a vacuum.

It was proposed by **Prof. Perry**, and seconded by **Prof. Armstrong**, that a meeting should be held to discuss the address.

The meeting then adjourned until Feb. 23.

COMPANIES' MEETINGS AND REPORTS.

WATERLOO AND CITY RAILWAY.

The half-yearly meeting of the shareholders of this Company was held last Thursday.

Mr. Wyndham S. Portal (chairman of the directors), who presided, moved the adoption of the report and accounts. He said the difference between the gross receipts and the working expenses (at 55 per cent.) £7,341, would not be sufficient to pay a dividend of 3 per cent., so, under the working agreement of March, 1894, the South-Western Company had made up the deficiency of £2 517. The directors hoped the undertaking would do better in the future, and they thought it would. January, 1900, showed a great improvement over January, 1899. In the past month the daily average was £91, or a daily increase of £5, which they considered very encouraging.

Lieutenant-Colonel the Hon. H. W. Campbell (deputy-chairman) seconded the motion, which was agreed to.

CAMBRIDGE ELECTRIC SUPPLY.

Directors: D. Munsey, Esq. (chairman), Meadowcroft, Cambridge; A. A. Campbell Swinton, Esq., M.I.C.E., M.I.E.E. (managing director), 66, Victoria-street, S.W.; P. W. Latham, Esq., M.D., Trumpington-street, Cambridge; the Hon. C. A. Parsons, F.R.S., M.A., M.I.C.E., M.I.E.E., Wylam-on-Tyne; John B. Simpson, Esq., M.I.C.E., Bradley Hall, Wylam-on-Tyne. Manager and engineer: John H. Barker, A.M.I.C.E., M.I.E.E.

Report of the directors (with abstract of accounts) to be presented to the ordinary general meeting of the Company to be held at the Company's offices, Thompson's-lane, Cambridge, to-day, Feb. 16, at 12 noon:

Your directors have pleasure in reporting that the prospects of the Company continue to be satisfactory. During the year 1899 there has been added to the Company's mains the equivalent of 3,043 8-c.p. lamps, making the total 28,123. The number of units supplied has been 298,392, an increase of 38,085, or 14 per cent. In spite of the large increase in the price of coal, the cost per unit sold for this item has been reduced by over 8 per cent. To meet the growing demand for electricity in the town, it has been necessary to largely increase the machinery in the engine-room as well as the mains and transforming apparatus in the town. A new 500-kw. dynamo and a fourth boiler have been installed, which it is expected will effect some saving in the expense of coal and labour. The capital outlay for the year has been £12,310. 6s. 2d. The supply mains now extend along 8¾ miles of street. The Company after paying all charges, placing £250 to the reduction of preliminary expenses, £750 to depreciation account, and £150 to the credit of suspense account, has a balance of £3,766. 11s. 2d., which, added to £123, 11s. 9d. brought forward from last year, makes £3,890. 2s. 11d. An interim dividend of £1,176. 1s. 10d., and interest on temporary overdraft £68. 3s. 5d., have already been paid, leaving a net balance of £2,645. 17s. 8d., out of which the directors recommend the payment of a dividend of 4½ per cent., making, with 2½ per cent. already paid, 7 per cent. for the year. This will absorb £2,412. 16s. 4d., leaving a balance to carry forward of £233. 1s. 4d. The Hon. C. A. Parsons retires by rotation, he is eligible, and offers himself for re-election. The auditor, Mr. Arthur Rutter, also offers himself for re-election.

REVENUE ACCOUNT.

Dr.	£	s.	d.
Generation of Electricity.			
Coal, including dues, carriage, unloading, storing, etc.	1,256	0	3
Oil, waste, water, and engine room stores	181	19	4
Proportion of salaries of engineers and officers, as certified by the engineer	107	9	7
Wages at generating stations	698	19	3
Repairs and maintenance	390	11	7
Distribution of Electricity.			
Proportion of salaries of officers, as certified by the engineer	12	10	0
Wages to linesmen, fitters, labourers	62	8	7
Rents, Rates, and Taxes.			
Rents, rates, and taxes	456	11	2
Management Expenses.			
Directors' remuneration for year 1899	210	0	0
Salaries of managing engineers, secretary, accountants, clerks, messengers, as certified by manager	239	19	1
Stationery, printing, etc.	59	17	6
Auditor of Company	10	10	0
Auditor appointed under the provisions of the order	15	0	10
Law Charges.			
Law expenses	51	12	11
Depreciation, etc.			
Depreciation in respect of leasehold works, buildings, plant, machinery, etc.	750	0	0
Reduction of preliminary expenses	250	0	0
Amount written off suspense account	150	0	0
Special Charges.			
Insurance, etc.	24	13	0
Total expenditure	4,928	3	1
Balance carried to net revenue	3,766	11	2
	£8,694	14	3

Cr.	£	s.	d.
Sale of current	7,715	14	10
Public lighting	17	12	4
Rental of meters	347	10	1
Transfer fees	1	12	6
Cash discounts and sundry receipts	612	4	6
	£8,694	14	3

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	57,572	0	0
Sundry creditors	2,095	10	6
Net revenue account, £3,821. 19s. 6d.; less interim dividend, paid Aug. 10, 1899, £1,176. 1s. 10d.	2,645	17	8
Depreciation fund account	1,750	0	0
Bankers	2,376	10	7
Workmen's deferred pay	340	9	3
Unclaimed dividend account	36	14	8
	£66,817	2	8

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	59,184	19	0
Stores on hand: coal, £279. 13s.; oils, waste, etc., £14. 15s. 3d.; general (lamps, etc.), £254. 7s. 4d.; stores on capital account, £2 974. 11s. 10d.	3,523	7	5
Preliminary expenses, £1,752. 14s. 8d.; less amount written off, £1,502. 14s. 8d.	250	0	0
Sundry debtors for current supplied to Dec. 31, 1899	3,855	4	4
Cash in hand	3	11	11
	£66,817	2	8

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		454,092
Quantity sold	Public lamps 1,188	298,392
	Private consumers by meter 297,204	
Quantity used on works, offices, and workmen's houses		11,517
Total quantity accounted for		309,909
Quantity not accounted for		144,183
Number of public lamps		1
Total maximum supply demanded, kilowatts		845

SCARBOROUGH ELECTRIC SUPPLY.

The report of the Company for the past year states that 257,412 Board of Trade units were supplied at a revenue of £6.235. 12s. 11½d., as against 220,009 units and £5.442. 9s. 8½d. revenue for 1898. The profits were £2,705. 8s. 9½d., as against £2,331. 16s. for 1898. After paying income tax, etc., and allowing £471. 17s. 5d. for depreciation, a sum of £2,576. 0s. 11d. remains available for distribution. The directors recommend a dividend of 6 per cent. (free of income tax), which will absorb £2,416. 13s. 3d., leaving a balance of £159. 7s. 8d. to be carried forward.

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ST. JAMES'S AND PALL MALL ELECTRIC LIGHT.

The ordinary general meeting of this Company was held on Tuesday last at the Central Station, Golden-square.

Mr. W. Leaf presided in the absence of the chairman, and in moving the adoption of the report and accounts said that the past year had again shown rapid growth in the business of the Company. The policy of a reduction in price charged for current had fully answered their expectations. They showed a growth in the gross revenue of £7 723, equal to 11 per cent. The results for the first six weeks of 1900 had been very satisfactory, and showed a further increase in the number of 8-c.p. lamps, the total lamp connections being 164,750 equivalent candle-power. With regard to the Company's Bill in Parliament for the compulsory acquisition of land adjacent to their Carnaby-street station, the absolute need of that extension was proved to both Houses. The Company had entered into possession of the land, and they would leave nothing undone to erect the buildings in time to meet next winter's demand. In conjunction with the Westminster Electric Supply Company, they had promoted a second Bill with the object of erecting a station outside the parish large enough to meet all future demands for many years to come, and here also they had been able to prove their case to the satisfaction of Parliament. The new shares had been issued without a hitch. Since the date of the accounts the final instalment had been paid, and they had now a reserve fund of about £75,000. He felt that the shareholders would approve of the policy of the Board in agreeing to pay half wages to the families of the six reserve men in the Company's employ who had gone to South Africa. If the men returned they would be reinstated in their old posts.

The report was seconded by **Sir John Morris** and adopted, and a total distribution of 14½ per cent. for the year on the ordinary shares agreed upon.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING.

The thirteenth ordinary general meeting of this Company was held last Wednesday at 1, Great George-street, Mr. Granville R. Ryder in the chair.

The Chairman, in moving the adoption of the report, stated that he was pleased to be able to submit a satisfactory report for 1899. This had no doubt been an electrical winter, but apart from this material progress had been made. The increase in the number of houses and shops taking the light last year was 229, but this year they were 259. The lamps had increased this year by 27,304, as against 18,205 in 1898, and the gross receipts had also increased very considerably. The net profits during 1899 were £19,201, while in 1898 they were £14,462. There had also been an increase of 400 000 in the number of units sold. This increase had been gained with but a small increase in the cost of production. They had put by this year £4,000 to the renewal account. The conversion of the system was still steadily going on, about two-thirds of the consumers now having the 200 volts installed. They would this year probably require capital for several purposes. Considerable progress had been made on the new site, and the foundations of the station had been laid.

The report was seconded by **Sir F. J. Bramwell**, and adopted unanimously.

SMITHFIELD MARKETS ELECTRIC SUPPLY.

The second ordinary general meeting of this Company was held at Winchester House on Friday last, Mr. H. S. Leon presiding.

The Chairman, in moving the adoption of the report and accounts, stated that circumstances had been against them. The light generated by their predecessors had been unpopular, and they had had a difficulty in regaining the custom of the butchers and other shopkeepers. Then they had not had sufficient working capital, and were very much handicapped in that respect. Considerable progress had, however, been made. There were altogether 408 shops in the markets, and in September, 1898, they had 188 of these shops connected, with the equivalent of 9,723 8-c.p. lamps. On Dec. 31, 1899, there were 266 shops connected, with a total of 16,960 8 c.p. lamps. This left 146 shops not yet connected, but they hoped to obtain the custom of the whole of them in the course of time. Besides this, they had four other large installations, the profit from which they could not ascertain until the end of the year. There was a net loss of £775 on the first year's working, which had been reduced to £210 at the end of last year. This had been wiped out by the profits for January this year. They might, too, expect to save something by their new accumulators. The Chairman then gave the capital expenditure for the 15 months as follows: accumulators, £2,643; market extension (new shops), £1,830; mains, £1,885; and improvements at the generating station, £627. The total was £6,985, and £1,700 had been paid out of earnings. The directors wished to place a further 5 per cent. second mortgage debentures to the amount of £6 000 in order to secure the Company's position. The net profits for the past 15 months were about £350, and consequently the interest was, he considered, fully secured. If the shareholders wished to see dividends they must put more money into those debentures, as otherwise the Board would be obliged to meet capital liabilities out of revenue. That would, perhaps, be a good thing for the Company, but it would still further defer the payment of dividends to the shareholders, whose prospects for the next year were not at all hopeful. At the last general meeting £25,000 of 5 per cent. second mortgage debentures had been authorised. The directors had asked the shareholders to take up £12,500, but only £2,450 had been subscribed. If other gentlemen would do the same; he himself would subscribe £1,000 or £2,000 in that way. In conclusion, the Chairman stated that the light which the Company supplied compared more than favourably with that of other companies, particularly with that of the City of London Company, and that their charges were as low as, or lower than, other London prices.

Mr. J. Browne Martin seconded the motion, which was carried unanimously.

BLACKPOOL AND FLEETWOOD TRAMROAD.

A general meeting of this Company was held on the 9th inst. Mr. George Richardson presided.

The report of the directors for the half-year ended Dec. 31 last stated that the balance of profit, after providing for debenture interest, was £10,028, and the directors recommended a dividend at the rate of 10 per cent. per annum, which would absorb £7,247, writing off £521 from the costs of application to Parliament for further powers under Act 1898, and £500 from preliminary expenses, and leaving a balance of £1,759 to be carried to the current half-year. The number of passengers carried during the half-year was 1,161,786. The gross receipts amounted to £20,476.

The Chairman said that the undertaking was gradually earning more money, though their takings were necessarily subject to conditions of weather.

Mr. Richard Henry Prestwich, deputy-chairman, seconded the resolution, and it was adopted.

A recommendation of the directors that a dividend of 10 per cent. should be paid was passed. The retiring directors, Messrs. George Readman and John Greenwood, were re-elected, and the meeting reappointed as auditors Messrs. W. Aldred, Son, and Co.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING.

The thirteenth ordinary general meeting of the Newcastle and District Electric Lighting Company, Limited, was held on Tuesday at the Company's offices, Newcastle. Mr. J. D. Milburn, chairman of the directors, presided.

The annual report of the directors stated that the installations connected to the Company's mains during the year are equal to 5,600 10-c.p. lamps, bringing the total up to about 41,878, and 1,008.622 units of electrical energy have been supplied, as against 778,828 units supplied in 1898. During the past year 3,433 yards of main and branch piping have been laid, together with 9,768 yards of main and branch cable. The gross earnings during the year amount to £3,811. 7s. 9d., and after paying interest and placing £1,000 to reserve, and making provision for depreciation, your directors are able to recommend a dividend of 5 per cent. for the half-year ending Dec. 31, less income tax, which, together with the interim dividend paid in August last, makes the dividend 8½ per cent. for the year.

The Chairman, in moving the adoption of the report, said the increasing demand had made it necessary for them to look out for further ground and further productive power, and they bought a site by the riverside, between the High-Level and the Redheugh Bridges, having an area of more than 4,000 yards, and, according to the present designs, it would be possible to deal with 14,000 e.h.p. They had already made contracts which already drew upon the new premises, so far as work went. Even in making provision for the future, they found they could not go fast enough, and they had found it convenient and desirable to fit up a continuous-current system, for supplying power to machinery, in their present works, so that they might supply power to customers whom they had hitherto been obliged to delay or refuse.

Sir B. C. Browne seconded the motion, which was adopted.

The retiring directors (Messrs. J. D. Milburn and the Hon. C. A. Parsons) and the auditors (Messrs. Strachan and Co.) were re-elected.

At a subsequent extraordinary meeting the following resolution was carried: "That the capital of the Company be increased to £200,000 by the creation of 10,000 ordinary shares of £10 each." The Chairman explained the new shares would be issued at par to the existing shareholders, *pro rata*—each holder of shares being offered shares to the same amount as the shares he now held.

LIVERPOOL OVERHEAD RAILWAY.

The half-yearly meeting was held on the 13th inst. at the Law Association Rooms, Cook-street.

Mr. Richard Hobson, deputy chairman, who presided, in moving the adoption of the report, said it was the best report in regard to the number of passengers carried, the amount of money earned, and the dividend recommended which the directors had ever been able to present to the shareholders. The dividend had been earned entirely upon normal lines, but it must be admitted that on account of the great desire to witness the departure of soldiers and volunteers for the war the railway had benefited by the enormous crowds of people to the extent of between £1,500 and £2,000.

Mr. John Brancker seconded the motion, which was adopted.

A dividend was then declared of 5 per cent. per annum, free of income tax, on the preference shares for the half-year, and of 5 per cent. per annum, free of income tax, for the half-year on the ordinary shares of the Company. Messrs. R. Hobson and James Barrow were re-elected directors, and Mr. G. Nicholson, the retiring auditor, was reappointed at a salary of 50 guineas.

At a subsequent special general meeting the following resolution was agreed to: "That £50,000, being the whole of the share

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capital authorised to be created by the Liverpool Overhead Railway Act, 1899, be and the same is hereby created in 5,000 ordinary shares of £10 each, and that the directors be and they are hereby authorised to issue the same in such amounts and manner, at such times, and on such terms as they may think fit."

Another special general meeting followed, at which the following resolution was carried: "That this Company do approve of the Bill proposed to be introduced into Parliament intituled, 'A Bill to authorise the Liverpool Overhead Railway Company to make certain new railways and a widening of a portion of their existing railways, and for other purposes.'"

DUBLIN UNITED TRAMWAYS.

The half-yearly general meeting of the Dublin United Tramways Company was held on the 13th inst. at Dublin.

The **Chairman** (Mr. Wm. Murphy, J.P.), in moving the adoption of the report, said that during the half-year they had practically completed the conversion of their system to electric traction. The generating station at Ringsend was working for some months under unfavourable conditions for the most economical production of electrical energy, because the overlapping of expenses and disorganisation incident to the changes in the operating system could not be wholly avoided. Moreover, the war and the prevailing epidemic had caused the absence of many of their skilled men, so that they could not at all times provide sufficient service to carry the public. The profits enabled them, nevertheless, to increase their dividend by 1 per cent. The accounts showed an increase of £5 561 in gross receipts, but the net profits were £10,691 more than in the corresponding period, from which it was apparent not only that they increased their traffic receipts by more than £5,000, but that it cost them £5,000 less to earn the increased receipts, and that was the secret of the success of the electric system—namely, increased receipts and diminished expenses; £1,841 of the increased profits were absorbed by wayleaves, which only accrued in the last half-year. The cars on the Company's system during the half-year travelled 2,180,832 miles, of which 730,245 miles, or more than one-third of the whole, were still covered by horse haulage. There was a proved difference of 4d. per mile in favour of electric haulage. The increase in the net profits of the Southern District Company's system was £2,644, the profits being in 1898 £8,951 and in 1899 £11,594, after deducting wayleaves of almost equal sums in both cases. The proportion of working expenses to gross receipts on the southern system was 48·5, and by charging each system with its own proper expenditure and by a ratable division of expenses for horse and electric working the United Tramways Company's system did not exceed 50 per cent. of the gross receipts. They had now 180 cars in operation, and looked forward to finding profitable employment for the additional 70 which they were providing by August next. They also looked forward to a large saving in the cost of production of electric energy in the Ringsend power station. The economy in working from Ringsend had led to the closing of the Clontarf station, and when the proposed multiphase machinery was completed the Ballsbridge station would be closed down and the entire system would be worked from the central power station, thus saving £25 000 per annum. The past half-year was not a favourable one, owing to the high price of money, for selling the balance of debentures, and they did not press the sale. The difference the Company had with the British Thomson-Houston Company regarding the costs of the lowering of the Kingstown sheds would be disposed of by a friendly suit.

Mr. J. R. Wigham seconded the motion, which was adopted.

BRISTOL TRAMWAYS AND CARRIAGE.

The report of the directors for the year ending Dec. 31, 1899, states the gross receipts for the year amount to £158,727. 19s. 6d., and the working and general expenses and renewals are £108,233. 16s., leaving a net revenue of £50,494. 3s. 6d. The following amounts have already been distributed—viz.: interim dividend at the rate of 7 per cent. per annum (free of income tax), for the half-year ending June 30, £16,770. 16s. 8d.; interest on 4 per cent. mortgage debenture stock, and temporary loans, £5,245. 2s.; dividend on 4 per cent. preference shares and interest on calls in advance, £1,884. 13s. 1d.; and it is proposed to appropriate the balance as follows: dividend for the half year at the rate of 8 per cent. per annum (subject to income tax), £19,333. 6s. 8d.; to carry to reserve and renewal funds: contingencies, £5,000; leased premises redemption, £500; electrical renewals, £1,000; permanent-way renewals, £760. 5s. 1d.—or a total of £50,494. 3s. 6d. With the amounts thus set aside, and interest on investments, the reserve funds will be increased from £80 832. 18s. 1d., at which they stood at the corresponding period, to £90 444. 11s. 6d., and the Company's investments from £75,091. 12s. to £87,438. 3s. 3d. The receipts from the tramways department show an increase of £7,799, and those of the carriage department an increase of £4,708. The total number of passengers, excluding postal riders, carried during the year on the Company's cars and omnibuses was 25,330,806. The important works in connection with the extension and reconstruction of the tramways, and more especially the conversion of the entire system preparatory to electrical working, have continued to engage close attention during the past year, and satisfactory progress has been made in every department. Ten and a-half miles of new lines have been laid, and 16½ miles of horse tramways reconstructed with girder rails and copper-bonded, leaving 10 miles of track still requiring to be done to complete the permanent way. The cable conduits have been laid for a length of 10½ miles out of a total of 12½ miles, and the major portion of the requisite street standards and overhead equipment have been erected. The foundations and harbour wall of the central power station having been finished in November last, the erection of the building is now proceeding expeditiously, so that it will very shortly be sufficiently advanced to admit of the installation of the electrical and steam plant. Similar good progress is being shown with the building of the new depôts, those at Brislington and Bedminster approaching completion. All efforts are being generally directed to the introduction of electrical working over the completed undertaking in the course of the ensuing summer. As indicated at the general meeting in February last, the extension to Arno's Vale, and the sections of the system serving Totterdown and the joint railway station in connection with both the tramways centre and Old Market, were converted from horse to electric traction in July last, and have been in successful operation since that time, with results that justify the directors' anticipations. The new issue of preference shares sanctioned at the last general meeting was allotted to the shareholders, and fully subscribed. It will be seen that the expenditure of capital during the year has amounted to £236,000, and when it is remembered that nearly the whole of this sum is in respect of new works which are for the present unproductive, but that nevertheless the interest and dividend charges are borne by the current revenue, the result of the year's working cannot fail to be gratifying to the shareholders. Mr. William Butler, director, and Mr. Solomon Hare, auditor, retire at the ensuing meeting, and offer themselves for re-election.

The ordinary general meeting of the Company was held at Bristol on Wednesday, Alderman C. H. Low presiding.

The **Chairman**, in moving the adoption of the report and accounts (as abstracted above), stated that the year's business showed a distinct advance both in gross and net revenue. On account of the great reduction in working expenses, the directors were able, after the payment of the interim dividend of 7 per cent., interest on debenture stock, temporary loans, and preference shares, to recommend a dividend at the rate of 8 per cent. per annum for the last half-year, and carry £7,260 to the various reserve funds. This would bring the reserve funds up to £90,444.

The motion was duly seconded and agreed to.

LEGAL INTELLIGENCE.

RUCKER v. THE LONDON ELECTRIC SUPPLY CORPORATION.

In the Lord Chancellor's Court on Monday last Mr. Justice Farwell gave judgment in the case of Rucker *v.* The London Electric Supply Corporation, Limited. The following is the text of the judgment:

Mr. Justice Farwell: The plaintiff claims by assignment letters patent of March 16, 1885, for an invention for improvements in distributing electricity communicated by Zipernowski and Déri, of Budapest, and by his writ dated July 1, 1898, seeks for an injunction and an account of profits or damages against the defendants for breach of his patent. As his patent has expired since the date of the writ he can, of course, obtain no injunction, but that does not affect his claim for an account or damages for breaches during the existence of the patent. The defences raised are that there is no patentable invention disclosed in the plaintiffs' specification, prior, publication and want of novelty. The first issue that I have to determine is the state of knowledge of electricians with reference to lighting by electricity at the date of the patent. Since the year 1870 electricity had been applied for lighting purposes, and various advances have from time to time been made in the means adapted for that purpose. The first lamp used was the single arc lamp with a dynamo of its own. Then Jablochkoff showed the possibility of subdividing the electric light by putting several lights in series on a circuit, and by connecting several circuits to one dynamo. Then the arc lamp was replaced by incandescent lamps which were run in parallel and required constant potential, a requirement which entailed considerable practical difficulties. The desideratum was to obtain a constant pressure on the lamps, and a small amount of copper in the mains, and this involved sending out from the station at high pressure and using the power for the lamps at low pressure; both continuous and alternating currents were used. I find the following facts to have existed in March, 1885: (1) The parallel system of distribution given on each consumer's premises a supply of electric energy at constant potential, to be drawn off in multiple arc both for continuous and alternating current, was well known. (2) Transformers on induction coils were well known as machines by which the electrician could transform up or down—that is, could multiply or divide the tension in the primary. (3) It was also known that the E.M.F.'s of the two coils bore a constant ratio to one another depending on the number of turns of wire on the primary and on the secondary. This question of the ratio of turns is well put in the article "La Lumière Electrique," where Mr. Marcel Deprez, referring to Gaulard and Gibbs secondary generators writes in 1884 as follows: "In substance these generators are composed of a series of solenoids of little height and large diameter traversed by an alternating (so-called primary) current taken from any source; this alternating current generates by induction in a second series of solenoids situated at a very short distance from the first solenoids, and, moreover, intercalated between them an induced (called secondary) current, the tension of which depends on the propor-

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tion of the number of inducing spires to the number of the induced spires, and also on their grouping." Moreover, both M. Fesquet and Mr. Ferranti told me that they knew this themselves in 1885. I have mentioned this because there is some conflict of testimony on this patent between the plaintiff's and the defendants' witnesses, and I desire to say that I accept the defendants' witnesses as more accurate in this respect than the plaintiff's; I think that Mr. Swinburne does less than justice to the electrical knowledge of himself and his fellows in 1885. (4) The excitation or actuation of an induction coil by a machine for the purpose of utilising the secondary circuit was not novel. (5) Putting machines in parallel or secondaries of an induction coil was not novel. (6) Positive and negative poles in the consumer's house which are connected with the double series of mains required in the parallel system are the equivalent of a dynamo producing a constant current. In the year 1882 the Electric Lighting Act was passed, and in that and subsequent years many Acts have been passed confirming provisional orders under the Act. The basis of that legislation was that it was feasible to generate electricity at central stations and supply it to consumers in much the same way as water is supplied. The powers of the supplying body, however, ceased at the two poles in the consumer's house referred to above, and the consumer took his supply by straddling the mains at those two poles—*i.e.*, by putting the transformers on the poles in parallel on the secondary circuit—and, as Mr. Swinburne told me, the consumer can himself put on the transformers in parallel on an ordinary parallel system. The customer is at liberty to use the current which he so obtains for any purpose that he thinks fit. I should add that the Acts extend both to continuous and alternating currents, and both to the parallel and the series system. Before considering the various documents referred to in the defendants' particulars, I will consider the construction of the patent. Now the claim of the patent is as follows: "In the application of induction coils or transformers for alternating electric currents, the arrangement of several stations of second order as branch circuits of the main line—*i.e.*, connecting up the local centres with the main in multiple arc—to which main line is supplied an alternate current of a tension as constant as possible substantially as described and shown in the drawing." In my opinion this is a claim for arrangement, and for arrangement only: it is merely a continuation in a particular way of old well-known methods. The difficulty of construing this patent is increased by the fact that the patentee amended it some time ago by striking out claims for a means of maintaining an invariable tension at the points where the primary current enters the local centres. On the unamended patent I should have been of opinion that the words "substantially as described" referred to the means of keeping the tension as constant as possible, but I cannot so read them now that the provisions relating thereto have been struck out. In my opinion, therefore, the words must be read, "the arrangement substantially as described." I have therefore to consider if there is anything in the body of the specification affecting that claim in any way. Now, the specification commences by a historical statement, followed by a reference to the inefficient modes of distribution then in use, and states that the object of the invention is to make all individual points of consumption of electrical energy quite independent from one another, and it goes on to state in general terms the mode of doing this, which is in effect what is stated in the claim that I have already read. The inventors then state that "the distinctive feature of our system of distribution is that each group of induction coils or transformers of the several stations of second order shall merely constitute branch circuits of the main line for the primary current—*i.e.*, that primary circuits of the several local centres, any one of these being taken as a whole, are connected in multiple arc. In this manner we have distributing the primary (high-tension) current in as many branch circuits as there are local centres, and any desirable number of secondary (low-tension) circuits."

I pause to observe that there is nothing here as to the form of transformer to be used, but that the patentee says that the distinctive feature of his invention is the arrangement in parallel arc. It appears to me that he believed himself to have discovered the use of transformers in parallel arc on secondary circuits, and this seems to have been to some extent the view of Mr. Swinburne when, in answering Mr. Moulton's question, "In what respects do you say defendants infringe?" he replied, "In that you have a system of distribution with alternating current transformers with high tension in primaries of 2,400 volts, and secondaries supplying lamps in parallel at 100 volts," and he said also that he considered the high tension and the low tension of the mains both essential. Pausing here, I am of opinion that no patentable invention is disclosed by this part of the patent if this be the essential feature of it. Mr. Swinburne a short time before had admitted that as early as 1882 the advantages of high tension and low tension were well known, and, further, that high tension and low tension are now descriptive epithets having no technical meaning. I hold as a matter of construction that high and low tension are not within the plaintiff's claim—*i.e.*, that the words are merely descriptive, and express nothing beyond the fact that the primaries are of high tension in comparison with the secondaries. The next four lines of the specification have (as I have already stated) given rise to some conflict of testimony; they are as follows: "How the E.M.F.'s of the two coils of a transformer bear a constant ratio to one another: therefore if the internal resistance of such an apparatus is very low the secondary tension will remain almost unaltered, if we only have a constant difference of potential at the terminals of the primary coil." I have already found that the various statements in these four lines were, and were intended to be, mere statements of well-known facts, and that this was intended to be so as a matter of construction is made clear to my mind by reference to the unamended specification which I am entitled to look at for this purpose, according to Lord Watson's statement in the House of Lords' case cited by Mr. Bousfield. It is in my mind plain on the original specification that these lines were statements of facts leading up to and emphasising the value of the means for maintaining an invariable tension which formed part of the original specification. Some argument was used on the advantage of keeping the resistance as low as possible. But this appears to me to be a mere truism, amounting simply to a statement that it is desirable to avoid useless waste, because excessive resistance exhausts the energy that is wanted for lighting by turning it into heat. Passing over some paragraphs in the specification I come to the following statement on the last page: "We desire it to be distinctly understood that the form of induction apparatus or transformers may be of any kind whatever without departing from the principle of our invention." That is a claim extending to all transformers of every sort, but transformers were well known and were in common use before the date of the patent. Lord Kelvin told me that no practical man would have been afraid to put inductors straddling across mains of high-pressure alternating current circuit, and that there was absolutely nothing novel in it. Mr. Swinburne put the plaintiff's case very neatly when he said, "Everybody knew that we wanted a high pressure from the station and a low pressure in parallel distribution in houses; they—that is to say, Z and D—came, and they realised that a transformer arranged in a particular way which was not the usual way of arranging them, gave them the key to the solution of the problem." Assume that it was not "the usual way," as he says, it was, however, a well-known way, and I am wholly unable to discover any invention in it. Authorities on different specifications are of little value on questions of construction, but I think the case of Gaulard and Gibbs in the 7th Patent Reports gives a useful illustration of the application of the principles on which the Court acts. To my mind, this specification contains at the utmost good advice, and is very far removed from invention. It recommends one of two well-known modes of transformers as most suitable for conducing to a particular result. I should add that all transformers are said to be within the arrangement claimed, but as a fact all are not suitable. The plaintiff, however, can get no benefit from this, for he certainly does not point out any particular form of transformer as the appropriate one or give any guidance whatever in this direction.

I will now proceed to consider briefly the defendants' particulars of objections. The most important document, to my mind, is the article in the *Zeitschrift für Electrotechnik*. It was proved that this document was sent over to the Patent Office here, and was laid on the table of the public reading-room two days prior to the plaintiff's patent, and it is admitted that it is a description of the plaintiff's arrangement. If, then, this document contains sufficient information of the details of the plaintiff's arrangement to enable a practical electrician to put in operation the plaintiff's arrangement, the plaintiff's case would fail, even if (contrary to the opinion that I have already expressed) the plaintiff's arrangement was a patentable invention. In my opinion, the article does contain all such information. I have come to this conclusion, both as a question of fact after weighing the evidence of the witnesses and also as a question of construction, treating myself, as far as possible, as possessed of the knowledge of the subject which a competent electrician would have had in 1885. On construction, I am of opinion that the article indicates with sufficient precision that there was a parallel distribution, and that the consumer was to take his supply by transforming down from high-tension primaries. Lord Kelvin was clear about this, and I do not consider that his testimony was at all shaken by the cross-examination, although he for the moment forgot the statement in the last paragraph but one in the article—namely, currents of respectively six and seven amperes at the maximum flowed through the primary conductors. He set this right in re-examination, pointing out that these words clinched it, and as a matter of construction I agree with him and M. Fesquet and Mr. Ferranti. Further, I do not think that Mr. Swinburne really differed, judging from his manner and tone in answering Question 453 (and it is needless to say that Mr. Swinburne is not only a most competent, but a most straightforward and candid witness). I think that he meant that he agreed with Mr. Moulton and the construction that he put upon the sentence that I read above. In view of the opinion that I have expressed it is not necessary for me to consider the other documents mentioned in the defendants' objections in any great detail—they are important as showing the general state of knowledge prior to the plaintiff's patent, and they confirm me in the view that I have already expressed. The first is Brush; in this specification the defendant relies on a drawing only—namely, Fig. 9. This figure does, in my opinion, show diagrammatically the system of distribution by parallel mains and of drawing off by transforming and using secondary circuits. As Mr. Swinburne put it, "Fig. 9 is the diagrammatic method of representing transformers in parallel on parallel mains—that is to say, that they are primaries on parallel mains." Again, Lord Kelvin said that "Fig. 9 shows diagrammatically with perfect clearness five transformers placed in parallel on the mains of an alternating current dynamo machine—the diagram alone with the statement that this applies to transformers in alternating-current machines is unmistakable." And, as Lord Kelvin said, "The problem of distribution is represented in Fig. 9, although the problem as to the size of dynamos or the method of getting electricity over a large area was not dealt with." But I cannot see that this affects the question when you have once arrived at the fact that parallel distribution was well known before 1885. I agree with Lord

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Kelvin that, given that knowledge, there was no invention in proposing to add at 20 places what was done on one. I will pass by the article in the *Times* referring to Fuller's patent with the remark that I hold that the statement on p. 3 is a statement of parallel distribution, but that if that article stood alone I should have had some difficulty in thinking it sufficiently explicit. The next document is Edison's patent of 1883. This is very remarkable because, on the evidence before me, I find that Mr. Edison has the whole of the plaintiff's arrangement and something over and above and quite independent of that arrangement, and that Edison—I say it with hesitation of so eminent an inventor—apparently failed to appreciate the full advantage of his own invention, but to have been led away by his desire to secure continuous current. As Lord Kelvin said, "Edison's arrangement without the commutators is the plaintiff's arrangement, and the only object of the commutators was to convert the continuous current into an alternating current of high tension, which then passed through the transformers and came out as an alternating low-tension current to another commutator, the object of which was to deliver a continuous low-tension current, but no alteration was effected either in the tension or the quantity." Mr. Swinburne did not really disagree with this view, for he said that if you remove the whole of the commutators and substitute alternating current, you have the Zipernowsky system, and the only objection that he suggested to Edison's system had a reference to the commutators—namely, that there would be such serious sparking at the commutators that they would not work. The only other matter to which I need refer is the installation under the Gaulard and Gibbs system. I accept M. Fesquet's testimony with regard to the exhibition at the Aquarium in 1883. I make no sort of reflection, of course, on Mr. Mackenzie, but he had for some years ceased to be employed in electrical engineering, and I am convinced that he had no really accurate recollection on which I could rely. I find that in 1883 Fesquet coupled the primaries in parallel as well as in series many times, and that the lamps were placed in parallel on the secondary wires, and, further, that in 1884 there was an installation on the Metropolitan Railway running for some months in which alternating high-tension currents were transformed down, and that the lamps were in parallel. I mention this because I desire to say that in my judgment Mr. Ferranti was a competent and trustworthy witness, on whose evidence reliance can be placed. I think that it is unnecessary for me to refer in detail to the Imray specification or to Rankin Kennedy's article, the last sentence of which is certainly remarkable. The result is that the plaintiff's action fails, and must be dismissed with costs.

After considerable argument between **Mr. Cripps** and **Mr. Walter** over the question of costs, his **Lordship** decided to grant these on the higher scale, and an agreement was also come to as to which articles should be included in the costs, as certain which had been mentioned in the pleadings had not been used in the trial. Leave to appeal was given on the usual terms.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Blackburn.—The Corporation invite tenders for feeder cables. Tenders by 26th inst. Details in our advertisement columns.

Newington.—The Vestry invite tenders for two water-tube boilers, etc., for the electric light station. Tenders by 20th inst.

Birkenhead.—The Corporation invite tenders for the supply and laying of feeder and distribution mains. Tenders by March 1.

Islington.—The Vestry invite tenders for supply of electrical and engineers' stores for one year from March 15. Tenders by Feb. 22.

Wimbledon.—The Urban District Council invite tenders for the supply of lamp-posts for incandescent electric lamps. Tenders by 26th inst.

Rochdale.—The Corporation invite tenders for the supply and delivery of electricity meters. Tenders by 28th inst. Full particulars in our advertising columns.

Bournemouth.—The Corporation invite tenders for cables, arc lamps, wiring, switchboards, fittings, etc., for the electric lighting of pleasure grounds. Tenders by March 3.

Walthamstow.—The Urban District Council invite tenders for the supply and erection of electric and Dowson gas plant at the isolation hospital, Chingford. Tenders by 23rd inst.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for 130 car bodies, trucks, and electric equipment. Tenders by March 2. Details in our advertising columns.

Aberdeen.—The Tramways Committee invite tenders for the supply of four electrically-equipped tramcars and other material. Tenders by Feb. 28. Details in our advertisement columns.

St. Annes-on-the Sea.—The Urban District Council invite tenders for battery and accessories and meters and demand indicators. Tenders by 26th inst. Details in our advertisement columns.

Gloucester.—The Corporation invite tenders for the wiring of the guildhall, public baths, and electricity works; also for the necessary electric light fittings for these buildings. Tenders by 27th inst.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for (A) one 50-ton electric crane; (B) one 25-ton hand-crane; (C) one 6-ton electric crane; and (D) one 2-ton hand-crane. Tenders by noon on March 5.

Newcastle-upon-Tyne.—The New Tramways Committee of the Corporation invite tenders for copper bonds. Tenders by Feb. 22. Details in our advertising columns.

Sunderland.—The Corporation invite tenders for the supply of steam, exhaust, feed, and other pipes, and two steam-driven induced-draught fans and accessories. Tenders by March 2. Details in our advertising columns.

Kingston-upon-Hull.—The Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked, to seat about 51 passengers). Tenders by Feb. 19. Details in our advertising columns.

Poplar.—The Board of Works are prepared to consider schemes for the fixing-up of consumers' houses for electric lighting free of all initial cost to the Board or the consumer. Tenders by March 1. Details in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply and fixing of steel roof trusses and girders, cast-iron columns, and other metal work at the intended electric car shed, Queen's-road, Cheetham. Tenders by 24th inst.

Sydney.—Tenders are invited by the Public Works Department for the erection of electricity works, engines, dynamos, cables, and telephone apparatus. Tenders are to be addressed to the Chief Engineer, Road, Bridges, and Sewerage Branch, by March 20.

Shoreditch.—The Vestry invite tenders for the supply of various material and works for the electricity department and for street lighting. Samples can be inspected at the Town Hall, Old-street, E.C., or at the Coronet-street lighting station. Tenders by the 27th inst.

Hull.—The Corporation invite tenders for the supply of 35 double motor equipments and 10 car bodies (double-decked, to seat about 51 passengers). Specifications, etc. (£1), may be obtained of Mr. A. E. White, city engineer, Town Hall, Hull. Tenders by Feb. 19.

Keighley.—The Corporation invite tenders for the supply and erection of switchboard and balancer, 10-ton overhead travelling crane, storage battery, mains, conduits, arc lamps and posts, ejector condensers, exhaust pipes and tanks, and main, steam, and feed-water pipes. Tenders by March 1. Details in our advertising columns.

Salford.—The Corporation invite tenders for the supply and delivery and erection of electrically-driven mechanical stokers, economisers and fittings, jet condensers and pumps, with steam, exhaust, and water pipes, electrically-driven feed pumps and feed pipes, and travelling crane. Tenders by 28th inst. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of tramways switchboard. Specifications and forms of tender can be obtained of Mr. J. F. C. Snell, borough electrical engineer, at his office, Dunning-street, Sunderland, on payment of two guineas. Tenders to Mr. Fras. M. Bowey, town clerk, by 12 noon on 26th inst. Details in advertisement columns.

Farnworth.—The Urban District Council invite tenders for the supply, delivery, and erection of the following: Lancashire boilers, economisers, condensing plant, feed pumps, steam and exhaust pipes, etc., three 100-kw. steam dynamos, lighting switchboard, traction switchboard, accumulators, underground cables, travelling crane, and recooler tower. Tenders by March 7. Details in our advertisement columns.

Durban (Natal).—The Corporation are prepared to receive tenders for the supply and delivery at Durban of 1,900 tons steel girder rails, 64 tons fishplates, the necessary quantity of fishbolts, nuts, tie-bars, and electric bonds, 407 loads Australian hardwood stringers, the necessary quantity of dog-spikes, etc. Tenders by March 8. Specification, etc., may be obtained from Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation.

Horsham.—The Urban District Council invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, &c., pipework, etc., in engine and boiler house, two steam dynamos (vertical enclosed high-speed engines), and motor boosters, storage batteries, main switchboard and connections, six-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed type) and posts, station lighting. Tenders by March 1. Full particulars in our advertising columns.

Melbourne (Victoria).—The Corporation invite tenders for the supply and delivery of the necessary plant, and the superintendence of its erection, and of the carrying out of the work in connection with the electric lighting of the city, to specifications as follows: (1) boilers (dry-back or water-tube type, with superheaters) and economiser; (2) steam-engines, dynamos, equaliser, booster, and switchboard; (3) feeders, mains, and arc light leads, with all bitumen or insulating material; (4) accumulators. Specifications, etc., can be obtained from the Agent-General for Victoria, 15, Victoria-street, Westminster, London, S.W., on and after the 28th instant, on payment of £1. 1s. for each specification, to be returned on receipt by the Corporation of a bona fide tender. The specifications and drawings may be seen at (but not obtained from) the office of Dr. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London, S.W. Tenders by March 1. Full particulars appear in our advertising columns.

RESULTS OF TENDERS:

Morecambe.—The tender of Messrs. Hughes and Stirling for a refuse destructor has been accepted subject to certain modifications.

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Croydon.—The Council have accepted the tender of Mr. S Page, Borough-hill, Croydon, at £4,713, for extending the buildings at the Corporation electric light station.

Coventry.—The City Council have accepted the tender of J. W. Singer and Sons, Frome, at £250. 2s. 6d., for the electric lighting fittings in St. Mary's Hall and the Mayor's Parlour.

Battersea.—The tender of the General Electric Company, Limited, for the supply of arc lamps, for the sum of £1,776. 12s., has been accepted, subject to their entering into a contract upon the lines suggested by Prof. Kennedy.

Birkenhead.—The Corporation have accepted the tender of Mr. W. H. Forde, Claughton road, Birkenhead, at £10,426. 17s. 6d., for constructing and erecting a new electricity generating station in connection with the electric tramways in Craven-street, Birkenhead.

Aberdeen.—The Tramways Committee have accepted the offer of the Seaton Brick and Tile Company, Limited, for the purchase of cars Nos. 1, 4, 5, and 6, formerly used on the Woodside route, the price for three of the cars being £15 each, and for the remaining car £20.

Aberdeen.—The Electric Lighting Committee have accepted the tender of the British Westinghouse Electric and Manufacturing Company, Limited, Westinghouse-buildings, Norfolk-street, Strand, W.C., for the supply of one 420-kw. direct-coupled continuous-current dynamos.

Halifax.—The following tenders have been accepted: Electric Construction Company, Limited, Wolverhampton, four electric motors, at £93. 5s. each; Mr. J. Berry, New Bank, to supply and fix iron and steel work in connection with the boiler-house at the electricity works for £539. 8s. 6d.

Wigan.—The Council have accepted the following tenders: Bedford Engineering Company, travelling crane; Barrow Hematite Steel Company, steel tramrails and fishplates; Blackwell and Co., street poles, brackets, etc.; Babcock and Wilcox, Limited, mechanical stokers, water softener, and tanks.

Bradford.—The Tramways Committee have accepted the following tenders: Macartney, Elroy, and Co., Limited, 53, Victoria-street, London, S.W., for the complete electrical overhead equipment of about eight miles of tramway (Lister Hills, Stanningley, Thornton, and Whetley Hill sections); Jarrah Timber and Wood Paving Corporation, Limited, to supply 200,000 Jarrahdale Jarrah wood paving blocks, at £10. 7s. 6d. per 1,000.

Tunbridge Wells.—The following tenders have been received for the enlargement of the central station:

Battley, Sons, and Holness (recommended for acceptance)..	£2,249
J. Jarvis	2,431
R. L. Tonge	2,500
Strange and Sons	2,638
Thomas and Edge	3,512

Hackney.—The Vestry have received the following tenders for accumulators: (No. 5) Tudor Accumulator Company, Limited, London, £8,155; maintenance after the expiration of the 12 months' guarantee, 14 years £405 per annum. (No. 2) D.P. Battery Company, Limited, London, £8 733. (No. 3) Electrical Power Storage Company, Limited, London, £9 918; maintenance after the expiration of 12 months' guarantee, 14 years £443 per annum. (No. 4) Hart Accumulator Company, Limited, Stratford, E., £10,823; maintenance after the expiration of 12 months' guarantee, 14 years £904 per annum. (No. 1) Chloride Electrical Storage Syndicate, Limited, Clifton Junction, £12,567; maintenance after the expiration of 12 months' guarantee, four years £748 per annum, second period of five years £872 per annum, third period of five years £997 per annum.

BUSINESS NOTES.

TRACTION.

Folkestone.—The Town Council intend to petition against the Tramways Bill.

Brierfield.—The District Council intend to oppose the Burnley tramways scheme.

Widnes.—The Town Council intend to petition against the Manchester and Liverpool Electric Express Railway Bill.

Mountsorrel.—At a recent public meeting a resolution was passed in favour of the proposed Loughborough light railway.

Dover.—The Council have decided to oppose the Cinque Ports light railway scheme so far as its connection with Dover is concerned.

Waterloo-with-Seaforth.—A sub-committee has been appointed in connection with the extension of the Liverpool Overhead Railway.

Bewdley.—The Town Council have agreed to the British Electric Traction Company's application for a tramway from Kidderminster to Bewdley.

Sheffield.—The Tramways Committee have recommended that the city surveyor be authorised to lay tramlines in Market-street to form a dock for certain cars.

Wotton-under-Edge.—The Light Railway Commissioners have decided to recommend the application for a light railway from Charfield to Wotton-under-Edge.

Higham Ferrers.—The Council intend to support Wellingborough tramways scheme.

Plymouth.—The suggestion that the tramways should be extended to the Barbican is being considered, and a sub-committee are about to report as to its feasibility.

Burnley.—The minutes of the Tramway Committee, which provided for proceeding with the Tramways Bill in Parliament, have been confirmed by the Town Council.

Scottish Private Bills.—The Examiner has reported non-compliance in the case of the Aberdeen Corporation Tramways Bill and the Dundee and East Forfar Tramways Bill.

Northfleet.—The by-laws of the Drake and Gorham Electric Power Company in reference to the tramway which they have now taken over have been referred by the District Council to the clerk for report.

Queensbury.—The question of terminus has been settled by resolutions passed last week giving Bradford leave to work certain lines, and offering Halifax to purchase part of the Queensbury undertaking.

Elland.—The question of whether Elland shall oppose the Halifax Corporation Bill, and thus probably postpone tramways running into the district for years, will come before a meeting of the ratepayers.

Llanishen.—A meeting of the parishioners on Thursday last week passed a resolution expressing disapproval of the Cardiff Corporation Bill, and pledging the meeting to assist the Rural Council to oppose it.

Rhondda Valley Light Railways.—The Light Railway Commissioners have refused the application in so far as concerned Railways Nos. 2 and 3, and have further adjourned the consideration of Railway No. 1.

London County Council Tramways Bills.—The Examiners of Standing Order Proofs of the House of Commons have agreed to a postponement until the 26th inst. for the submission of proofs of compliance with the rules of Parliament.

Wigan.—The enquiries as to cars have resulted in a recommendation that the Liverpool type be adopted to the 3ft. 6in. gauge, and that tenders be asked for it from the Westinghouse, Thomson-Houston, and Dick-Kerr Companies.

Poole.—The Town Council have agreed to the application of the Poole and District Electric Traction Company, Limited, to the Board of Trade to extend the time for commencement of the light railways for two months from Feb. 17 next.

Dundee and East Forfar Tramway.—Various public authorities in Dundee, Broughty Ferry, and Carnoustie have received intimation from the promoters of the Dundee and East Forfar tramway that the scheme was not to be gone on with.

Stirling and Bridge of Allan Tramways Co.—At an extraordinary general meeting of the shareholders of this Company last week an agreement for the sale of the tramway company's undertaking to the British Electric Traction Company, Limited, was adopted.

Cheltenham.—The Light Railway Commissioners have intimated that they have "settled" the order for the light railway through the town, and have passed it on to the Board of Trade without the usual procedure of submitting a preliminary draft to the parties concerned for objection or comment.

Leeds.—In consequence of the agitation for a reduction of the fares on the Roundhay route from 2d. to 1d., it has been decided to obtain the opinion of the Works Committee as to whether sufficient electrical power would be available for the increased service that would necessarily follow the alteration.

Wirral and Mersey Railways.—On Monday, at a special meeting of the shareholders of the Wirral Railway Company held at the Queen Hotel, Chester, Mr. T. H. Jackson, of Manor House, Birkenhead, presiding, it was resolved that the shareholders approve of the Bills to work the Wirral and Mersey Railways by electricity.

Lanarkshire.—At a recent special meeting of the County Council it was decided to oppose the Glasgow district tramways, at least until satisfactory terms were obtained. It was explained that the promoters of the Hamilton, Motherwell, and Wishaw Tramway Bill had been able to meet the views of the District Committee.

Glasgow.—It is expected that at the next meeting of the Town Council some definite decision will be arrived at as to whether the Corporation should take up the tramway scheme for Kirkcaldy or hand it over to a company. While there is division of opinion on the subject, it is considered certain that electric tramways will be proceeded with without delay.

Penge.—At the last meeting of the Vestry a letter was read from the clerk of the Lewisham Board of Works informing the Vestry that a resolution had been passed opposing the tramways coming through the hamlet of Penge. It was stated that the London County Council had decided not to give its consent to the tramways coming through the hamlet.

Carlisle.—The Carlisle Town Council have approved of the decision of the General Purposes Committee requiring the tramways company to adhere to their scheme, with the exception of one or two modifications. The company wished to lay a single line on the Warwick road, but the Town Council objected, and they are supported by the County Council.

Central London Railway.—It is reported that a trial is to be made at the end of the present month. All the locomotives have been delivered and erected, 12 miles of cable have been laid, the

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station buildings are well advanced, the subways opened, and most of the electric lifts installed. The equipment for electric motive power, however, is not quite finished.

Gloucester.—An enquiry was held on the 12th inst. by the Light Railway Commissioners into an application of the Gloucester Tramway Company for power to take up the present tramway, lay down new lines, and substitute a light railway, the traction power to be electricity. Mr. Coward, who appeared for the promoters, said the cost of the undertaking would be about £95,000. There was no opposition.

Mansfield Woodhouse.—The Highways Committee are considering a letter from the tramways syndicate stating that they undertook not to construct any part of the railway in the Council's district till they had purchased sufficient property to widen the road to their satisfaction, unless at any time the Council should consent to their construction notwithstanding the road not being widened, such agreement to be subject to the Council consenting to the scheme going through.

Barnsley.—The Barnsley Corporation Bill last week came before Mr. Jeune, one of the examiners of private Bills in Parliament, for proofs of compliance with the Standing Orders. As the Corporation had withdrawn all the portions of the Bill relating to tramways no proofs relating to tramways were submitted, and a formal non-compliance in respect of the Bill was returned. Application will be made that the Standing Orders may be dispensed with in respect of the tramway proposals.

Aldershot.—The Light Railway Commissioners have held a public enquiry as to the expediency of granting an application which had been made to them by Messrs. Power and Traction, Limited, for an order to authorise the extension of the Aldershot and Farnborough light railway from the Cavalry Gates at Aldershot to the Aldershot Town railway station. At the end of the sitting it was announced that, subject to an adjustment of the various details, the Commissioners would be prepared to recommend the granting of the order.

Warrington and Northwich Light Railway.—In accordance with the combined request of the Parish Councils of Barnton, Anderton, Little Leigh, and Winnington, there is every prospect that a western branch of this railway will be made, so as to ensure the areas within those authorities having the benefits of increased communications between the two centres, Warrington and Northwich. Mr. Scotter has mapped out a route from Stretton, through Whitley, Little Leigh, Barnton, and Winnington, to within a short distance of Town Bridge, Northwich.

Tonypandy.—At a public meeting last week a resolution was passed requesting the Rhondda Urban District Council to use every effort to come to an amicable arrangement with the British Electric Traction Company in order that the present opposition to the light railway scheme to Tonypandy be withdrawn. It was also decided to request the Council to endeavour to obtain a pledge from the company that they will apply on the earliest possible date for powers to extend their present projected line from the square at Tonypandy to Treherbert, and from Porth through Tylorstown to Ferndale.

Wirral.—Sir F. Bramwell has reserved his decision as umpire in the arbitration between the Wirral Tramways Company and the Corporation of Birkenhead. The arbitrator is to decide, under Section 6 of the Birkenhead Corporation Act, 1899, the amount to be paid by the Corporation for the unexpired term of 16¼ years of lease of tramways within the borough, the property of the Corporation; of 548 yards of tramway in the urban district of Lower Bebbington; and of the stables, land, and buildings belonging to the company. The valuers on behalf of the company claimed from £30,083 to £30,485 as the value of the company's undertaking.

Hampton.—At a recent special meeting of the Council, which was attended by the chairman, the managing director, and the solicitor to the London United Tramways, Limited, several details were discussed. The company agreed to make a double line throughout the Hampton Court-road, and also along the Upper Teddington-road conditionally upon the Council enabling them to secure the land necessary to make the road wide enough to take the double line. It was resolved that, subject to the sealing by the company of an agreement embodying these further conditions, the Council consent to the Bill now being promoted by the company.

Paisley.—The Town Council have agreed to consent to the Glasgow District Tramways Bill, subject to the Town Council of Renfrew and the Commissioners of Johnstone giving a like consent to the Bill being heard in Parliament this session, on the promoters of the Bill entering into a formal agreement stipulating, *inter alia*, that the promoters shall, without any process of law, but on the simple letter addressed to them or to their agent or agents by the town clerk, requesting them to do so, absolutely withdraw and abandon the said Bill at any stage thereof, in so so far as it affects the burgh of Paisley. Unconditional consent being required by the rules of Parliament, a meeting has been arranged between the promoters and a committee of the Town Council.

Poole Electric Traction Co.—Power is sought in the Bill promoted by this Company to construct three sections of electric tramways, of an aggregate length of nearly eight miles, to form a line from the Dorset County Gates through Bournemouth to Christchurch, and from Bournemouth to Winton. A generating station will be erected at Christchurch, and a special provision is inserted in the Bill under which it is proposed to prohibit the local authorities from exercising their statutory right of purchase until after a period of 35 years. The Bill also proposes to amend the general law by enacting that the terms upon which the Company may be required to sell its undertaking shall be only on payment of the fair market value as a going concern, but without any allowance for compulsory purchase.

Hastings Tramways Co.—A Bill has been deposited to invest the Hastings Tramways Company with powers to construct nearly 11 miles of electric tramways within the borough of Hastings. The proposed tramways will be worked in connection with the Bexhill and St. Leonards light railway, which was authorised in 1899, but for which none of the capital has yet been subscribed. The capital of the new Company is proposed to be fixed at £300,000. Authorisation is also sought by the Company to take over the powers granted by the Bexhill and St. Leonards Light Railway Order, 1899, and to recoup the light railway company all expenditure already incurred by them. The Bill provides for the ultimate acquisition of the undertaking by the Corporation, and for the supply by the Company of electrical energy.

Huddersfield.—Alderman Haigh, chairman of the Tramways Committee of the Corporation, on the 13th inst. laid the corner stone of the new generating station which is to be erected at Longroyd Bridge, Huddersfield, for the purpose of supplying electrical energy to run the trams on one of the sections—about 11 miles in length. The Mayor of Huddersfield, Alderman G. W. Hillawell, presided, and gave a short history of the development of the tramway system in Huddersfield. The proposed works are designed to provide power to haul cars over 50 miles of rail, covering 47 miles of road. At present there are 26½ miles of single line within the borough, and this, under the new system, will be extended to 31 miles, while outside the borough boundary there will be laid 19 miles of rails. The cost of the whole scheme and of the first section of tramways will be £60,000.

Croydon.—A report has been received from the consulting engineer on the general arrangements of the tramway system and estimate of cost. Two alternative schemes are described. Scheme 1: Total length of route, 10·94 miles; total length double line, 3·89 miles; total length road reduced to single track, 14·83 miles; estimated cost, including rails, fishplates, bolts, tie-bars, points, crossings, labour, excavation, concrete, and wood paving for width of track, and 1ft. 6in. on each side, say £76 000; feeders, bonding, poles, etc., £27,750; 40 cars at £660, £26,400—total, £130,150. Scheme 2: Total length of route, 10·94 miles; total length double line, 6·57 miles; total length road reduced to single track, 17·51 miles; estimated cost, including all as per Scheme 1 and extra rails, £37,000; overhead gear as Scheme 1, plus extra bonding, £27,750; 37 cars at £660, £24,420—total, £139,370.

Lowestoft.—At an adjourned meeting of the Town Council on Tuesday the following proposals, amongst others, were submitted and adopted: The Corporation to have the right either to construct the light railways and tramways, or to purchase them from the company at cost price; upon construction or purchase by the Corporation, a lease to be granted to the Drake and Gorham Company for 7, 14, 21, or 28 years, the rent to be equal to the annual sum which the Corporation will have to pay for interest and repayment of capital borrowed for the construction or purchase and for costs, together with 1 per cent. per annum upon such capital, the Corporation to borrow for the longest period for which they can obtain power; that the General Purposes Committee be authorised to seal an agreement with the promoters carrying out the proposals, and to take all necessary steps for carrying the same into effect.

Grimsby.—The Grimsby Street Tramways Bill came before Mr. Campion, one of the examiners of private Bills, in the House of Commons on the 12th inst. Mr. Frere (parliamentary agent for the promoters) said on Aug. 21 the promoters sent the heads of an agreement to the Corporation of Grimsby, and they were accepted on Sept. 6. The promoters were thus placed under an obligation to carry out the scheme, but for some reason or another the Corporation subsequently refused to seal the final agreement and withheld their consent. He would ask the examiner to treat the previous action of the Corporation as a consent. The Examiner said the application was tantamount to asking the examiners to act as a court of law and say what is a contract. It was an exceptional case, and he would make a report to the House. He formally marked the Bill as not having complied, but that the necessary proofs were submitted save the consent of the Corporation.

Bradford.—The Tramways Committee have recommended the Council to accept the offer of the Bradford and Shelf Tramways Company, Limited, to sell to the Corporation their unexpired leases of tramways and their property and plant on the following conditions: The Corporation to pay to the company compensation for profits for the remaining period of the leases on the basis of the average profits of the past three years, the settlement of the amount of such profits to be left to Mr. Lee (the company's accountant) and Mr. Thorpe (the city treasurer); the Corporation to pay for the land and buildings the price paid therefor by the company; the price for rolling-stock, machinery, fittings, and plant at a valuation on the basis of the concern coming to an end in three years' time, when the whole stock would come on the market for sale at such price as could then be obtained, to be fixed by two arbitrators, one to be appointed by each party; in the event of the arbitrators being unable to agree, they are to appoint an umpire, and such arbitrators and umpire to be instructed as to the terms accordingly.

Ashton.—A meeting was held on Monday night, when the advantages of the South Lancashire light railways scheme were set forth at considerable length by various speakers. The principal recommendations this scheme has for Ashton are the lighting of certain roads along which the proposed line would

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pass, the opening up of communication with a large number of townships, the conveyance of goods as well as passengers, and the improvement of the corner of Warrington-road and Gerard-street. All very desirable things. The scheme is a comprehensive one and the acquiescence in it of a multitude of local authorities is required. The Ashton Council will have none of it, and probably what has led to this is that the scheme resembles what is colloquially termed "too large an order." In favour of the Wigan scheme is the geographical situation, the sympathetic industrialism, and the fact that Wigan is practically the colliery metropolis and the market town of the neighbourhood. At a special meeting of the Ashton District Council on Thursday of last week it was decided to oppose the South Lancashire Tramways Company's Bill.

Edinburgh.—A meeting was held last Friday in accordance with an agreement come to between the representatives of the Corporation of Leith and the Edinburgh and District Tramways Company's directors. Provost Mackie laid before the directors a statement showing that the Leith company valued their whole undertaking at the present time at £92,000, but were prepared to accept £90,000. Deducting the value of certain property the value of the tramways was reduced to £62,450, on which sum the Corporation of Leith proposed that the company should pay 7 per cent. annually. The estimate for electric traction was £41,817, making a capital expenditure for cable and electric traction of £56,817, upon which the company should pay 7 per cent. The directors stated that they considered that the proposed charge of 1½d. per unit for electric traction to be supplied by the Leith Corporation was excessive, and mentioned ¾d. as a more reasonable sum. The question was whether in view of the revenue they would be able to give 7 per cent. as proposed by Leith. Mr. Blyth, the chairman of the company, intimated that since they had heard the views of the Leith representatives, the directors would take the question into their serious consideration, and give a reply within the next eight or ten days.

LIGHTING AND GENERAL.

Fairfield.—It is proposed to establish a telegraph office at Dove Holes.

Burnley.—A full report is being prepared on the electric lighting at the workhouse.

Leigh.—The Town Council intend to oppose the Lancashire Electric Power Bill.

Trowbridge.—The Urban District Council are making enquiries with regard to electric lighting.

Thornaby.—Steps are being taken to obtain advice on the construction of electricity works.

Garstang.—The Postmaster-General has been asked to establish a telegraph office near Brock Station.

Pontypridd.—The District Council intend to oppose the South Wales Electrical Power Corporation Bill.

Shoreditch.—The Vestry have decided to lay electric mains along Canal-road, the estimated cost being £900.

Hendon.—The Guardians intend to ask the advice of an expert as regards the electric lighting of the workhouse.

Basingstoke.—Steps are to be taken to ascertain on what terms the borough could be supplied with electric current.

Llanelly.—The National Telephone Company are asking the Council for permission to run a cable through the sewer.

South Bank.—The Urban District Council are discussing the advisability of obtaining a provisional electric light order.

Blackburn.—A bazaar is being held in order to raise the amount required for an electric light installation at St. John's Church, Victoria-street.

Fulham.—At the Vestry meeting on Wednesday last it was decided to issue tenders for 250 Aron electricity meters as a trial of these instruments.

Godalming.—The Council have been discussing the necessity of reducing the cost of public lighting. Electric light entered largely into the debate.

Derby.—Several alterations and promotions have been made in the staff of the Electric Lighting Committee. Mains are to be extended to Thornhill-road.

Aberaven.—The Gas Committee have been invested with full powers to oppose the County and South Wales Electric Lighting Bills in the session of Parliament.

Durham.—The Corporation have adopted a centrally-situated site for a generating station. They have also decided to support the Electrical Power Distribution Bill.

Penarth Docks.—The Taff Vale Railway Company are erecting at the Penarth docks an engine-house to contain the machinery for the installation of electric light.

Sleaford.—The Urban District Council have resolved to obtain the opinion of another expert on electric lighting before commencing operations for an electric light installation.

Bradford.—Mr. R. A. Chattock, superintendent engineer at the City of London Electric Lighting Company's works, has been appointed electrical engineer to the Corporation.

Whitechapel.—The Electrical Committee of the Vestry are making an application to the London County Council for a loan of £20,000, to be taken up in two sums of £10,000 each.

Clyde Lighthouses.—The Clyde Lighthouses Trustees have now altered the fixed light at Cumbrae to a group electric flashing light, giving two flashes in quick succession every half-minute.

Henley's Telegraph Works Co.—The directors recommend a dividend of 15 per cent. on the ordinary shares for the past year, including the interim dividend of 4 per cent. paid last September.

Pudsey.—The District Council have decided to provide a refuse destructor, and to utilise the waste heat from the destructor for producing electricity and warming water for the proposed public baths.

Wembley.—The Council have requested Harrow Council to arrange for a meeting of local authorities affected by the North Metropolitan Electric Power Supply Bill with a view to opposing the Bill.

Beverley.—The Town Council on Monday night resolved to engage Mr. A. H. Gibbings, consulting electrician to the Bradford Corporation, to report on the expediency of introducing electric lighting in the borough.

Plymouth.—The installation of the electric light in St. Andrew's Church has practically been completed, and the light was tested last week. There are about 300 16-c.p. lamps grouped in twelves. The cost of the work was about £350.

New Company.—The Electrical Regulating and Lighting Syndicate, Limited, has been registered with a capital of £75,000 in £1 shares to acquire various patents and to carry on the business of electrical and mechanical engineers, etc.

Arbroath.—The Arbroath and St. Vigean's Parish Council are considering favourably a proposal, on behalf of the inhabitants of Auchmithie and neighbourhood, to establish telegraphic communication between Auchmithie and Arbroath.

Sheffield.—At Wednesday's meeting of the City Council the statement of the working of the electric light department during the past year was submitted. After allowing for interest on loans and sinking fund, there is a profit of nearly £1,000.

Bury St. Edmunds.—The Local Government Board have sanctioned the raising by the Council of a sum of £800 for the purpose of the public lighting of the roads on the Brown Estate, to be repaid by means of a sinking fund in 25 years.

Aylesbury.—The Urban District Council have received a number of replies to queries addressed to 12 local authorities of towns of about the same size as Aylesbury as to their experience of electric lighting. The matter will be further considered shortly.

Wimbledon.—The approval of the Local Government Board has been given to the use for purposes of electric lighting of the messroom and store at the High street fire station. The Board have also sanctioned a loan of £21,545 for the purposes of electric lighting.

Perth.—Application is to be made for a loan of £43,000, the estimated cost of the supply works. Contracts for three-fourths of the electric lighting undertaking have been accepted, and the only remaining tenders to be obtained are those for the erection of the station.

Willing's Press Guide.—The twenty-seventh issue of this cheapest of Press directories is uniform with prior issues, and is commendable for the concise manner of its compilation, and the ease with which the various items contained in the 400 pages are get-at-able.

Twickenham.—The District Council have written, in reply to a letter from the Richmond Electric Lighting Company stating the advantages of their scheme, that inasmuch as the Council had refused their consent they could not enter into the merits of the question at all.

Rochdale.—Sanction has been obtained to the loan of £9,876 to meet the cost of installing the electric light at the workhouse, and the Guardians, not desiring to pay the recently-increased rate of the Public Works Commissioners, are taking steps to obtain the loan elsewhere.

Buxton.—At the last meeting of the Urban District Council Mr. Calvert, the newly appointed electrical engineer, said Buxton would have the electric light for Easter next, if they had no mishap. It was decided that £150 a year be paid to Mr. Smedley as consulting engineer.

Belgian Enterprise.—A Belgian company has just concluded with the Corporation of Tsaritsin, on the Volga, a very important contract for the laying down and working for 35 years of the electric lighting of that town, an electric tramway, and an electric railway for the transport of timber.

Morecambe.—The Local Government Board have sanctioned the small loan for electric lighting, but they refused the further application of £24 000 on the ground that the Council have already reached the limit of their borrowing power. A sub-committee is now discussing the town's financial position.

Kensington.—The Vestry will appoint Mr. Robert Vigers as umpire in connection with the question of the price to be paid by the Kensington and Notting Hill Electric Lighting Companies for the land in Wood-lane on the understanding that no counsel should be employed or witnesses called on either side.

Crewe.—Several companies having written asking the Town Council to hand over to them certain wayleaves for a telephonic service in the borough, the question of the advisability of providing a municipal telephonic exchange for the town has been remitted to the Electric Lighting Committee for consideration.

Bowness.—It having been recommended that an electric light inspector be appointed to test the mains and supply of energy given by the Windermere Electric Supply Company, the Urban District Council have appointed a committee to confer with a committee from the Windermere Council on the matter.

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Newcastle.—The River Tyne Improvement Commissioners have adopted the report of a sub-committee appointed to consider the advisability of lighting the entire dock system by electricity. The offer of Messrs. Handcock and Dykes, electrical engineers, London, to report upon the proposed lighting has been accepted.

Brush Electrical Engineering Co.—The directors have made the following appointments: Mr. C. S. Thomson to be superintending engineer, in charge of lighting and power contracts; Mr. E. H. Taylor to be traction engineer, in charge of traction contracts; Mr. A. P. Haslam to be in charge of the estimating department.

Alfreton.—The Urban District Council have resolved that in pursuance of the Electric Light Act, 1888, the clerk should give to each member of the Council the month's notice of a special meeting as required by the Act, with a view of applying to the Board of Trade for a license to commence electric lighting works for the town of Alfreton.

Heywood.—The Town Council intend to petition against the Lancashire Electric Power Bill. A number of members of the Town Council visited Darwen last week to inspect the refuse destructor and electric light works in that town. It was suggested that Heywood should run the two schemes together, and erect the destructor on the Hind Hill site.

Eastbourne.—The electric lighting works, which have recently been taken over by the Council, are being enlarged considerably. A Willans engine (300 h.p.) and a dynamo manufactured by the Electric Construction Company, Wolverhampton, are being fixed. The voltage has been altered from 100 to 200, and a large number of arc lamps are to be placed in the public streets.

Chesterfield.—The Town Council have adopted a report of the Electrical Energy Committee on a scheme for supplying electric plant for light and power, prepared by the Westinghouse Company. The committee's recommendation that application be made for the necessary sanction of the scheme, and the raising of a loan of £25,000 to carry out the same, has also been adopted.

Edinburgh.—At the fortnightly meeting of the Town Council on Tuesday, a recommendation by the Electric Lighting Committee, that additional plant should be obtained for M'Donald-road power station, was considered. It is proposed to obtain two steam dynamos of 1,200 h.p. from Messrs. Mather and Platt at a cost of £12,319, and four boilers from Messrs. Sinclair, Leeds, at £4,800.

Tiverton.—The Town Council have appointed Mr. Walter P. Adams, of 35, Queen Victoria-street, London, consulting electrical engineer to the Council, to report on the system of electric lighting to be adopted for the town, and the best means of carrying out the work, with estimates of cost and probable revenue and working expenses. The lighting of Westexe is to be included in the scheme.

Croydon.—A deputation of consumers recently waited upon the deputy-chairman of the Electric Light Committee and complained about the charges. They were told that as soon as a respectable reserve had been accumulated for the protection of the ratepayers, the intention of the committee would be not only in the direction of saving the rates, but in the reduction of the cost of current to the consumers.

Colne.—At the last meeting of the Town Council, the Electrical Committee reported that the borough electrical engineer (Mr. Cooper) had received instructions to prepare plans and estimates for the necessary works connected with the erection of a generating station and the laying of electric mains, with a view to an application being made to the Local Government Board to sanction a loan. A site has been selected for the generating station.

South Shields.—The Borough Council have accepted the following estimates submitted by Mr. Jeckell, the borough electrical engineer: circulating pump, £650; pipes and connections for pumps, £1,000; girders and fixing pumps, £150; sub-station, £250; switchboards for sub-stations, £300; transformers, £2,400; high-tension and low-tension cables, £20,000; pipes and trenches, £9,000; connecting-in consumers, £3,000—total, £36,750.

Wealdstone.—The Urban District Council intend to oppose the North Metropolitan Electric Power Supply Bill, and they have notified the company that they would require a protective clause, in the following terms, inserted in the Bill: "Provided always that the company shall not, without the consent of the Wealdstone Urban District Council, exercise any of the powers conferred upon them by this Act within the district of that Council."

Middlesbrough.—The Electric Lighting Committee's report states that the total demand from the 88 applications is 4,525 8-c.p. lights, the capacity of the present plant being for 6,666 8-c.p. lights. The work in connection with the laying of wires is practically complete. All now depended upon the buildings, and they will be able to supply light by December next. The Guardians have abandoned the idea of lighting the workhouse by electricity.

United States Pacific Cable.—The Inter-State and Foreign Commerce Committee of the United States House of Representatives have decided by eight votes to five to report the Pacific Cable Bill, after rejecting a proposal for Government ownership of the cable. The committee are in favour of providing for the private ownership of the cable with a Government subsidy not exceeding £80,000 yearly for a period of 20 years for the transmission of Government messages.

Islington.—The Electric Lighting Committee will recommend at the Vestry meeting this evening that the provisional sanctions of the London County Council be declined. The Vestry had applied for sanction to two electric lighting loans of £13,200 and £56,261. The London County Council would only sanction £10,000 and £38,000 respectively on certain conditions, but stated that as regards the balances they would be reconsidered when more detailed information is sent.

Belfast.—The Borough Council have adopted a report of the Electric Lighting Committee with the exception of the following paragraph, which recommended, in regard to the electric lighting of Donegall-square North, eight 1,000 c.p. arc lamps burning from dusk till 11 p.m., and replaced by sixteen 16-c.p. incandescent lamps burning from 11 p.m. till dawn—estimated capital outlay on supply and erection of lamps, posts, and mains, £360; annual cost for lighting per lamp, £17.

York.—At the recent half-yearly meeting of the York United Gaslight Company, the chairman (Mr. J. R. Hill), in moving the adoption of the report, said that so far as the directors could see there was not the slightest need for gas shareholders to feel nervous about the future either on account of the price of coal or because of competition with the electric light. There was not an instance in the country where the electric light had prejudicially affected the dividends of gas property.

Consett.—A company is being formed for the purpose of putting down electrical works in the neighbourhood of Annfield Plain, and their tender has been accepted by the Annfield Plain Council to supply electric lighting to the district. The Consett Council have been asked whether they intended to take any action, as the company's wires would extend to South Medomsley, and they could be carried on to Consett. The company have been asked to send a representative to interview the Council.

Personal.—Mr. George F. Pilditch, who from the commencement of the electrical works at Rathmines superintended the work on behalf of Mr. R. Hammond, has been appointed chief engineer of the electrical undertaking by the Urban District Council.—On Friday evening last Mr. J. S. Highfield, the chief engineer of the St. Helens Corporation lighting and traction station, was presented by the staff with a handsome tantalus as a token of esteem and good wishes on the occasion of his marriage.

Stock Exchange.—The Stock Exchange Committee has appointed a special settling day for Aron Electricity Meter, Limited (125 000 vendors' ordinary shares of £1 each, fully paid, Nos. 1 to 125,000), and for the British Electric Traction Company's further issue of 20,000 6 per cent. cumulative preference shares of £10 each, fully paid. They have also ordered British Columbia Electric Railway Company, Limited (12,000 non-cumulative 5 per cent. preference shares of £10 each, fully paid, Nos. 25,001 to 37,000) to be quoted in the official list.

Appointments Vacant.—At the City and Guilds Central Technical College, Exhibition-road, London, S.W., an assistant in the electrical engineering department is required; also two men at the gas and electric lighting department of the Corporation of Leicester.—The Pembroke Urban District Council invite applications for the position of resident engineer to take charge of their electric lighting and refuse destructor works.—The borough of Brighouse require a working electrical engineer. Particulars of these and various other vacancies appear in our advertisement columns.

Tenbridge.—At the last meeting of the Urban District Council it was decided to ask Mr. Robert Hammond to report, at a fee not exceeding 50 guineas, on the proposed electric light installation. An amendment was brought forward with respect to the retaining of the services of Mr. H. Medhurst, who had submitted a report two years ago, but this was not carried. A second amendment to appoint Mr. H. L. P. Boot, of Tunbridge Wells, was also negatived. As might have been expected from the correspondence which had taken place between the first two gentlemen, considerable heat was shown in the debate.

London Gazette.—Notice has been given of dissolution of partnership between Messrs. Frank Monkhouse and Thompson Gradon, jun., 118, Pilgrim-street, Newcastle-upon-Tyne. A first and final dividend of 5d. in the pound has been declared *re* A. G. Inrig, 46, White Post-lane, Victoria Park, London, payable Feb. 16, 1900. A first and final dividend of 11½d. per pound has been declared *re* T. Ford, Victoria Works, Emily-street, Highgate, Birmingham, payable Feb. 19, 1900. An application for debtor's discharge has been made by E. L Joseph; day fixed for hearing is March 1, 1900, at 11 a.m. at Bankruptcy-buildings, Carey-street, London, W.C.

Telegraph and Telephone Interruptions.—The elements just now are conducting a successful campaign against telegraphic and telephonic communication. Two heavy falls of snow within 10 days have wrecked innumerable overhead wires, and on Monday last many of our important towns were practically isolated. On Monday last, the little business still being done on the Stock Exchange was practically stopped from this cause. On Wednesday last a fire completed this inconvenience. This happened while a Post Office employé was repairing the wires at the corner of Queen-street, Cheapside. He by some means overturned a naphtha lamp and set fire to the whole of the exposed guttapercha lines, of which there were 300. The man had to cut his way out through the canvas screen, and every wire was burnt out. Great difficulty arose in repairing them owing to the leaden tablets bearing the numbers of the different wires having been melted and destroyed. The cable companies suffered great inconvenience, and at 1 p.m. very few had got connection. The Eastern, Great Northern, and all the Atlantic companies suffered badly. There was not a single wire to the Stock Exchange, and the pneumatic tube to the Post Office was the sole means of dispatching messages. The more serious interruptions due to snow and wind have not been confined to Great Britain, but have been equally serious on the Continent.

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Edison and Swan United Electric Light Co.—The directors have resolved that a payment on account of the dividend of the current year be made at the rate of 6 per cent. per annum, less income tax, on the A shares of the Company in respect of the half-year ended Dec. 31, 1899. This will work out at 1s. 9¾d. per share on the partly paid £5 shares £3 paid, and 2s. 9¾d. per share on the fully-paid £5 shares, less income tax. The payment will be made upon the register as it stood on Feb. 13.

Gillingham.—The Council having expressed their dissatisfaction with the light in the High-street, the electric light company have asked permission to erect in that street a standard at their own expense on which a better type of lamp could be shown. They also added that as they were confident of this lamp proving satisfactory, they would do away with the present type altogether. The Council, however, have decided not to agree to the erection of any lamp on property they were responsible for.

British Electric Traction Co.—This week saw a further issue by this Company of £150,000 5 per cent. perpetual debenture stock at £120 per cent. The Company was formed in 1896 to acquire the business of the British Electric Traction (Pioneer) Company, and to develop electric traction in the United Kingdom and elsewhere. Dividends at the rate of 6 per cent. per annum for the year 1898, and at the same rate per annum for the nine months ended Sept. 30 last, have been paid on the ordinary stock.

Worcester.—The Town Council have agreed to waive their claim to a pecuniary penalty for delay under the contract with Messrs. S. Z. de Ferranti, Limited, for a steam alternator, etc., at the electricity works, and in lieu therefore accept the company's offer to alter the plant so as to convert it from 300 kw. to 400 kw., and so as to comply with guarantees corresponding to those applying to the smaller capacity, subject to the company completing the work in six weeks, and guaranteeing its execution and the running of the plant for 12 months.

Yarmouth.—At the meeting of the Council on Tuesday, the Electric Lighting Committee presented their quarterly report, which showed the income for the past three months to be £2,216. 5s. 9d., and the expenditure, £1,189. 16s. 2d., showing a sum of £1,026. 9s. 7d. carried beyond the cost of production. The Electrical Engineer stated that during the past five years the number of applications received had risen from 193 to 390, and the number of lamps connected to the mains from 5,800 in December, 1895, to 19,500 in December 1899. The report was adopted.

Colchester.—The Electric Light Works Committee reported last week that the additional cables had been delivered by Messrs. Siemens, and that the work of laying them would be proceeded with after expiration of the notices to be served upon the Postmaster-General and County Council. The committee have accepted certain amendments made by Messrs. Siemens in the draft contract by them for the supply of additional dynamo, switchboard, and cables, and have also approved dates for delivery by Messrs. Davey, Paxman, and Co., Limited, of the additional boiler and engine.

Greenwich.—The District Board of Works have decided to call the attention of the London County Council to the serious defaults of the London Electric Supply Corporation in carrying out its obligations to the consumers in the area over which the Board has jurisdiction, and to state their regret at not having power to take action against the company with a view to remedy the default. They therefore ask the Council to exercise all the powers it may possess in action against the London Electric Supply Corporation to secure the due fulfilment of that company's contracts with its consumers.

Wigan.—At their next meeting the Electric Lighting Committee will reconsider the following minute, which has been referred back to them, the proposed terms having been considered excessive: "That this committee are prepared to supply specifications for lighting plants, etc., and if the cost of the work exceeds £10, at a charge of 5 per cent. on the cost of the work." It was thought that 2½ per cent. would be sufficient under the circumstances. It was also resolved to call on the Telephone Company to substitute iron columns for wooden posts where such latter were on the Council's property.

Cardiff.—The following are the Lighting Committee's recommendations already referred to by us: "That the chief of of the electric light department have complete control over all the men in the employ of the electric lighting department, including the deputy electrical engineer and the mains superintendent; (2) that the chief of the department have power to engage and discharge all employés, with the exception of the deputy electrical engineer, mains superintendent, and clerical staff, whom, however he may suspend at his discretion, until the cause of complaint may be considered by this committee."

Southwark.—At Tuesday's meeting of the Vestry the Electrical Committee reported *re* the County of London and Brush Provincial Electric Lighting Company's Bill, that the provisions of the Bill to be promoted in the current session of Parliament are similar to those contained in the Bill promoted by the company in the last session of Parliament, and which was thrown out in committee. Therefore the committee recommended that a petition be presented against the Bill, and that the General Purposes Committee be empowered, if they deem it necessary, to employ parliamentary agents, counsel, and witnesses to oppose the measure.

Patent Corrugated Sheet Fillings.—We have received from the Metal Agencies Company, Limited, 31, Queen-square, Bristol, particulars of an invention they are about to place on the market. The advantages claimed for the patent are manifold, and the main object of it is to render leakage impossible by means of a metal combination saddle which has a raised boss, through which a hook bolt is passed and screwed down into a concave washer. The dropping of condensation is brought to a minimum by the saddle raising the corrugated sheet about ¼in. from the purlin, and so preventing the interception of the condensation by the purlin.

Whitby.—The delay in the electric light scheme was the subject of a discussion at the recent meeting of the Urban District Council, and it was explained that Mr. Preece's report was now being considered by the Board of Trade, and the plans were also before the Local Government Board, and it entirely depended upon the Local Government Board as to what delay took place now. They were awaiting their approval and sanction to borrow the loan, and until they got it they could not proceed any further. It will be remembered that in consequence of the report referred to the Council's application of £18,000 was increased to £26,000.

Warrington.—The County Council have decided to petition against the Lancashire Electric Power Bill. Several committees having charge of corporate buildings will be requested to consider the advisability of lighting the same with electricity, and of handing the same over to the Electric Lighting Committee for the purpose of being fitted up. The committee do not see their way to adopt any system of free wiring, and think it advisable that intending consumers should make their own arrangements for the wiring of their premises. The Local Government Board has sanctioned the borrowing of the sum of £41,966 for the purposes of electric lighting.

National Telephone Co.—The directors recommend the following dividends for the half-year ended Dec. 31 last: at the rate of 6 per cent. per annum on the first and second preference shares, at the rate of 5 per cent. per annum on the third preference shares, and at the rate of 6 per cent. per annum on the ordinary shares, carrying £80,000 to reserve and about £6,000 forward. The report of the directors for the half-year ending Dec 31 last states that the income was £663,523, as compared with £573,707 for the corresponding period of 1898, being an increase of £89,815, and the working expenses were £359,302 (£312,462), being an increase of £46,840. The net profit was £240,043. 19s. 6d. (£206,888).

Ramsgate.—At the special meeting of the Town Council last week a letter was discussed which had been forwarded to the Council from the Board of Trade, who were asking whether the Council intended to apply for an order themselves. The letter stated that Mr. Murphy's company is at present engaged in carrying out a system of light railways connecting the three places, Ramsgate, Margate, and Broadstairs, and is in the course of taking a transfer from the Margate Corporation of their electric lighting order, and have also been granted powers by the Board of Trade for the electric lighting of Broadstairs and Westgate. Mr. Murphy anticipates shortly having an interview with the Ramsgate Corporation on the subject.

Lancashire.—At a meeting of the representatives of urban district councils in Lancashire at Manchester on Tuesday it was resolved to oppose the Lancashire Electric Power Bill, 1900, for the purpose of obtaining protective clauses, and that a committee be appointed to formulate and carry out such opposition, and that the cost be borne *pro rata* according to ratable value. Mr. J. Ogden Hardicker was appointed solicitor for the purposes of the opposition to the Bill. The councils represented were Levenshulme, Withnell, Withington, Farnworth, Moss Side, Stretford, Failsworth, Royton, Abram, Audenshaw (who are actually opposing the Bill by resolution passed), and Atherton, Crompton, Sale, Tyldesley, Denton, and Littleborough (who approve of and will join in the opposition to the Bill).

Hereford.—The Town Council have adopted a report of the Electric Lighting Committee stating that lights had been connected with the installation equal to 2 283 8-c.p. lamps, 1,413 lights were ready for connection, and it was thought that another 1,252 would be added before the end of the current half-year. The estimated cost of the works—£20,000—had not been exceeded. The committee, however, had had under consideration the advisability of providing another engine and dynamo; but it was thought desirable to do with the present plant as long as possible, and then provide a much larger engine and dynamo than they would if the work were carried out now. The lighting of the butter and poultry markets by electricity was deferred.

Eston.—Messrs. Bolckow, Vaughan, and Co., Limited, iron and steel workers, who have taken over the business and plant of the Clay-lane Iron Company, are proceeding with a large installation of electric power with which it is intended to light the Eston jetty, the Clay-lane Ironworks, the South Bank Ironworks, the Cleveland furnaces, and the Cleveland Steelworks, all situated in the township of Eston. The motive power will also be utilised for driving the machinery on the railway bank and other outlying machinery. The power-house will contain three compound vertical condensing steam-engines of 500 h.p. each, with a steam pressure of 136lb. Each engine will drive a three-phase dynamo, each producing an electric current of 3,000 volts. The work is in the contractor's hand, and it is expected that it will be completed by the autumn.

Yeadon.—The report presented to the Town Council by Mr. Enright says that from examination of the township, and taking the price of gas and all the circumstances into account, he estimates that within about a year from current being available in the streets for lighting, the Council would have wired the equivalent 4 500 8-c.p. lamps. The class of shop in Yeadon is recognised as being the best customer for electric light. He suggests the provision of three engines of 100 b.h.p. each, with dynamos of corresponding power, and two storage batteries able to give 50 b.h.p. for about 2½ hours, and two Lancashire boilers, each capable of

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giving the steam necessary for two of the engines. Allowing £1,000 for contingencies, he estimates the capital expenditure at £12,600. The annual expenses he puts down at £1,540, and the yearly income, including £160 from the street lamps, he estimates at £2,035. Mr Enright fixes the price per unit at 5d., a figure which he strongly advises the Council not to exceed.

Maidenhead.—The Town Council have adopted the following report of the Electric Lighting Committee: "A communication has been received from the Local Government Board with reference to the application of the Council for consent to utilise for purposes of electric lighting a portion of the land at the sewage outfall, stating that if when the electric lighting undertaking is submitted to them with an application for sanction to a loan they should decide to sanction the loan, they will then sanction the use of the proposed site for the central station, on condition that the land remaining unappropriated shall be used for irrigation after it has been properly prepared. Plans to be submitted to the Local Government Board are in course of preparation, and the various information required by the Board before they proceed to consider the application for a loan will shortly be completed." An application by the National Telephone Company for the placing of their wires underground is being considered by the committee.

Leyton.—The Urban District Council have made a special grant of £100 to Mr. Dawson for services rendered by him as architect and surveyor in connection with the new works now in course of erection at the electric lighting works. The Electric Lighting Committee have reported as follows: "The following statement as to load and other curves has been presented to your committee by the engineer: Units generated during December, 1899 84,604; corresponding month, 1898, 47,928. Units sold during December, 1899, 56,630; corresponding month, 1898, 35,725. Lamps connected during December, 1899, nil; corresponding month, 1898, 928. Total lamps connected to December, 1899, 17,527; corresponding month, 1898, 11,878. Total number of consumers to end of month, 345. Applications received during the month (but no supply given), 8. Maximum load during the month, 324 kw., equivalent to 10,800 8-c p. lamps, being 61 6 per cent. of the total connected. The committee have directed the payment of 10s. a week to the parents of a member of the staff who has been called out for service in South Africa."

Bermondsey.—The loan of £16,500 from the London County Council for the purchase of the Limasol-street site has been completed. The contract for the purchase of property required for a dust destructor and the extension of the depôt have been exchanged, and negotiations have been entered into with the County Council for the loan of £19,000 to complete the purchase. The Electric Lighting Committee's scheme for dealing with the tenants of the 46 houses in Limasol-street, which the Vestry propose to demolish for the purpose of erecting an electric lighting station and extending the depôt, was accepted at the last Vestry meeting. Compensation from £5 to £1 is to be given to the tenants upon their removal if the tenants are out at the end of a month from the date of the notice and the rent paid. For every week a tenant remains in possession over and above four weeks from the date of the notice, the compensation is to be reduced by 25 per cent. The Vestry will petition against the County of London and Brush Provincial Electric Lighting Company's Bill, which would give them powers to lay mains for the purpose of connecting systems in surrounding parishes in which they already possess authority, to purchase four houses in Great Maze Pond, and to transform, transmit, and distribute electrical energy.

Sheffield.—The Electric Light Committee have received the following letter from the Local Government Board: "Sir,—I am directed by the Local Government Board to state that they have had under consideration the report made by their inspector, Colonel Coke, after the enquiry held by him with reference to the application of the Town Council of Sheffield for sanction to the borrowing of the sum of £100 000 for the purposes of their electric lighting undertaking. The Board have decided to comply with the application so far as it relates to the borrowing of a sum of £71,120, and their formal sanction to a loan of that amount is forwarded to you herewith. The sums which the Board have excluded from the loan are as follows: prospective expenditure on machinery (Item 1), £12 280; steam-boilers, steam-pipes, condensers, etc. (Item 5), £9,000; machinery connected with proposed public lighting (Item 6), £7,600—total, £28,880. The Board will defer giving a decision as regards these sums until the Town Council are in a position to furnish more precise information as to them. I am to add that in connection with any application which may hereafter be made for sanction to a further loan for the purposes of the undertaking the Board will require to be furnished with full particulars of the expenditure of the loan now sanctioned."

Battersea.—The Lighting Committee last Wednesday recommended an expenditure of £2,000 in connection with the excavation work now being carried out on the site for the central electric lighting station, the architect, Mr. C. S. Peach, having drawn attention to the fact that, owing to the nature of the foundations, it will be necessary to increase the depth of the excavations so as to ensure the foundations, etc., resting upon a more uniformly compressible bottom. The work of laying the electric light mains was commenced on the 5th inst. in Prince of Wales-road. An expenditure of £201 was also agreed to in consequence of a letter from Prof. A. B. W. Kennedy, stating that in order to check the tests made by the contractors in the laying of electric light mains and for the supply of plant, machinery, etc., at the central electric lighting station it is necessary that the engineer on the ground should have suitable testing instruments. These instruments will eventually be required by the engineer in charge of the station and the mains for making periodical tests to ascertain that the mains, etc., are in satisfactory order, and also when carrying out extension work.

Ealing.—The District Council have now adopted the following report of the Electric Lighting Committee. A sub-committee attended at the electricity works on the 22nd ult., when Mr. Knight, the electrical engineer, explained the various matters connected with his department with respect to the proposal for the extension of the works so as to meet the probable heavy load next Christmas. The committee think it will be better to incur a somewhat larger expense, and so avoid the necessity of altering the works at a future date. Mr. Knight's suggestions are as follows: (*a*) a steam dynamo, alternator, and storage batteries; and (*b*) an exciter directly coupled to a steam-engine. The full details of these respective purposes will be fully reported upon by Mr. Knight at the next meeting. The committee visited the depôt on the west side of the Ealing-lane, and are strongly of opinion that an enclosed lock-up shed should be erected capable of holding the large amount of valuable material now upon the open ground, the value of which Mr. Knight estimates at about £2,000, and the committee recommend that the surveyor be instructed to make the necessary arrangements, and report same as to cost, etc., to the committee.

South Wales Electrical Power Co.—A conference was held at Cardiff last week of all the local bodies affected by the Bill which is being promoted in the present session by the South Wales Electrical Power Distribution Company. The Mayor of Cardiff (Councillor S. A. Brain) presided. The following resolution was unanimously carried: "That this meeting is of opinion that the South Wales Electrical Power Distribution Company's Bill should be opposed on second reading, and that the local authorities of each borough and urban district in the counties of Glamorgan and Monmouth which are affected by the Bill be requested to bring the matter before their members of Parliament and urge them to support the opposition to the Bill, especially upon second reading, which will take place in the course of a few days." Three other resolutions were also unanimously carried to the effect that petitions to oppose the Bill on second reading be prepared and forwarded to all the local bodies within the proposed area of supply, and that they be asked to adopt the same and present them to Parliament; that the parliamentary representatives of South Wales and Monmouthshire be urged to strongly oppose the Electrical Power Bills of the County and City of Dublin, the Lancashire Electric Power, the South Wales Electrical Power, and the Tyneside Electrical Power Companies; and that the local authorities consider the advisability of putting themselves in a position to oppose the Bill on the second reading on the merits in the event of the second reading being carried."

Hampton Wick.—At the last meeting of the Council the Electric Lighting Committee reported, according to a report in the *Surrey Comet*, the receipt of a letter from the town clerk of Kingston, stating that the committee of the Corporation were prepared to offer that, should arrangements be made to supply current to Hampton Wick, the arrangement should continue for 18 years, its termination then or thereafter to be subject to three years' previous notice on either side, the maximum charge for the supply of current being the same maximum charge as that continued in the electric lighting order of the Corporation—namely, 8d. per unit. The committee explained certain arrangements which it would be necessary to make should the Council accept the offer of the Kingston Corporation, and left the matter to the consideration of the whole Council, merely remarking that they considered the arrangement proposed an equitable one. This report was adopted. Subsequently it was agreed that the clerk should write to the Teddington Urban District Council and ask what they were doing in the matter of electric lighting. At this decision both Dr. Nelson and Mr. Colpoys tendered their resignations as members of the Electric Lighting Committee, stating that, having been authorised by the Council to negotiate with Kingston, it was no good their "playing about" in the matter. Mr. Scotcher asked leave to withdraw his resolution, but the Chairman said the only course open to him was to give notice to rescind it at the next meeting. The matter was thereupon allowed to drop.

Bristol.—At the meeting of the Town Council on Tuesday, the Electrical Committee presented the following interesting report: "Your committee report that they desire, when purchasing goods and materials for the purposes of the electrical undertaking, to be in a position to enter into a binding contract immediately upon the acceptance of a tender. The resolution by which your committee are appointed annually does not expressly authorise them to enter into contracts, and therefore your committee ought, in the present circumstances, to submit every tender to the Council itself for acceptance, and to obtain a resolution of the Council to enter into a contract. A considerable interval of time often occurs between the receipt of a tender by your committee and its acceptance by the Council, and when prices are rising there is a tendency on the part of persons tendering to withdraw their offers before the Council can deal with the matter. Your committee are advised that to avoid this difficulty they should be empowered by resolution of the Council to enter into ordinary trading contracts, for and on behalf of the Council, and to affix the city seal thereto; and they are also advised that as an additional precaution the foregoing powers should be conferred on your committee by an instrument in writing under the city seal. Your committee therefore recommend that they be authorised to enter into trading contracts on behalf of the Council, for the purpose of carrying into effect the Electric Lighting Acts, 1882 and 1888, the Bristol Electric Lighting Order, 1883, and the powers of the Council for lighting the streets by electricity and to affix the city seal thereto, by an instrument in writing under

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the city seal. Your committee report that they have accepted the tender of Mr. William Galbraith, trading as Poole Bros., for supplying coal for the purposes of the electrical undertaking, from Dec. 1, 1899, to April 30, 1900. Your committee recommend the Council to enter into a contract with Mr. Galbraith accordingly. Your committee report that they have found it necessary to engage an architectural and engineering draughtsman, to assist in the city electrical engineer's department. Your committee have appointed Mr. K. O. Hale, at a salary of £200 per annum, rising annually by £30 to £260 per annum, and they recommend the Council to confirm the appointment."

Review.—We have received a copy of the "Practical Electricians' Pocket-Book," which is edited by Mr. H. T. Crewe, and published by S. Rentell and Co., of 13, Ludgate-hill. The published price of this little book is 1s. We are glad to note that the editor has adopted one or two suggestions we made when reviewing the 1899 edition, and that consulting engineers are no longer included under the head of where to buy. He has, however, included under this heading this year the Electrical Trades Union. We trust, however, that the cost of an insult to this union will be so high that it will not pay large electrical manufacturers to offer it. The first 200 pages of the pocket-book are devoted to useful information in connection with electrical engineering in particular and its branches. The author in this section commences with descriptions of the prime movers most frequently used for driving electrical machinery, and gives some useful information of a general character on a great variety of subjects. We notice particularly his comparative figures as to the cost of electrical energy for lighting and power as compared with other methods of illuminating buildings and of driving machinery. In this section the information is clearly put, and the advantages of electricity are not unduly exalted. Another useful feature in the book is the list of provincial and metropolitan electric supply companies, in which the voltage used, the system adopted, the frequency where alternate currents are employed, and the average price per unit for light and power are given. This list also includes the addresses of the companies, so that it will be of great service to electrical contractors when asked to quote for electric light apparatus or for electric motors in different towns. The usual tables of constants and equivalents of foreign measures are included. The last part of the book consists of a diary for the present year, which is, if anything, rather too small. We hardly like to suggest that the editor should leave out any of the information in the front part, but we certainly think that more writing space in the diary would be of great value to anyone who carries this book. At the end of the book some handy leaflets are given on which to make notes when estimating wiring of buildings for the electric light. On the whole, the book is a great improvement on the 1899 edition, and should be appreciated by electrical engineers.

London County Council.—An application of the Postmaster-General for permission to lead six 152 pair lead-covered cables from Budge row into the Queen Victoria-street subway, and to fix the necessary cable heads at the point of entry was agreed to at Tuesday's meeting, as was also a notice from the Charing Cross and Strand Electricity Supply Corporation of intention to lay mains along Carmelite-street and in the Victoria embankment subway as far as the western boundary of the City. The Highways Committee reported that they had for a very considerable time been endeavouring with the National Telephone Company's representatives the terms upon which the Council's consent should be given to such works. The company had, they were informed, not yet obtained the Post Office license; but it had, notwithstanding, carried out works at certain places, in some cases with and in some without the permission of the road authorities concerned, but it had not obtained the consent of the Council to those works. They had now to state, for the information of the Council, that they had directed the solicitor to take proceedings against the company for having infringed the provisions of the Telegraph Acts in that respect. The committee further reported that their attention had been called to a notice issued by the National Telephone Company to all its subscribers in London, stating that the snowstorm which occurred on Feb. 2 had caused a partial dislocation of the London telephone service, and also containing the following words: "During the past four years the company had been using its utmost endeavours, but without success, to induce the London County Council to consent to the wires being put underground. Had the County Council done so the present trouble would not have occurred." That statement, which was sent to something like 15,000 persons in London, was not in accordance with the facts. If the company had in the course of the negotiations which had been proceeding offered terms which they could have advised the Council to accept—terms similar to those given by the company to several provincial cities and towns—the matter could have been settled so far as the Council was concerned; although even in that event it would appear that consent given by the Council would be of no avail unless the company had first obtained a license from the Post Office. The report was adopted.

PROVISIONAL PATENTS, 1900.

FEB. 5.

2231. Telephone ear-instrument holder. Alfred Herring Stamp, The Willows, Sunderland.

2260. Improvements in electric arc lamps. Hugo Bremer, 42, Neuenweg, Barmen, Germany. (Complete specification.)

2271. Improvements in or relating to electric ignition devices for explosion engines. Alfred Julius Boult, 111, Hatton-garden, London. (La Société Anonyme des Moteurs et Voitures "Aigle," France.) (Complete specification.)

2282. Improvements in dynamo-electric machines. Gustaf Dalén and Arthur Hultqvist, 46, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 7, 1899, being date of application in Sweden.) (Complete specification.)

FEB. 6.

2297. Method of transforming alternating into direct currents and vice versa. David Cook, 165, Queen Victoria-street, London.

2310 Improvements in the application of electric lamps to dentists' and like mirrors. Joseph Henry Murray, 115, St. Vincent-street, Glasgow.

2340. Improvements in telephones. Eugene Ducretet, 18, Fulham-place, Paddington, London. (Complete specification.)

2356. Improvements in apparatus for regulating the electric lights on theatre stages. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien-Gesellschaft, Germany.) (Complete specification).

2357. Improved electromagnetic bell signalling apparatus. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktien-Gesellschaft, Germany.) (Complete specification.).

2366. Improvements in the production of filaments for electric incandescence lamps. Adolph Roubleff, 53, Chancery-lane, London.

2370. Improvements in means for maintaining a constant speed of a driven shaft, electric generator, spark generator, or other revoluble part. George Cecil Dymond, 6, Lord-street, Liverpool. (Homer Napoleon Motsinger, United States.) (Complete specification.)

2384. Improvements in or relating to alternate-current distribution. William Morris Mordey, 46, Lincoln's-inn-fields, London.

FEB. 7.

2409. Improvements in electrodes or electrical conductors. Henry Andrew Kent, 59, Myddleton-road, Bowes Park, London.

2473. Improvements relating to electric arc lamps. Edmond Charles Marçay, 45, Southampton-buildings, Chancery-lane, London.

FEB 8.

2518. Apparatus for recording without friction the indications of electrical and other measuring and indicating devices. August Eckstein and Herbert John Coates, Peel Works, Adelphi, Salford, Manchester.

2526. Improvements relating to incandescent electric lamps. William James Martin and Maurice Lachman, 6, Bream's-buildings, London.

2543. Improvements in and connected with primary batteries. Samuel William Maquay, 55, Chancery-lane, London.

2544. Improved means of making electrical connections to carbon electrodes. Harry Baker, 55, Chancery-lane, London.

2549. Improvements in contacts for electrical alarm bells. Jacob Kunst, 4, Duke-street, Charing Cross, London.

FEB. 9.

2590. Improvements in conduits for gas, air, water, and like pipes and electric wires. Richard D. Kimball and Alexander A. McKenzie, Fairfield, Kingston-on-Thames.

2595. Improvements in electrical storage or secondary batteries. Arthur William Baxter and Charles Baxter, 53, West-hill, St. Leonards-on-Sea.

2598. Improvements in phenographs. Emile Lavanchy, 65, Chancery-lane, London.

2621. A new or improved safety device for electric lamps. Adolf Ruhstrat and Ernst Ruhstrat, 70, Chancery-lane, London. (Complete specification.)

2638. Improvements in Rontgen-ray apparatus and in interrupters applicable for use in connection therewith or for other purposes. James Mackenzie Davidson, 323, High Holborn, London.

2639. Improvements in and relating to telephonic apparatus. Gregor Blanck, Simon Symons, and Augustus Pelham Brooke Loftus, 323, High Holborn, London.

2641. Improvements in electric traction on the road contact system. Josef Julian Steinbach, 22, Southampton-buildings, Chancery-lane, London.

FEB. 10.

2662. Improvements in brush-holders for dynamo-electric machinery. The Lancashire Dynamo and Motor Company, Limited, Arthur Pemberton Wood, and Robert Stafford McLeod, 34, Castle-street, Liverpool.

2670. Improvements in the production of vacuum bulbs for electric incandescent lamps. George Thomas Hutchison and Henry King Packard, 1, Cottage-grove, Bow, London.

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2684. A non-sparking (or sparkless) current collector for electric tramcars or other electric motors where bare supported mains are used. Norman Robinson, 1, Frederick's-place, Old Jewry, London.

2691. Improvements in electric cables. Henry Edmunds, 47, Lincoln's-inn-fields, London.

2700. Improved method of and means for indicating speed or current frequency of electric generators. Ralph Davenport Mershon, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 12, 1899, being date of application in United States.) (Complete specification.)

2702. Improved electromagnetic brake dynamometer. Emil Heinrich Rieter, 322, High Holborn, London.

2703. Process and apparatus for electrolytically impregnating textile fabrics of all kinds by means of metallic salts. Angel de Castro and Henry Wilhelm Schlomann, 322, High Holborn, London. (Complete specification.)

2710. Improvements in electricity meters. William Morris Mordey and Guy Carey Fricker, 46, Lincoln's-inn-fields, London.

2712. Improvements in telegraphic apparatus. Joseph Arthur Dearlove and Sidney George Brown, 45, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published March 3.

1898.

23556. Submarine cable telegraphs. Wise. (Crehore and Squier.)

1899.

2849. Electromagnetic apparatus for separating ores. Kreuser.

2872. Telegraphy. Jasinski.

3597. Electric railway switching and signalling apparatus. Boult. (Continental Hall Signal Company.)

3740. Electric switch. Murphy.

4321. Motor suspension for electrically-driven vehicles. Brookes. (Stort.)

5211. Electric incandescent lamps. Miller.

6322. Electric cables. Whalley.

7015. Telegraphing by means of sound waves. Varley.

7041. Electric arc lamps. Day.

9938. Protective conduit for the current conveyors of electric railways. Petzenbürger and Haisl.

10416. Incandescent electric lamps. Mengarini.

12842. Electrostatic measuring instruments. British Thomson-Houston Company, Limited. (Thomson.)

21665. Electric arc lamps. British Thomson-Houston Company, Limited. (Fleming.)

21666. Automatic cut-outs for rotary electrical converters and for alternators. British Thomson-Houston Company, Limited. (Steinmetz.)

22710. Apparatus for the electrolytic extraction of zinc. Lake. (Stepanov.)

24824. Electric incandescent lamps. Howard.

25432. Electrically-actuated air-douche apparatus. Thiergärtner.

25744. Dynamo-electric machines. British Thomson-Houston Company, Limited. (Reist.)

25747. Safety devices for dynamo-electric machines. British Thomson-Houston Company, Limited. (Buck.)

1900.

261. Safety electric fuses. Gover and Moffat.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Feb. 10	3 628	3,688	- 60	24,353	22,281
Blackpool-Fleetwood	,, 10	128	143	- 15	869	881
Bradford City Trams	,, 11	295	263	+ 32	25,947 *c*	—
Bristol Tramways Co.	,, 9	2,362	2 356	+ 6	—	—
City & South London	,, 11	1,149	1,119	+ 30	6,739	6,771
Dover Tramways	,, 10	146	146	—	897	853
Dublin U.T., elec. cars	,, 9	2,644	845	+1,799	—	—
Dublin S.D. Electric	,, 9	545	584	- 39	—	—
Halifax Corporation	,, 11	446	340	+ 106	26,460 *a*	8,802 *b*
Hull Corporat'n E.S.	Jan. 13	682	—	—	—	17,711 *c*
Liverpool Corporat'n	Feb. 3 *d*	6,471	5,393	+1,078	33,097	28,704
Liverpool Overhead	,, 11	1,344	1,223	+ 121	8,897	7,756
Sheffield Corporation	,, 12	1,620	—	—	—	—
South Staffordshire	,, 9	538	553	- 15	3,548	3,449

a Since April 1, 1899. *b* Since June 29, 1898.
c Total receipts. *d* Partly electrical. *e* Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	..	13-14
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6-6½
—— 5 per cent. Mortgage Debentures	100	—	100-102
British Electric Works, Ordinary, 50,001-95,000	1	..	1-1⅛
—— 6 per cent. Cum. Pref., 1-50,000	1	..	¾-1
—— 4½ per cent. First Mortgage Debentures	108	..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	4½-5½
Brush Electrical Engineering, Ordinary	2	..	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	..	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	..	110-115
—— 4½ per cent. 2nd Debenture Stock	100	..	102-105
Callender's Cable, Debentures	100	—	110-115
—— Ordinary	5	..	13½-14½
—— 5 per cent. Pref.	5	..	5½-6
Crompton and Co.	3	—	3¾ 4
—— 5 per cent. Debentures	—	..	98-101
Edison and Swan United, Ordinary	3	—	2-2½
—— 5 per cent. Debentures	5	—	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	..	93-95
Electric Construction	2	..	2¼-2⅜
—— 7 per cent. Cumulative Pref.	2	..	2¼-2⅜
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	103-106
Giffre Electro-Chemical and Power, Ordinary	1	—	¾-1⅛
W. T. Henley's Telegraph Works, Ordinary	5	—	13½-14½
—— 4½ per cent. Preference	5	..	5½-6
—— 4½ per cent. Debentures	100	..	111-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	—	100-104
Telegraph Construction and Maintenance	12	—	37-41
—— 5 per cent. Bonds	100	—	102-105
Telegraph Manufacturing, Ordinary	5	—	9-10
—— 5 per cent. Cum. Pref.	5	..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5	..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
Bournemouth and Poole, Ordinary	10	..	12-13
—— 4½ per cent. Cum. Pref.	10	..	10-11 xd
Brompton and Kensington, Ordinary	5	—	7-8
—— 7 per cent. Preference	5	—	8½-9½
Charing Cross and Strand	5	..	10-11
—— 30,001-50,000	5	..	10-11
—— 4½ per cent. Cum. Pref.	5	—	5½-6½
Chelsea Electricity Supply	5	—	7½-8½
—— 4½ per cent. Debentures	100	—	110-112
City of London, Ordinary	10	..	10½-11½
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9½-10½
—— 6 per cent. Cum. Pref.	10	..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	108-111
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4⅝-5⅛
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	8	—	8-8½
London Electric, Ordinary	3	—	1¾-2⅛
—— 6 per cent. Pref.	5	—	4½-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	101-103
Metropolitan, Ordinary	10	—	14½-15½
—— 62,501-85,000	10	—	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	—	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	—	96-97
Notting Hill Electric Lighting	10	—	16-17
Oriental, 1879	1	—	1⅛-1⅜
—— £5 Shares	5	—	7-7½
—— £4½ Shares, New	4½	—	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6¾-7⅛
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	1½	—	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100	—	104-106
South London, Ordinary	3	..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 40,081-52,080	5	..	15-16
—— 7 per cent. Pref.	5	—	9-9½
Westminster, Ordinary	5	—	14 15
Electric Railways.—			
Central London, Ordinary	10	—	9½-10
—— Pref. Half-Shares	5	—	4½-5
—— ,, ,, deferred	5	—	4½-5
City and South London, Consolidated Ordinary	100	—	58-61 xd
—— ,,	5½	—	4-5
—— 4 per cent. Debenture Stock	100	—	125-130
—— 5 per cent. Pref. Stock '91	100	..	140-145 xd
—— ,, ,, ,, '96	100	..	132-137 xd
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	101-104 xd
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	17½-18½
Brisbane Tramway	100	..	104-106
British Electric Traction, Ordinary, 1-30,000	10	—	16-17
—— 60,001-75,000	10	..	15½-16½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	18½-18¾ xd
—— 5 per cent. Perpetual Debenture Stock	100	..	125-128
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	—	105-108
Costa Rica Electric, Light and Traction, 5 per cent. First Deb., 1-1,000 of £100 and 1,001-1,600 of £50 each	—	..	75-85
Isle of Man Electric Power, 1-95,000	1	..	1 3/16-1 5/16
—— 6 per cent. Preference, 100,001-170,000	1	..	1 3/16-1 5/16
Kidderminster and District Lighting and Traction, Pref.	8	..	8-8½
New General Traction, Ordinary	5	—	3¾-4
—— 6 per cent. Cum. Pref.	5	—	5-5½
North Staffordshire Trams	6	..	—
Oldham, Ashton, and Hyde Tramway, Ordinary	10	..	18-19
—— Preference	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11½-12⅛
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11 xd
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	½-¾
National Telephone, Ordinary	5	—	5½-5⅞
—— 6 per cent. Cum. First Pref.	10	—	14-15
—— 6 per cent. Cum. Second Pref.	10	..	14-15
—— 5 per cent. Non. Cum. Third Pref.	5	—	5⅝-6⅛
—— 3½ per cent. Deb. Stock, Red.	100	—	98-100
Oriental Telephone and Electric Company	1	—	¾-1

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NOTES.

Obituary.—We regret to note that the death is announced at Rome of Senator Betrami, the eminent mathematician, and president of the Accademia Dei Lincei.

The Metric System.—The introduction of the metric system of weights and measures in Russia is likely to take place before long, as a scheme to that end, prepared by the Ministry of Finance, has already received the approval of the Council of State on the condition that it should be supplemented by a scheme for organising the aid which different scientific societies and the universities are ready to render in the verification of the new weights and measures for commerce. This latter scheme is nearly ready, and will shortly be brought before the Council of State.

Overhead Wires.—The director of the Bilbao section of the Spanish Telegraph Department, who is called Señor Don Esteban de Urrestarasu y Gutiérrez de Páramo, has invented an apparatus which, it is said, serves for the double purpose of preventing the entanglement of telegraph wires and of cutting the wires which have become entangled. Why the latter should be necessary if the apparatus effectually prevents the former, is not quite clear from the meagre details at hand at present. Anyhow, the Spanish Government have decided to institute practical trials with the "nemapiro," as the instrument is called, and we await further events, as an invention of this sort would fill a long-felt want—if it can be made to work properly.

Electricity in St. Marylebone.—Dr. J. Fletcher Little has forwarded us a reprint of some communications he has sent to a local paper on the question of the relative cost of electricity in Brighton and St. Marylebone. He works out an instance as to what the charge would be for a certain consumer who took 399 units for the quarter ending Christmas, 1899. The actual bill in St. Marylebone comes out at £10. 4s. 6d., whereas in Brighton the same amount of electrical energy would have been supplied for £4. 1s. 9d. Dr. Little strongly upholds the system of charging adopted in Brighton, but we do not see any suggestion in the correspondence as to what steps should be taken to secure electricity as cheaply in St. Marylebone as at that place.

Irish Policy.—The Limerick Corporation at its last meeting had the scheme of the Shannon Water and Electric Power Company explained by the engineer of the company, Mr. S. G. Fraser. He stated that the company proposed to spend £500,000 on a power-house at Doonas and a system of distributing mains. The curious and thoroughly Irish outcome of the meeting was the acceptance by the Corporation of Mr. Fraser's offer to pay an expert 100 guineas for a report on the possible damage to the Corporation's waterworks from the operation of the company's scheme. The further consideration of the matter is deferred until the expert's report is received by the Corporation, and paid for by the company. In this case we suppose that the man who pays the piper has not the right to call the tune.

British Automobilism.—At a recent meeting of the Automobile Club the Hon. J. S. Montagu, M.P., read a paper on the general aspect of the British automobile manufacture. A fair proportion of this paper was devoted to a condemnation of Mr. Harry J. Lawson and the various companies which he has promoted. The author went so far as to state that he did not believe the patents owned by the British Motor Company were of any practical value. His conclusion as to the part which the United Kingdom had taken in the development of automobiles for heavy goods traffic is that we in this country easily lead. He also added that but for the unsound finances and want of practical experience of the companies manufacturing smaller vehicles, England would also take a prominent part in this department as well.

Oil in Transformers.—The Pittsburg Transformer Company has recently issued a bulletin in which the advantages of using oil in a transformer are well brought out. The most striking effect of the oil is the improvement it gives in the insulation. Tests made by the above company show that the insulating properties of a thin hard paper were increased 82 per cent. by saturating it in oil, while a thicker and more porous paper was improved by over 300 per cent. The oil also renders the paper more durable, and tends to close up faults. A useful hint is given as to how to prevent the oil creeping up the stranded conductors of cables and damaging the indiarubber. This is done by stripping back the cable for a good length and immersing the copper construction in solder, so that all the interstices are filled up. In this way the oil does not creep back, to the detriment of the rubber.

Presentation.—In connection with the Electrical Engineers (R.E.) Volunteers an interesting ceremony took place on Friday last, the 16th inst., at the Northampton Institute, when Mr. Kenelm Edgcumbe, who holds a commission in the detachment which is proceeding to South Africa, received the good wishes of his numerous friends in the institute. Mr. Edgcumbe has for two sessions been senior demonstrator in the electrical engineering department, and in this position has been a popular member of the staff. His colleagues and the students therefore combined to present him with a Goerz binocular field glass of the prism type and a prismatic compass of the latest pattern. The presentation was made by Dr. Walmsley, the principal of the institute, at a well-attended meeting in the large hall last Friday, amidst the enthusiastic demonstration of members and students of the institute.

London Electric Railways.—The subject of electric traction being used on the ordinary underground railways of London does not seem to have dropped. Thus, at the half-yearly meeting of the Metropolitan District Railway, the Chairman stated that a report had been submitted to the company by Sir W. H. Preece and Sir J. Wolfe Barry as to electric traction on their line. In this case they were proposing to use electric traction under circumstances entirely different from those of the ordinary electrical railways, which were constructed in a special manner to be worked by electrical power, as their scheme was to adapt electrical power to a railway constructed for an altogether different locomotive power. This was not at all an easy thing, but experiments which had been carried out had shown that better results could be obtained by using electricity as the motive power than by using steam. More passengers could be carried with a given weight of rolling-stock, and at a smaller cost. The Chairman hinted that in three years the whole of the Metropolitan Company's lines would be electrically equipped.

Engineering Education.—The January number of the *Wisconsin Engineer*, which is the organ of the College of Engineering at the University of Wisconsin, contains an article on "Engineering Education in Europe" by Mr. J. B. Johnson. In this the systems in vogue in Germany are first described, and condemned because they do not allow of regular practical work on the part of the students. The author states that in the great mechanical testing laboratories, such as Charlottenberg and Munich, the students watch the professors perform experiments, and that the students do not carry out much experimental work themselves. He concludes that this system, while tending to exact knowledge in a few points, produces engi-

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neers who are dependent upon the experience of others for practical details, and who also are not trained at all to consider elements of first cost or the importance of time in engineering matters. The technical education of England is condemned as not sufficiently thorough, and Mr. Johnson holds that a three years' course is not sufficiently long to enable a practical education to be given. As regards his own college, the author considers the educational facilities good in every department except chemical engineering.

Electrical Volunteers.—We are glad to note that Lord Kelvin has made definite arrangements to preside at the send-off dinner to be given on March 3 to the first section of the Electrical Engineers Volunteers for the front. As honorary colonel his presence in the chair is most appropriate, and he may be able to express mathematically the rate of increase in the speed of our troops advancing to Pretoria with the increased lighting facilities provided by the Electrical Volunteers. We would again remind our readers that those who wish to attend at the dinner should send their applications and cheques at once to Mr. Henry Edmunds, as it is important to know how many wish to be present. Cheques may also be sent by those who wish to be represented as hosts in the send-off dinner but who find themselves unable to attend. The grant by the Government for the equipment of the corps now about to start for South Africa has been increased from £3,000 to £5,000. This, we understand, works out at a higher figure per head than has been allowed for any other section of the force. We are pleased to see that the War Office has acted thus liberally, and rely on the corps to return good value for outlay, as they have been accustomed to do in commercial life.

A Link with the Past.—Through the kindness of Sir W. H. Preece we are able to give the following particulars of an aged telegraph engineer who died on the 10th inst. at Ladywell Park, Lewisham. This was Mr. William Watkins, who has been actively connected with telegraphy since its introduction into England in 1837. He was born in 1823, and in 1836, whilst still a boy, he assisted Sir William Fothergill in all his early experiments. In 1844 he assisted in the construction of the first permanent line of poles and wires erected to Portsmouth for the Admiralty and the London and South-Western Railway Company. He remained an inspector on that line in the service of the Electric Telegraph Company, and in 1870 was pensioned by the Post Office. He then entered the service of the South-Western Railway Company, from the staff of which he only retired on April 13 of last year. Mr. Watkins was quite an historical figure on the South-Western lines, and was a very good specimen in appearance, feeling, and character of his class. He was much respected by everyone with whom he came in contact. He acted on the staff of Sir W. Preece from 1856 to 1870, and on Mr. Goldstone's staff from 1870 to 1899. His length of service, however, as a telegraph engineer extended over 63 continuous years. A record of his experience would practically coincide with the growth of the electrical telegraph in England.

Rapid Transit in New York.—We notice in the *Scientific American* some interesting illustrations of the new underground railways about to be constructed in New York for giving an express service between the suburbs and the heart of the city. These illustrations consist of typical cross-sections showing the arrangements of the various tracks at different parts of the road. The company constructing this system have taken the right step in having independent lines for the slow and fast services. In this way express trains can be run between important points, which, without much increasing the maximum speed of the train, enables the time taken to be reduced very largely indeed. The expense of the extra tunnels for the express service must, of course, be considerable, but it must be evident to all that a similar duplication in connection with the Metropolitan and District Railways would be of inestimable worth. It will be remembered that a deep-level scheme has been proposed between the Mansion House and South Kensington, and we trust that before long active steps will be taken to carry out this scheme. The contract sum for constructing the tunnels and roads of the New York line is said to amount to some £7,000,000, and the time of completion is to be three years. It is, of course, too soon yet to expect full particulars of the electric equipment, but it is likely that a third-rail system will be employed.

The Hub Motor.—In the series of articles on American types of automobiles appearing in the *Electrical World* we notice a description of what is called the Hub motor electrical vehicle, which is turned out by a Chicago firm. In this vehicle four motors are used, these motors forming the hubs of the four wheels. In the vehicle illustrated in our contemporary these motors are capable of developing 1½ b.h.p. The hubs only measure some 10½in. in external diameter, so that an unsightly wheel is not obtained. These wheels are provided with pneumatic tyres and are 43in. in diameter. The framework of the wheels is made of wood. In the description of the vehicle the part which interests us most—*i.e.*, the construction of the motor and gearing—is not gone into. We gather from the illustration that the armature of the motor is free to revolve round the axle, and that this armature drives by means of epicyclic train the field which forms the hub of the wheel. There are no less than eight lines of balls, forming four distinct bearings in the motor, so that a considerable amount of skill in manufacture will be required in turning out these motors and also in keeping them in repair. The manufacturers claim for this type of vehicle that by having all four wheels independently driven they are able to get a much better driving efficiency on bad roads. Also in starting the maximum current can be cut down by placing the four motors in series. The motors are said to have done well on trial.

Pacific Cables.—We are informed by Reuter's Ottowa correspondent that on Monday last, in reply to a question in the Canadian House of Commons regarding the action which the Canadian Government intended to take in view of the concessions granted by the Legislature of Victoria to the Eastern Extension Telegraph Company, Mr. Mulock, the Postmaster-General, stated that protests had been sent by the Government to the Premiers of Victoria and New South Wales, and also to the Imperial authorities, saying that Canada's position in the matter was that such concessions would seriously menace the success of the Pacific cable, in which all were interested alike. The Government have also declined to allow the question of concessions to be considered by a Board of Cable Commissioners in London. This matter has now assumed a new phase, as the Government of Victoria have raised the question as to whether the concessions now resisted would also be opposed after the Imperial scheme had become an accomplished fact and commenced actual working. This feature is now being considered, as it involves the question as to whether the Imperial scheme is to be a Government monopoly or a competitive system. With respect to the American Pacific cable scheme we notice that the Interstate and Foreign Commerce Committee in the House of Representatives has decided by eight votes to five to report the Pacific Cable Bill, after rejecting a proposal for the Government ownership of the cable.

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Electrolytic Formation of Hypochlorite.—The following is an abstract of a paper by Mr. F. Foerster published in the *Zeitschrift anorg. Chemie.* The abstract appears in the *Journal* of the Chemical Society, and reads as follows: Investigation of the formation of hypochlorite and chlorate as a purely chemical process has prepared the way for a theory of the electrolytic preparation of these substances. A review of the work dealing with the electrolysis of alkali chlorides, shows that the following conclusions may be regarded as established. Hypochlorite is formed chiefly by the interaction of the chlorine liberated at the anode with the alkali produced during the electrolysis or previously present: in alkaline solution, hypochlorite can be oxidised to chlorate by a primary anode process; the formation of chloric acid in the electrolysis of dilute hydrochloric acid is due to the direct oxidation of $\overline{Cl}$ ions at the anode. A theory of the secondary electrolytic formation of chlorate is discussed, based on two suppositions: (1) that in the electrolysis of neutral alkali chloride solutions, chlorine is continually being liberated at the anode; (2) that the hypochlorite takes part in the electrolysis, and that its ions are discharged at the anode with evolution of oxygen. The known facts regarding the influence of current density, temperature, acidity, and alkalinity, on the formation of chlorate, are largely in harmony with the theory; further experiments to determine the exact nature of the process have been made by Müller.

Dynamos without Commutators. — Mr. H. E. Heath in the *Electrical World* gives some actual experience in the manufacture of direct-current dynamos without the use of commutators. The most interesting part of the article gives some details of a machine manufactured by the Eddy Company in 1896, which has continued since then to do commercial work. This machine was made with the armature 15in. in diameter, revolving round poles 10in. in diameter. The current was collected at either end of the cylindrical armature and at either end of the spindle which passed through the axis of the poles. The density of the field of the magnetic circuit was about 15,700 C.G.S. lines per square centimetre, while the density of the armature itself was almost the same. The machine was excited by a single coil absorbing about 700 watts. At the time it was tested at the works 9,000 amperes were taken from it at 1½ volts with a speed of 1,200 revolutions per minute. As far as can be ascertained, the eddy-current loss due to unequal distribution of magnetism was less than 100 watts, so that the electrical efficiency of the machine would be over 94 per cent. Mr. Heath also states that all the drop in voltage between no load and full load was due to the resistance at the collecting brushes, and that there was practically no armature reaction in the machine. He concludes that for the production of large currents at low voltages a commutatorless dynamo is much simpler and more efficient than the ordinary types of machine designed for these low voltages.

Power Distribution Scheme.—We are glad to note that the *Newcastle Daily Chronicle* in its issue for Feb. 14 gave a concise and true *résumé* of the whole question of power distribution as it stands at present in the United Kingdom. In this article the opposition brought by municipalities to schemes which may be of great service to a district is condemned in no measured terms. According to our contemporary, the Tyneside Company should have the support of the local authorities, because of the great impetus which cheap power would give the industries of the district. Our contemporary adds that unless the local authorities take an enlightened view of their position in what may be termed an industrial crisis like the present, they will soon find a portentous decrease in the ratable value of the areas under their control. In the contrary case they will find a gratifying increase. In conclusion, the opposition of the Town Clerks' Union is referred to, accompanied by the statement that if the public and the local authorities, who should be the guardians of popular liberty, do not suppress the Town Clerks' Union, the Town Clerk's Union will strangle the nation. Outspoken criticisms such as these will do much to show manufacturers and others interested in trade that there are undertakings which can advance the interests of a municipality, without being of such kind that the municipal authority could well undertake the same. They will also gather that the greatest good is not always obtained by giving even a municipal authority a monopoly in any one particular commodity.

The Nernst Lamp.—Prof. R. A. Fessenden, of the Western University, Pennsylvania, has been giving a considerable amount of thought to the improvement of the Nernst lamp. The result of his experiments has led him to take out no less than five patents covering improvements which he foresees in this type of lamp. To get over the regulation trouble due to the fact that as the rise of temperature causes the resistance to fail the magnesia pencil is apt to be destroyed, Prof. Fessenden proposes to connect in series with the pencil a substance which will suddenly increase in resistance when more than a certain current flows. He finds that lead enclosed in a glass tube exhibits this phenomenon in that when lead begins to soften under heat, its resistance rises very rapidly. To get over the trouble with the contacts due to the high temperature, it is suggested to make the ends of the pencil of a substance of less specific resistance, and which also becomes a conductor at a lower temperature than the material used for the central portion. He suggests for these ends a mixture of 10 per cent. of chloride of magnesia and 90 per cent. of magnesia, while the central portion of the pencil is formed of magnesia only. With these ends, terminals of nickel, or an alloy of nickel and iron, may be used instead of platinum for the conductor. Graphite is also suggested as the intermediary conductor between the pencil and the terminals. Seeing the large number of scientific men who are working on the manufacture of lamps on the Nernst principle, we trust that it may not be long before some commercial results are obtained.

Power Distribution Bills.—The Association of Municipal Corporations met on Monday to consider what course should be adopted to oppose the various Electric Power Distribution Bills now before Parliament. These Bills propose to supply electrical energy over large areas of country, and to break up streets without the consent of the local authorities. It was determined at the meeting to get the assistance of members of Parliament to oppose the County of Durham Electric Supply Bill, the Lancashire Electric Power Bill, the South Wales Electrical Power Distribution Bill, the Tyneside Electric Power Bill, and the Dublin Electric Lighting Bill. Copies of petitions have been forwarded to members of Parliament pointing out the dangerous powers demanded in the Bills. For instance, the Lancashire Power Bill seeks to supply electrical energy to over three millions of population, and it is urged that such Bills are against public policy in interfering with local authorities. These Bills were down for second reading on Monday, but in view of the strong protest made by several of the members they were postponed until March 1. Meantime all the local authorities in the country are requested to petition their members of Parliament to oppose the Bills on second reading. Wholesale condemnation is not advisable in such matters, and it would be well for the association to

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get evidence that these power schemes will not benefit the districts they are designed to serve. At present large consumers can generate electricity at a cheaper rate than municipal undertakers will supply them, and if these organisations can still further cheapen the supply of power they should be encouraged even within the boundaries of the large towns.

Hysteresis.—An investigation by Dr. Samuel Sheldon on the hysteretic qualities of iron viewed from the magnetic standpoint is described by the experimenter himself in the *Electrical World*. The first phenomenon which he explains is that a soft-iron wire, when twisted at one end, by being held in the chuck of a running lathe while the other end is stationary invariably becomes magnetised without being subjected to any magnetising force. Dr. Sheldon found that the induction density was about 2,000 lines. The other phenomenon which he explained was that connected with a number of small compasses having very short and strongly magnetised needles. When these were arranged in a line running east and west, it was found that the needles ranged themselves with their axes in this direction. These appear to be unaffected by the earth's magnetic field. When the distance between two magnets was gradually increased, at a critical point the needles moved round until they were in line with the earth's field. Dr. Sheldon was then led to the supposition, which is the direct conclusion of Ewing's magnetic theory, that the value of magnetic substances might be dependent upon the distance between their molecules. He proceeded to experiment with these small magnetised needles on the supposition that they acted as molecules, but it is, of course, questionable to what extent deductions made from such experiments can be applied to the treatment of iron. Still, assuming this, Dr. Sheldon concludes that iron to have a small hysteresis loss should have its molecules separated along the direction of magnetisation, and close together in the direction perpendicular to that of the magnetisation. The conclusions are in accordance with observations made on iron by cutting the strips to be tested from the same sheet with and against the grain.

Electric Light Charges.—The consumers of electrical energy at Croydon have recently expressed their dissatisfaction with the way they are charged for electricity by means of a deputation to the deputy chairman of the Electric Light Committee. The cause of the complaint is that the maximum demand system of charging was introduced last year instead of the old rate of 6d. per unit, the rates now charged being 7d. per unit for the first 1½ hours, and 2d. afterwards. One man, who stated that he was one of the largest consumers, complained that he had not got so large a reduction during the Christmas quarter as in the September quarter. The reason for this is obvious as at Christmastime this consumer on two or three evenings had a large number of extra lamps on. This, of course, created a large maximum, and consequently increased his charges, as with the maximum demand system the indicator shows the maximum consumption of energy at any one time from which the rates are calculated. It is the proportion between this maximum and the total quantity of electricity used which determines the value of a customer to the central station. In the various cases in Croydon, however, in which complaints were made, and more especially in the particular case referred to, the average rate paid was about 4d. per unit, as against 6d. per unit under the old style of charging. The Deputy Chairman pointed out that the circular which had been issued to the consumers as to the maximum demand system might possibly have been more explicit, but that it was wrong for them to say that the charging was not carried out in accordance with the terms shown on the circular. The complaints as to the payment were entirely unfounded, as the light was supplied in practically all cases considerably under 6d. per unit.

Wiring Tables.—It will be remembered that there were recently issued a series of constants and formulæ connected with copper cables, which rules were drawn up by the Institution of Electrical Engineers. At this committee eight of the principal manufacturers of insulated cable were represented, and also the General Post Office. From the formulæ so arrived at Messrs. W. T. Glover and Co. have prepared two tables giving particulars of practically every size of cable which is required, from the fine wire used for winding the coils in telegraph instruments to the heavy cables used in distributing electric light on the low-pressure system. The value of these tables to electrical engineers is very great, and we are glad to see that the same have been prepared in a way which makes reference to them exceedingly easy. The alternate lines are printed in red and dark blue, so that the figures referring to one particular size of cable can be easily followed along the line. The following information is given for each size of cable: the current it will carry at 1,000 amperes per square inch, which corresponds to a drop of 2½ volts per 100 yards; the current which is allowed in the same wire by the formula adopted by the Institution of Electrical Engineers; the over-all diameter of the strand and the effective area of the same in square mils, square inches, and square millims. Columns are then given to the resistances and weight per 1,000 yards, per mile, and per kilometre, with further information as to the minimum weights and resistances allowed under the Institution's rules. These rules are reproduced at the bottom of each table, so that the constants adopted can be readily seen. These lists are copyright, and the price of them is 5s. per copy. This price is not high for the information contained, but we understand that these tables are being supplied free to the profession.

Salford.—For some time past there has been considerable friction between the Electric Lighting Committee and the Tramways Committee. The cause of this friction is that in the early days of the electric tramways in Salford the Electric Lighting Committee took over certain maintenance work connected with the tramways. The Tramways Committee considered that this was part of their work, and hence the dispute. At a meeting of the Town Council last week, however, an attempt was made to put matters straight, and a resolution was moved to the effect that the following resolution, passed in October, 1898, be rescinded: "That the Electric Light Committee be requested to include in their charge for electricity supplied to this committee such an amount as will cover the outlay and maintenance of the trolley lines, telephones, and test wires and section pillars, and the maintenance of the bonding of the lines." It was also moved that the Tramways Committee undertake to provide and fix poles and overhead wire under the supervision of the consulting electrical engineers and the tramways engineer; and further, that the Electric Light Committee be requested to undertake the maintenance of the overhead wire when fixed, and to charge the Tramway Committee for the same, the costs for power and maintenance to be separate. After a very animated discussion an agreement was come to that the Electric Light Committee should fix and maintain all plant up to the point of contact of the trolley wheel and overhead wires required to work the tramways, and charge the capital cost and maintenance thereof to the Tramways Committee, and that the Electric Light Committee should make a separate charge for current from any cost of maintenance. This is

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no doubt a better arrangement, as it leaves the Electric Light Committee to do the technical work, and the separate charges for maintenance and for current will also simplify matters considerably.

Electric Ship's Telegraph.—The *Electrical Review* of New York gives an illustrated description of the proposed electromechanical order telegraph which has been designed by Lieutenant Schroeder, of the United States navy. The system is an excessively simple one, requiring only two wires to be run between the signalling station and a number of receiving stations, which can be placed anywhere in the ship. The receiving mechanism consists of a ratchet wheel mounted on a disc on which some 10 or 12 different orders are described. As the disc is moved round, these orders come successively opposite the aperture on the vertical axis of the face of the instrument, so that they can be easily read. The ratchet wheel is propelled forward by a simple device with a single electromagnet, and the connections at the sending are exactly the same as at the receiving points. As soon as the key at the sending station is depressed the discs commence to revolve synchronously, and the signaller lifts the key when the correct signal is shown on the instrument. At each of the receiving stations an electric bell is placed so as to call attention to the fact that a signal is being sent. The simplicity of the arrangement tends to prevent faults. The worst which could happen would be that one of the conductors should be broken and the two ends should make intermittent contact. In that event the particular instrument supplied through this conductor would fall out of step, and would have to be synchronised by hand. On the whole we think that the device is not so good as one requiring three wires, which we had brought before us in Germany some two years ago. In this a system of revolving fields was set up which ensured that the receiving needles should be always synchronised while the circuits were intact. The failure of one wire would then render the receiving instrument useless, and as soon as the wire was repaired it would again synchronise with the others.

Aluminium Transmission Wires.—The *Electrical Review* of New York publishes an illustrated article on the aluminium transmission lines of the Hartford Electric Lighting Company. These lines, of which there are three in number, are used to transmit three-phase currents at 20,000 volts from the water-power station of the company two miles out of the town. Some 20,000 h.p. is there available. The actual length of the aluminium line is a little over 11 miles, as the current is carried through the streets of the city by copper cables in conduits. In all, some 60,000lb. of aluminium was used for the work, each conductor being equivalent to a No. 0000 copper wire. On the specification to which the wires were supplied, the aluminium was to have a conductivity of not less than 60 per cent. of Mathiessen's standard. The breaking strain was guaranteed to be not less than 2,770lb. per square inch, while the elastic limit of the wire was one-half this. As a bending test, the wire was to be able to be wrapped six times round its own diameter, unwrapped, and wound up in the same way again, without showing any cracks. The wire contained at least 99·6 per cent. of pure aluminium. Each conductor consisted of seven strands each approximately $\frac{1}{4}$in. in diameter. In fact, the actual diameter of the cable over all was slightly less than $\frac{3}{4}$in. The stranded conductor was delivered in lengths of 2,000ft., and the lengths were jointed up by means of a sleeve. This sleeve, which was about 7in. long, is made to fit tightly round the strand at either end, but the internal diameter is enlarged at the centre. The individual wires were then spread out round this enlarged diameter, and the whole sleeve filled up with pure tin, with the addition of a small proportion of phosphorus. Before making the joint the ends of the conductors in the inside of the joint were carefully tinned, hydrofluoric acid being used to clean the surface of the aluminium. The poles supporting these overhead conductors were placed 100ft. apart, the sag allowed in each span being calculated on a factor of safety of 3 at 20deg. below freezing. This will give a sag of some 15in. at a temperature of 120deg. The actual weight of the stranded conductors was only about half of what would have been required had copper been used, which was an important factor when erecting the line. Our contemporary concludes that this line is a success, and that aluminium is able to stand the severe strains due to a cold winter.

Accumulator Regulation.—The value of accumulators in electric lighting undertakings has been recognised from the earliest stages of central-station work, while their chief disadvantage lies in the cost of upkeep. Under the present system of making manufacturers responsible for the maintenance of accumulators when the order is given for the same, the cost of upkeep to the users is now reduced to about 5 per cent. on the actual outlay. The annual charge of 5 per cent. is well within the depreciation which should be written off each year from the capital cost of running machinery required to produce electrical energy. Amongst the greatest changes which have been made in the working of accumulators of late years is the introduction of a booster for charging, and the use of connections by which the whole battery of accumulators is treated as a single unit. In the older system of connections without charge and discharge regulators the end cells were systematically overcharged, while the amount of overcharge varied with the position of the cell at the end of the battery. In order to provide against this some engineers inserted accumulators of larger capacity at the end of the battery, so that the excessive charging might not disintegrate the plates. The more modern arrangement, however, of using a booster for charging so that the outgoing load can be supplied by the charging dynamo at normal voltage, does away with the above-mentioned fault. The best practice of all is to use the booster again when discharging so that no provision for varying the number of cells in circuit need be made. In stations supplying on the three-wire direct current accumulators are used at light loads to balance the system, and it is thus necessary to have two boosters so that either battery may be charged independently. We notice that Mr. A. S. Hubbard, of New York, who is connected with the Gould Storage Battery Company, has patented an arrangement which enables one booster only to be used. With his system of connections the positive and negative ends of the two batteries are connected to the positive and negative omnibus bars respectively, and the regulating cells are connected to the earthed middle wire. He then uses charge and discharge regulators at this earthed end of the battery, and provides for a single booster between the levers of the charging-switch handles. The levers of the discharging-switch handles are connected to the earthed middle wire. The levers can then be regulated so that one battery of accumulators is charged more than another, but the system involves all the disadvantages of charge and discharge regulators. Thus a large number of cells have to be connected up to the discharge switch in order that the voltage on the lamps may keep at its proper value when charging, and it follows that if a considerable current is taken out at the time the end cells are overcharged, and will give trouble.

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THE ELECTRICITY WORKS OF THE COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY.

The above company was formed in 1890, and obtained provisional orders in 1892 for the united parishes of St. James and St. John, Clerkenwell, and for St. Luke, Middlesex, on the north side of the Thames; and on the south side, orders for the district of the Wandsworth District Board of Works and for the parish of St. George-the-Martyr, Southwark. Further orders were subsequently obtained by the company, whose present areas of supply are shown on the accompanying map. The work of laying mains in both the Holborn and St. Giles's districts was commenced in the early part of 1899, by which time the mains in the eastern portion of Holborn, for which the order had been granted in 1897, as above stated, were laid. By 1898 orders had been obtained by the company for 11 of the 45 London districts, and up to date the supply of electric current for lighting and power purposes has been inaugurated in seven of these districts. These districts are shaded in the map (Fig. 1), while those which are shaded and cross-hatched are those in which supply is not yet available.

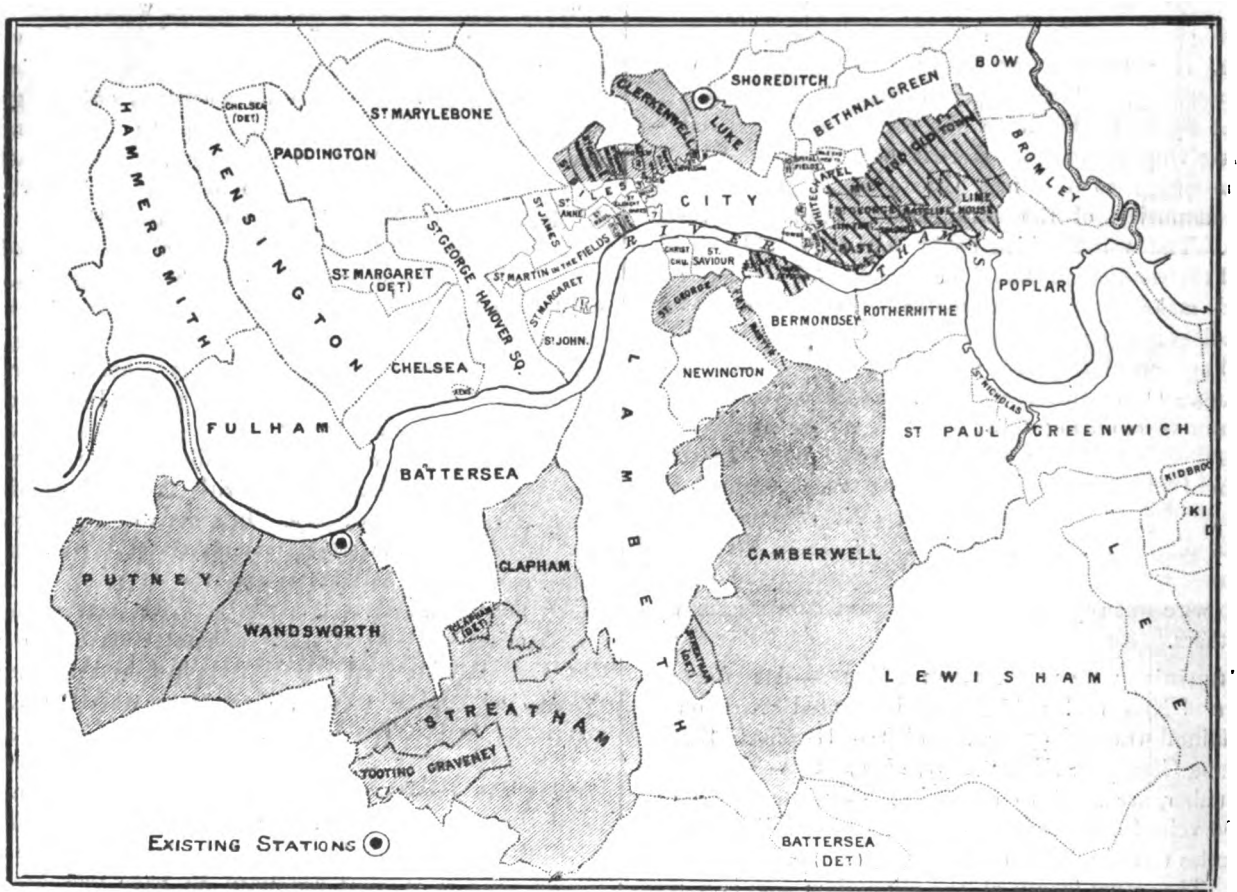

FIG. 1.—Map of the Districts in Greater London, showing by shading those in which the County of London and Brush Provincial Electric Supply Company have Electric Lighting Powers.

The plans of Mr. A. J. Lawson, who from the commencement of operations and until quite recently was the engineer and manager of the company, provided for the supply of all the districts on the north side of the river from one station at City-road, and for all districts to the south of the Thames from the station at Wandsworth, until such time as the company might be required, under an award by the Board of Trade, to provide for a separate station in the parish of Camberwell, when it was intended that both the Wandsworth and Camberwell stations should be interconnected and run in parallel during the winter at times of maximum load, but that each station should be shut down during part of the summer in order to undergo a complete overhaul before the recommencement of supply in the autumn.

City-road Station.

In the latter part of 1894 the premises formerly used as a coal wharf by Messrs. Rickett, Smith, and Co, and known as Oak Wharf, City-road, were secured as a site for a generating station. The plans were approved by the County Council and local authorities in 1895, and building work was commenced, but owing to strikes of builders' workmen it was not until the beginning of 1897 that the building work was completed, nor until September of the same year that a supply was available from the company's own plant, although current had been given to consumers from the company's mains by arrangements with a neighbouring company for nearly two years prior to that date. The site of the station extends 303ft. 6in. along the canal basin of the Regent Canal Company, 165ft. along Graham-street parallel to the canal, 140ft. from the canal to Graham-street at the northern end, and being cut diagonally by City-road at the south end, the length along City-road to Graham-street is 198ft. 9in. The wharf level rapidly sloped down from Graham-street to the canal, and the subsoil was found to be of made earth in the greater part, with, however, a large quantity of gravel and sand overlying the blue clay, which was reached at about a depth of 30ft. This sand was found to be of sufficiently good quality to be used in mixing with cement for builders' work, and thus lessened to a considerable extent the cost of construction. It was decided to construct the buildings within what is practically a watertight tank, formed by thick concrete foundations overlying the whole area of the land, and with water and moisture-proof walls towards the canal, along which a cofferdam had to be placed by the builders.

The buildings, which were designed by the company's architect, Mr. C. Stanley Peach, F.R.I.B.A., in consultation with the company's engineer, are constructed throughout of best selected stock bricks and Portland cement, and the general design is shown in the photographic views herewith. The large size of the buildings prevents us showing the architectural details in the elevations. The chimney is a massive structure 200ft. in height, with an internal diameter at the top between the parallel sides of 12ft. The boiler-room is a two-floored building with mezzanine floor for a short distance at one end. The interior of the engine-room is lined with glazed bricks and tiled over with adamant tiles, thus securing one of the greatest desiderata in engine-rooms of generating stations—cleanliness. The switchroom, off the engine-room, is also similarly lined with glazed bricks and with tiled floor. All floors throughout the building are of concrete on iron joists, the only woodwork being that

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used for doors and doorposts, wood block floors laid over the concrete, and the boarding for carrying the slates over the engine-room roof. The staircases leading to the upper floors of the building are of stone, and those from the landing platforms to the engine-room floor and to basement are of iron, as are also the window frames and sashes. Messrs. Mowlem and Co., of Westminster, were the building contractors.

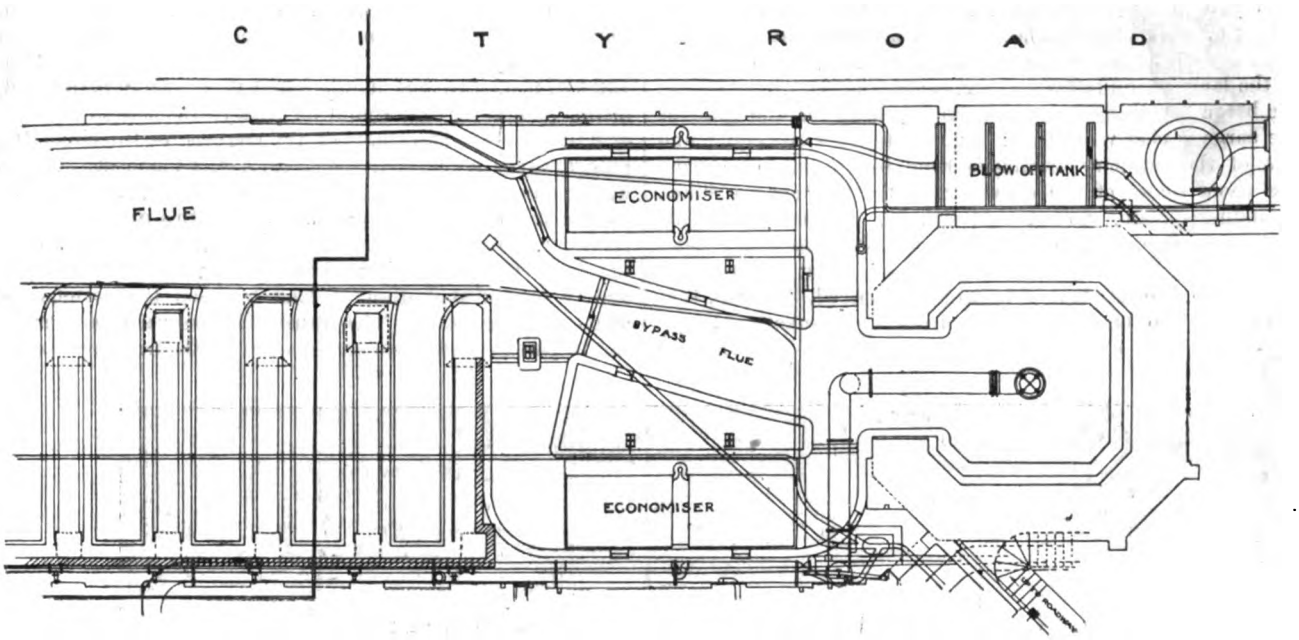

FIG. 2.—Detail of the Main Flue and Economiser Arrangements at the St. Luke's Station.

Steam Generating Plant.—The boiler-room fronts on to the canal. The space at one end contains a double set of economisers and gearing of E. Green and Co.'s make (Fig. 2), above which there is a short length of flooring upon which the feed pumps are placed. There are now installed two batteries of six boilers each, of Babcock and Wilcox make, while there is still room for a third battery of five boilers. These are fired automatically by Vicars's stokers, the hoppers of which are supplied with coal through

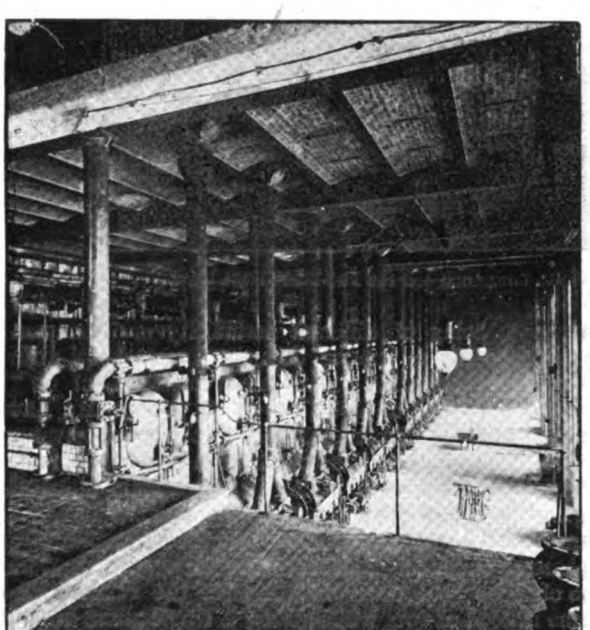

FIG. 3.—View of the Boiler-Room, showing the Coal Shoots and Mechanical Stokers.

vertical tubes from the coal store above. These stokers have hitherto been driven by two Chandler enclosed engines, but in order to avoid the loss by condensation in long lengths of steam-pipe, it was decided to replace at least one of these engines by a small motor, to be supplied off the continuous-current mains. The stoking floor is some 2ft. above the level of water in the canal basin, and the ash and clinker is wheeled out into steel barges belonging to the company, which are alternately used for carting away the ashes and bringing up coal from the lower reaches of the river. Fig. 3 is a view of the boiler-room.

On the pump-room floor, which is just on a level with the roadway leading off the abutments of the City-road bridge, there are placed two Weir steam feed pumps, capable of supplying 4,000 gallons each per hour against a pressure of 160lb., as well as two feed pumps driven by electric motors off the continuous-current mains, each also capable of supplying 4,000 gallons or more per hour against the same pressure, the one nearest the steam feed pumps being a Hayward Tyler three-throw pump, driven by a motor of the Electric Construction Company's make, the other, a pump of similar construction, driven by a Mordey motor of the Brush Company's manufacture. On the same floor there is a large hot-water tank, into which the condensed steam from the engines is returned and where it is freed as much as possible from any cylinder oil which may come along with it, while underneath in the feeder ring mains are two oil filters of Messrs. Railton and Campbell's manufacture, similar to those generally used on ocean steamers. Off this pump-room floor short ladders lead to the platforms, from which the screw-down steam-valves from the boilers are manipulated. In addition to these screw-down valves, non-return valves are also inserted in each boiler's steam and feed pipes. The water-feed valves of each boiler are manipulated by handles on the boiler-room floor attached to long stems provided with universal joints.

Coal-Handling Appliances.—The coal store is built over the boiler-room, and extends the entire length. To render this portion of the building fireproof, the flooring is composed of brick arches between iron girders passing from one wall of the boiler-room to the other, sheeted over with steel plates. The roof is composed of corrugated iron on steel principals and purlins. Ventilation from the boiler-room below is carried out at the back of the coal bunkers by means of a box composed of steel plates, suitably supported from the wall, which carries the heated air from over the boilers and under the coal-store floor out to the roof. Ample ventilation is also provided for the coal bunkers by means of perforated iron pipes. These bunkers are divided longitudinally by a passage-way along which rails are laid, upon which rails an automatic recording weighing machine of Messrs. W. T. Avery's make runs. This machine, which was specially designed by Mr. Lawson, is so constructed that all coal, even the smallest, must be discharged on each opening of the door, and it automatically records the number of times which the door has been opened. This record has then to correspond with the number of printed tickets of weight handed in by the trimmer at the end of each eight hours' shift. Into the bunkers on each side (which are divided transversely by steel plate bulkheads) the coal is conveyed by a Bennis automatic conveyor fed from a hopper under the weighing machine, which receives all the coal coming in. A powerful hydraulic crane is stationed on the

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platform abutting on the end of the coal store at the edge of the wharf, and is fitted with Hone's patent grab. This grab lifts the coal from the barges and deposits it in a hopper, which takes the impact of the fuel before it reaches the weighing mechanism, which is self-registering, and integrates the weight of each grab load. The conveyor is a steel chain running in a cast-iron trough, and travels up an incline from the weighing machine to the two similar conveyors running longitudinally along the coal store at a height of 12ft. from the floor. This apparatus is capable of dealing with 35 to 40 tons of coal per hour, and the whole of the labour required to work it consists of two labourers in the barge below to trim the coal into a heap for the grab as the barge is nearly emptied; one man to work the crane, and part of the ordinary trimmer's time in opening or closing the shoot doors of the conveyor as the bunkers are filled. Including steam, water, and labour, but not including interest or depreciation on the cost of the appliances used, the cost of handling is approximately 1d. per ton from the barge into the bunkers. It will be noticed, however, that the coal has to be fed by hand from the bunkers into the small weighing machinery on its way to the boilers, the cost of which could have been saved by making the bunkers self-trimming into the coal shoots to the boilers. Records of the coal used could then be obtained by measuring gear on the individual shoots, and the coal burnt per boiler would then be obtainable, as is not the case at present. The coal store is capable of containing about 1,000 tons.

Feed water is taken from two large water storage tanks. A feed-water purifier of Doulton's make is used to treat the New River Company's supply for the make up of feed only, as the condensed water is used over again.

Engine-Room Plant.—The engine-room is situated behind the boiler-room and is 60ft. in width, with an average length of 180ft. It is provided with a row of pillars along the centre supporting the roof and the girders carrying the two 20-ton cranes. Owing to the peculiar shape of the land by the diagonal cutting off of the southern end, it was found impossible to utilise the whole space for generating sets, and it was decided to put two landing-stages on the road level, the floor of the engine-room itself being at the same level as the floor of the stoke-room. On the right-hand side on entering there are two centrifugal pumps driven by steam-engines and one motor-driven centrifugal pump for supplying circulating water, which is drawn from the canal at the southern end of the building and discharged at the northern end. To the left of these pumps and close by one of the landing-stages are three steam-driven exciters—two of the Electric Construction Company's make and one of the Brush Company's manufacture. Further along on the same side there are six 200-kw. two-phase 50 ⌒~ generators, built by the Electric Construction Company, of Wolverhampton, and driven by Brush engines, and space for a motor-generator, bi-phase to single-phase. On the other side there are five single-phase alternators, of the Brush Company's make and of Mordey's well-known design, of 180 kw. each. These were originally supplied as 150-kw. machines, but it was found that, owing to improvements in design, they could be safely loaded to 90 amperes at 2,000 volts. The whole of the engines for the circulating pumps, exciters, and main generators were made and supplied by the Brush Electrical Engineering Company, and are of the cross compound marine type, with Raworth's patent flywheel governor, fitted with attachments for speeding up or down the engines when running, so as to ensure easy synchronising and an even distribution of load between the various sets when run in parallel. The Brush Company's machines are run in parallel with themselves, and the Electric Construction Company's being of different periodicity are also run by themselves; but to ensure economy in working until all machines are converted to two-phase machines of 50 ⌒~ periodicity instead of 100 ⌒~ as at present, Mr. Lawson arranged to place a motor-generator in the space between the Electric Construction Company's main generators and the exciters, the function of which is to generate either as a single-phase 2,000-2,200 volt 100 ⌒~ machine, or as a two-phase 2,000-2,200 volt 50 ⌒~ machine, according as a bi-phase or single-phase steam generator may be at work at time of light load, thus providing for the running of one engine instead of two, while giving a single-phase supply to the older parts of the district and a two-phase supply to the later connected districts in which mains have been laid.

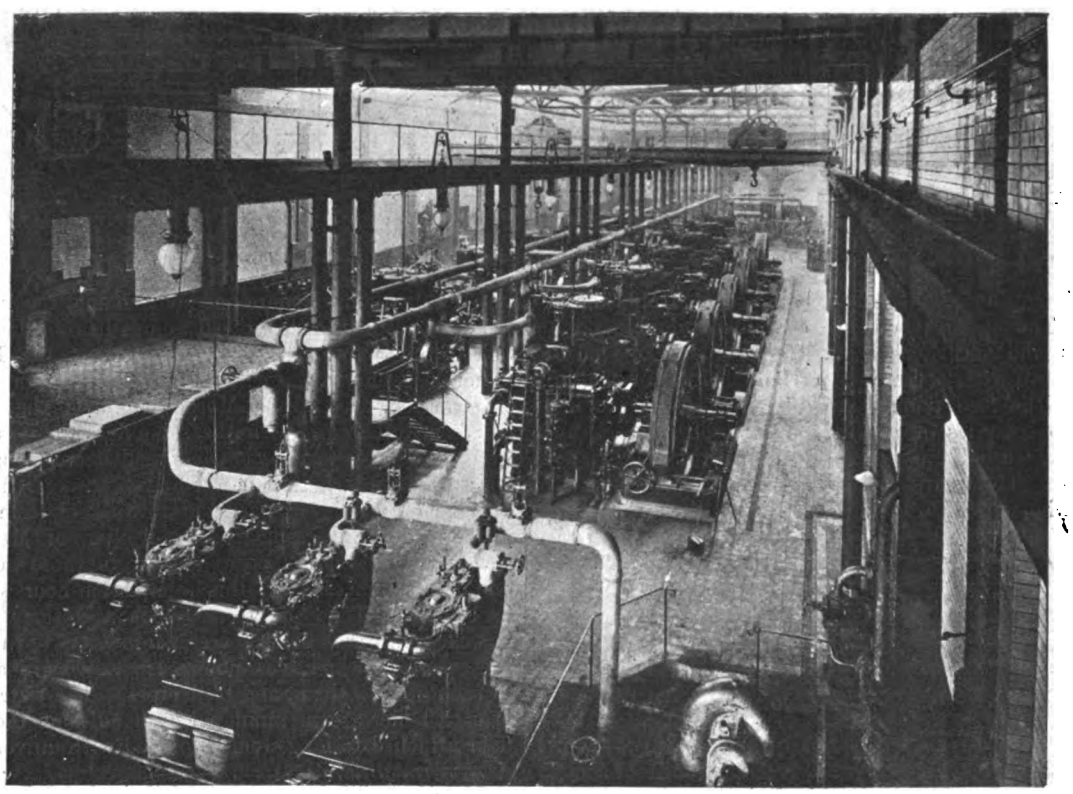

FIG. 4.—View of the St. Luke's Station, showing the Exciters in the foreground and the Two-Phase Plant beyond.

At the far end of the engine-room are two cross compound engines of Messrs. E. P. Allis and Co.'s make, direct coupled to 550-kw. generators of the General Electric Company of America's manufacture, supplied by the British Thomson-Houston Company. The circulating water for the condensers of engine is provided by the same pumps which supply the other engines, but the Wheeler condensers are separate from the engines and are fixed in the basement, the air-pumps being three-throw electrically-driven pumps of Blake, Knowles, and Co.'s make. The condensed water is raised into the

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pipes supplying the feed tanks at the south end of the boiler-room building by means of small three-throw pumps, also driven by motors. On the switchroom side of the building there are also two alternating single-phase motor-generators, coupled to two 75-kw. 550-volt direct-current machines, which have hitherto supplied the direct current for motors throughout the Clerkenwell and St. Luke's districts. There is also a bi-phase 50 ⌒ motor-generator direct coupled to a direct-current machine of similar voltage and output. Figs. 4 and 5 show two views of the engine-room.

The steam-pipes form a ring in the boiler-room and a ring on each side of the central pillars in the engine-room, and are cross-fed by pipes underneath the floor, so as to have a clear way for any machinery carried by the cranes. All these pipes are fitted with section valves in the main rings, so as to have as small a length of steam-pipe alive at one time as possible, and the valves for the engines are placed close up to the main steam-pipe, so that in shutting down the engine the length of pipe between the main pipe and the engine is also shut off and condensation lessened. The steam-valves throughout are parallel slide ones of Messrs. Hopkinson's make. The exhaust pipes are fitted with automatic valves, so that engines may either exhaust to atmosphere or through the condensers. The latter are fitted in the back standards of the engines driving the alternators, each engine being provided with its own air-pump, driven by means of a lever off the low-pressure cross-head. Although the speed of these engines is 215 revolutions, a satisfactory vacuum is obtained. The condensed steam is returned by means of a small drum pump, worked by a chain and sprocket wheels on pump and main shaft, it having been found that the force pumps, which were also driven along with the air-pumps, ran at too high a speed to deal with the whole of the condensed water.

The engines when exhausting to atmosphere are connected with a main exhaust pipe, which runs along underneath the floor on either side of the building and thence to the stoke-room floor, where it is joined into one main pipe, which continues to the top of the chimney, a height of some 200ft. from the ground level.

The condensing water from the canal is brought into two large tanks under the roadway between the chimney and City-road. A grating is provided in an aperture of the wall leading from the canal so as to strain the water before it enters the tanks, and each tank is connected with a main pipe leading round to the centrifugal pumps, where both pipes are joined together, and these are provided with suitable valves to shut off one length of pipe from the other. The tanks are also provided with sluices to shut off the water from the canal so that the tanks may be periodically cleaned out. The discharge of the circulating water from condensers is carried through to the northern end of the building, a considerable distance thus separating the intake from the outfall. The general arrangement of the plant in the station and of the buildings can be seen in Figs. 6 and 7. We regret that, owing to the large size of the plan, we have had to reproduce it in two halves.

Switching Gear.—Within the engine-room is erected the switching gear, made by E. F. Moy and Co, for dealing with the exciting current from the main exciters and from the exciting battery, which was installed in order to ensure absolute evenness of pressure. These panels deal with the currents from the three main exciters, with the connections of two small self-exciters attached to two Brush machines, and with the main current to and from the exciting battery. At the other end of the building there are two switchboards for direct-current generators of the General Electric Company of America's standard make, with panels for two more sets.

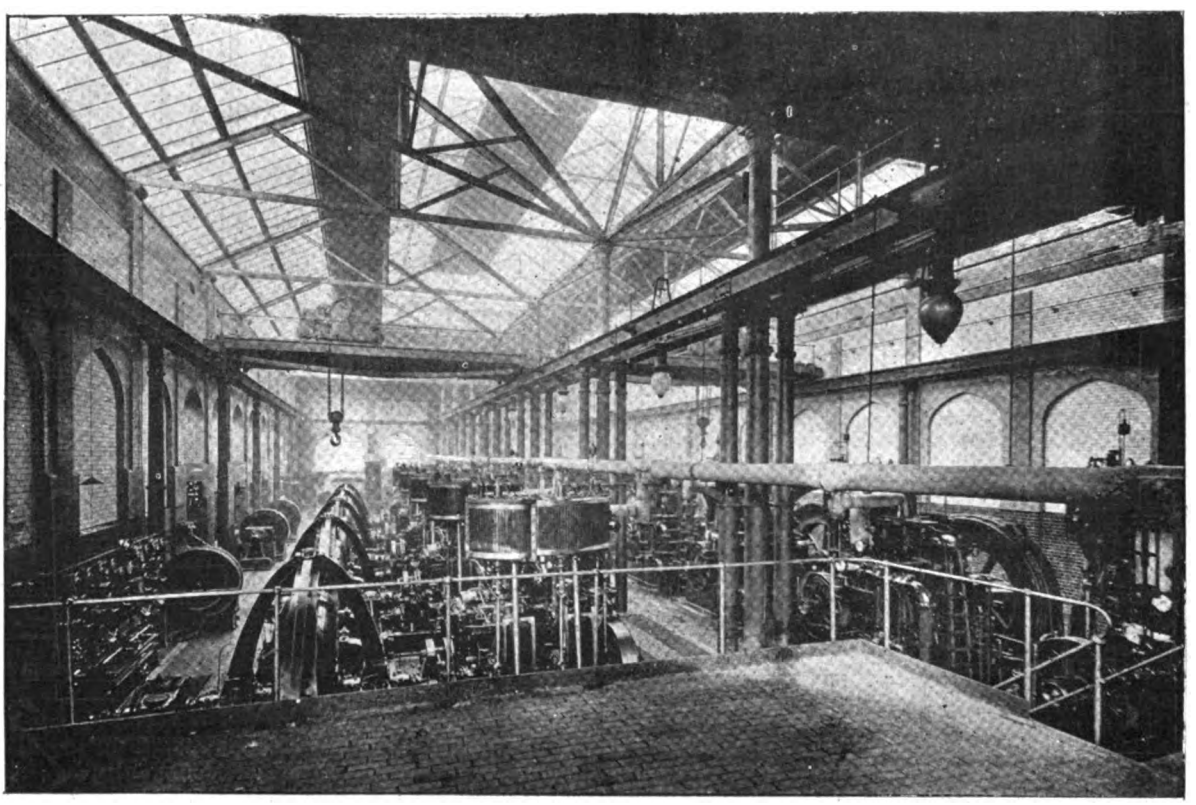

FIG. 5.—View of the St. Luke's Station taken from Arrival Platforms, showing the Brush Single-Phase Alternators.

These latter switchboards are connected by cables to the distributing power switchboard, to which are also connected three switch panels, made by the Electric Construction Company, of Wolverhampton, to control the motor-generators, which may be operated either as direct-current machines, taking direct current and supplying alternating current to the mains, or *vice versâ*. Between these machine switch panels and the circuit panels there is a main measuring board, upon which are mounted ammeters and two Thomson integrating wattmeters for light and heavy load, a recording ammeter, and recording voltmeter. Beyond this latter board are 10 circuit panels of Ferranti's make, originally intended for alternating-current circuits, but now adapted for control of the power mains.

At the left of the switchroom are the main alternator switchboards, both consisting of 12 switch panels, and between them the main measuring board, upon which are mounted two sets of meters, one for light and one for heavy current. At present the board on the left is a single-phase board, while that to the right is a bi-phase board. On the right-hand side of the dividing board there are at present placed two instruments for recording the output of each phase of the bi-phase plant, while on the other side are the two sets of instruments for measuring and recording the

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output of the heavy and light load of the single-phase plant; but so soon as all the plant has been changed over to bi-phase, both sides can be altered so that they measure and record the outputs of phases A and B at light and heavy loads respectively. To the left of the main switchboards there are two switchboards of 12 panels each for the single-phase distributing mains, supplying respectively Clerkenwell and St. Luke's, and further on, right in the corner of the room, a six-panel board, now used for connecting up the single-phase motor-generators to the circuit, which latter is intended for use in connecting up the bi-phase motor-generators when the complete change over to bi-phase board, and auxiliary regulation is provided by the switch pillars shown to right and left of the table and in the rear of the switch attendant's table. The whole of these switchboards, with the exception of those specifically mentioned, have been supplied by Messrs. S. Z. de Ferranti and Co. Fig. 8 shows the general appearance of the switchroom.

In the basement underneath the roadway, between the main building and the offices at City-road, and underneath those offices, is a workshop provided with some of the latest repairing tools, such as lathes, drills, shapers, etc., driven by an electric motor, which are a great advantage to the staff of the station.

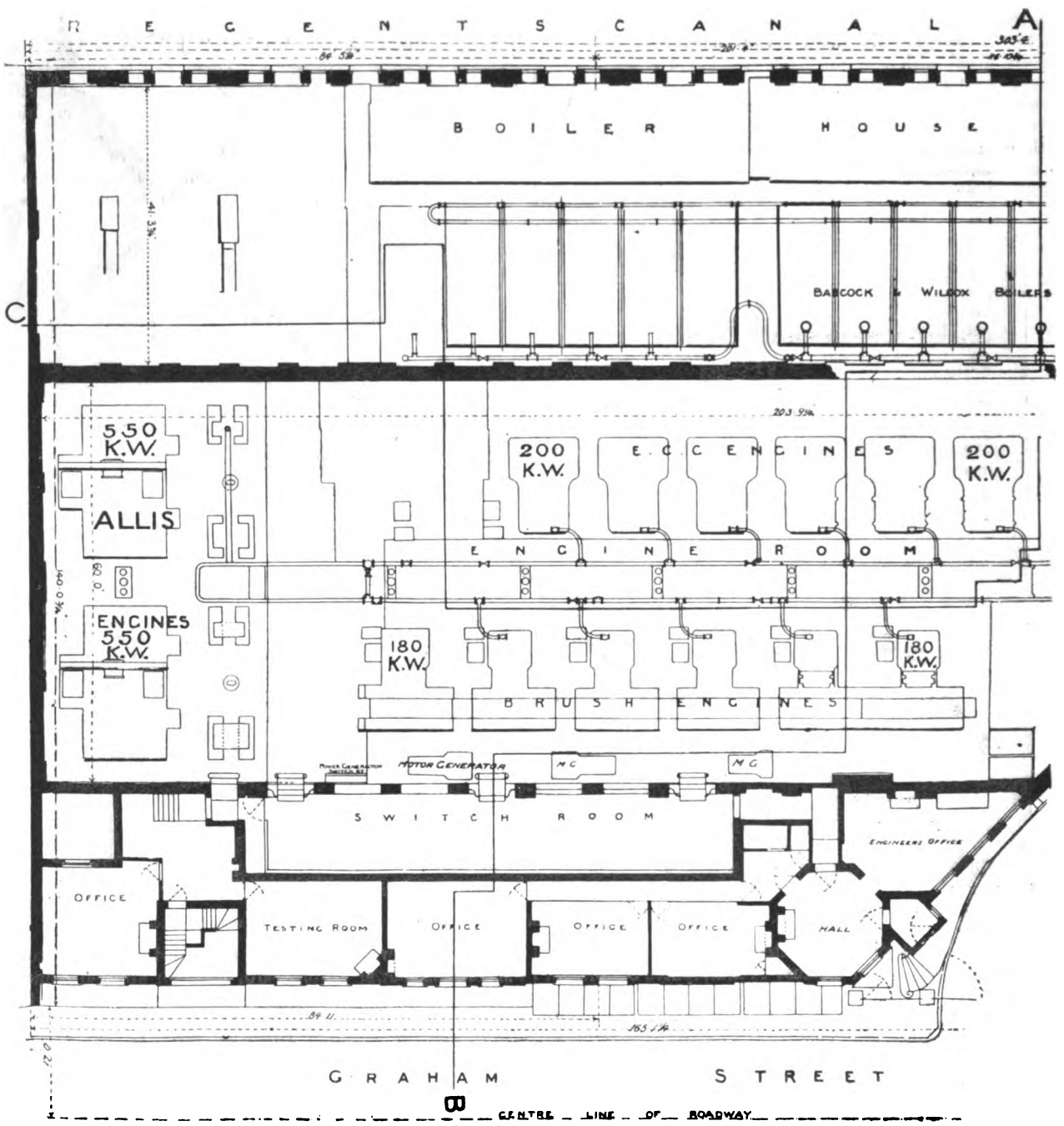

FIG. 6.—Half Plan of the St. Luke's Station, showing General Arrangements.

working is made. On the right of the alternator switchboard there are at present 12 panels for the bi-phase mains, which supply current to the districts of Western Holborn and St. Giles. There is also room for two other sets of panels of 12 each, one of which was intended for the mains for supply of the East-end districts, and the other for any further increase of the power mains or for further alternator switch panels if required.

Underneath each of the alternator panels are the handles regulating the resistance in series with the field windings of the main machines, in connection with which there is also an ammeter in each circuit. The regulation of the general voltage of the station is controlled by resistances placed on the regulating table in the front of the main measuring

Accumulators.—In a room above the landing platforms at the southern end of the building there is a battery of 302 Tudor accumulators (Fig. 9), having a capacity of 595 kilowatt-hours, which is run in parallel with the motor-generators or with the railway generators during the day or by itself at night for the supply of current to motors which may be then running in printing establishments, etc. On the same floor there is also a booster, or motor-generator, to raise the voltage sufficiently for charging, as well as a small milker for any cells which may fall "out of condition." Both these machines were supplied by the Electric Construction Company, of Wolverhampton. The switchboard, on which are double sets of terminals for charging and discharging, is also provided with an automatic motor-driven arrangement for throwing in

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or on cells, according as the voltage on the main lines falls or rises below the normal. This switchboard, designed by Signor Enrico, was supplied by Prof. Mengarini, of Rome, who also uses similar switchboards in connection with the Rome-Tivoli installation and distribution of current to the Roman Tramways Company, and is part of Prof. Mengarini's system of control of current for both lighting and power supply patented in this country and on the Continent. It is a most substantial piece of apparatus, and is an invaluable aid to a switchboard attendant. The design of the gear (Fig. 10) is apparent from the illustration. The longitudinal shafts on the face of the apparatus are made to move to and fro by the electric motor, and the pawls engage and move the connecting brushes to compensate for variations in voltage.

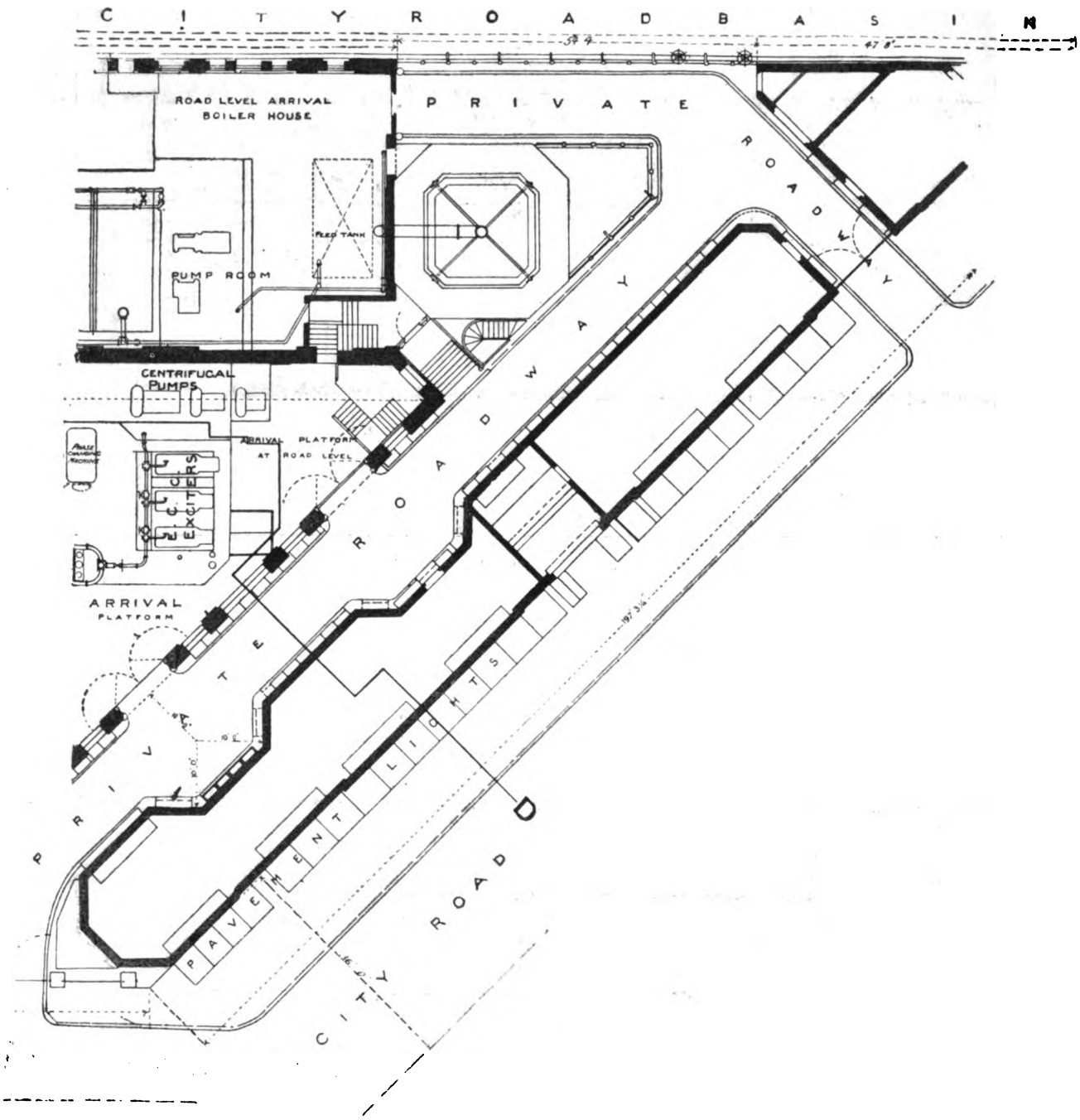

FIG. 7.—Completing Half of the Plan of the St. Luke's Station.

Systems of Distribution.—From no electric lighting station in the United Kingdom is the electrical energy sent out on so many systems as at St. Luke's station. Thus the original contracts for plant made with the Brush Company and the Electric Construction Company in 1894 were for high-frequency alternate-current plant giving 100 complete cycles per second. In order, however, to comply with the terms of the Clerkenwell order, a continuous-current system of power distribution had to be established in that district. This the company arranged to give at 530 volts, and the St. Luke's district is also equipped in the same way with direct-current mains. In extending the undertaking in other directions it was determined later to use two-phase alternating currents with a frequency of 50 complete cycles per second, and these mains have been laid throughout Western Holborn and St. Giles. From them both electric light and power are taken, and the variation in voltage is said to be less than 2½ per cent. if one phase is fully loaded while the other has no load.

Besides these three distinct systems of supply, in view of the fact that accumulators are used to supply the night load on the direct-current mains, this may almost be looked upon as a fourth system. We understand from Mr. Lawson that while engineer to the company he was proposing to extend the two-phase system of distribution over the whole area. In carrying out the work in these districts considerable interference was met with on the part of the London County Council, who refused to sanction the construction of transformer boxes under the streets. As the local authorities of St. Luke's and Clerkenwell gave their consent the matter was, however, taken before the Board of Trade, and, as will be remembered, the consent of the County Council was dispensed with. The Board of Trade decided that the construction of the boxes was to be such as to preclude the possibility of gas entering the boxes, or if it did enter, the construction was to be such that by no possibility could it remain there and cause an explosive mixture, which might be ignited by spark from the blowing of a fuse or other accidental interruption of

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circuit within the boxes. A specially ventilated form of box was thus rendered necessary, and such a box, designed by the late chief engineer of the company, was approved by the Board of Trade. The transformer boxes themselves, which at one time occupied a space 5ft. 6in. in width by 5ft. 6in. in length and 7ft. in depth, have now been made to take up a much less width under the footpath, though occupying a somewhat greater length. The output from these transformer boxes was limited to 75 kw. each. In the system of distribution certain of these

FIG. 8.—View of the Switch-Room at the St. Luke's Station

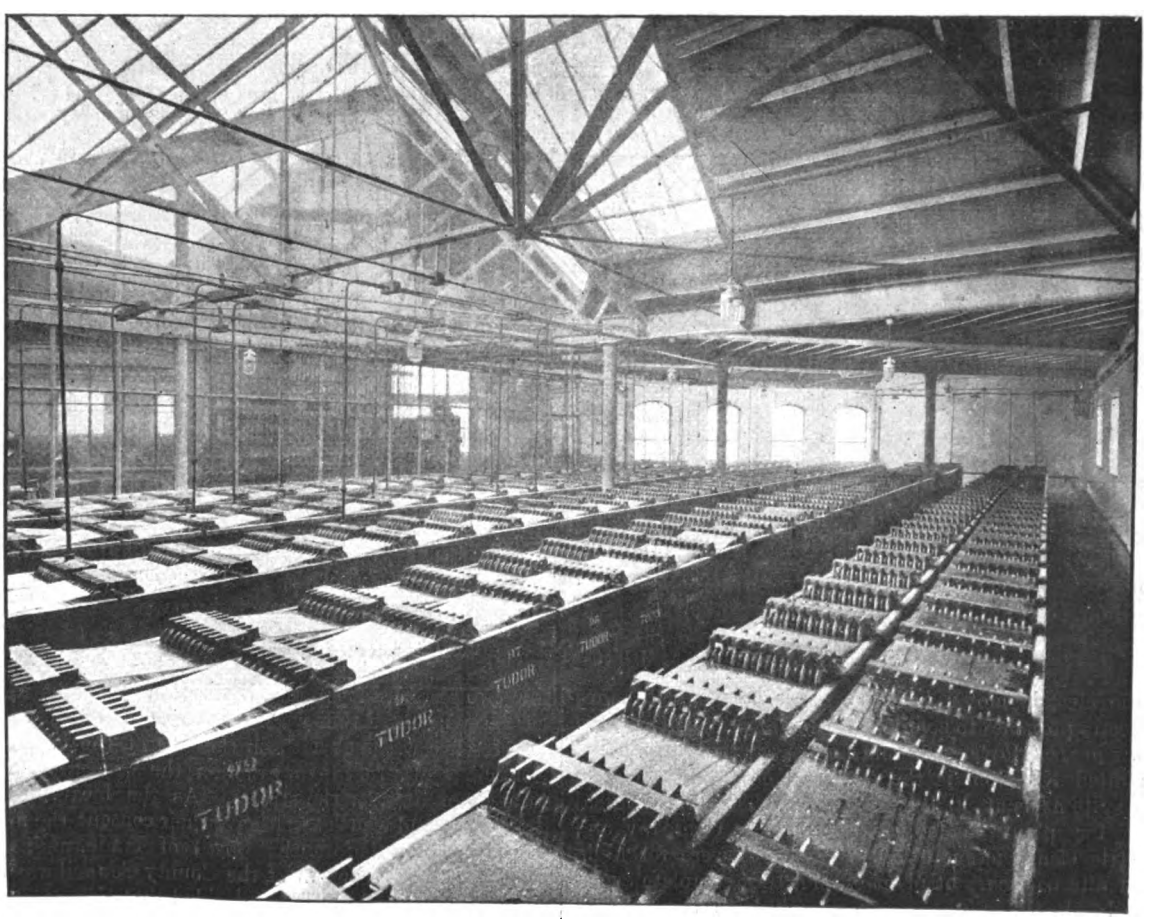

FIG. 9.—View of the Accumulator-Room with Tudor Cells.

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boxes are called "master boxes," to which the feeders from the station are laid. Between these master boxes and some others, or between some of the other boxes on each circuit, an extra cable is laid, so that a complete ring system practically prevails throughout the whole of the districts, thus enabling any one box to be made absolutely "dead" for purposes of removing transformers or for necessary work within the box. For high and low tension connections in these boxes special switching gear, designed by Mr. Lawson and Mr. C. E. Hodgkin, of the Brush Company, has been provided. By the arrangement of these switches it is impossible to open the low-tension circuit without having first opened the high-tension one, also the inner on both circuits is opened before the outer, and in closing the circuits the outer conductor of the low circuit and then the inner has first to be closed, and then the outer and inner of the high-tension circuit. Subsequent improvements tending to simplification of the general arrangement have been introduced by Mr. Lawson, Mr. Gosling, and Mr. Dallas, and are embodied in a patent covering a modified form of transformer box and its equipment. The whole of the mains throughout the district are laid on the draw-in system with cast-iron pipes. When the work was first undertaken, a sufficient number of pipes was laid in all the routes to provide for duplicate high-tension mains and for feeders from transformer boxes to various points along the routes of the low-tension mains, if required, without having to incur further expense in breaking up and reinstating streets and pavements. A separate pipe of similar size was also provided for mains for public lighting, which it was originally

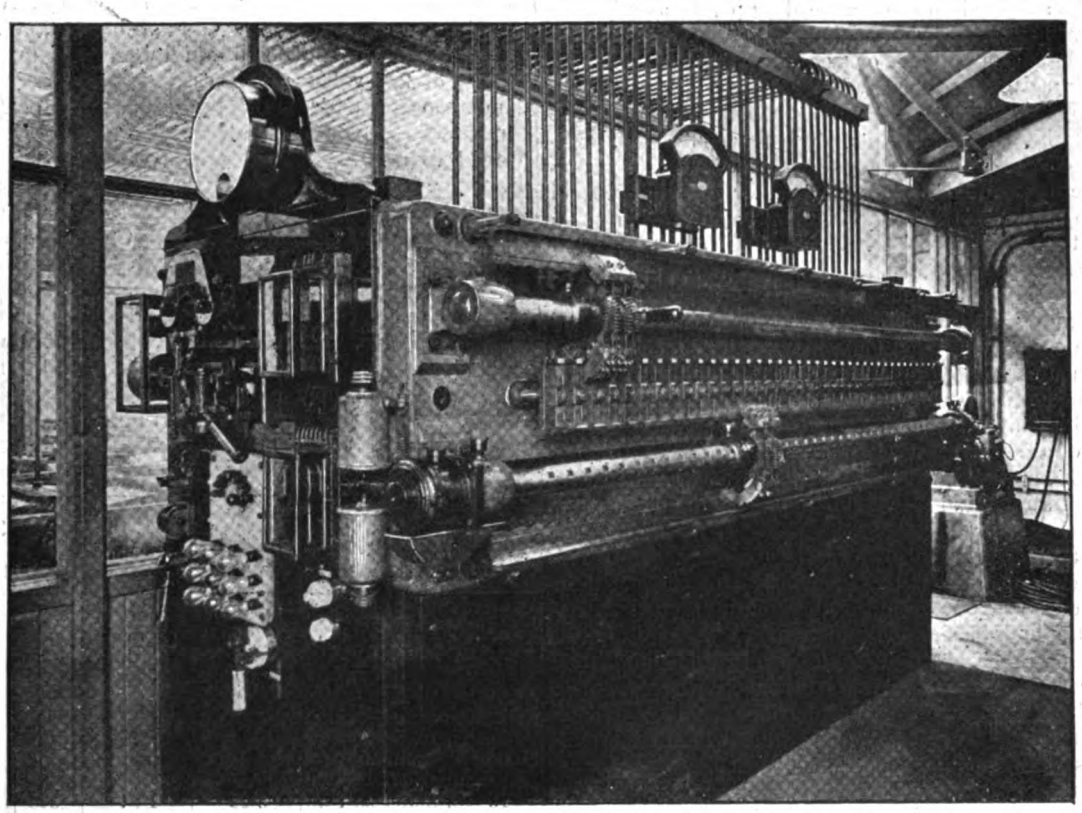

FIG. 10.—The Mengarini Voltage Regulator used with the Accumulators.

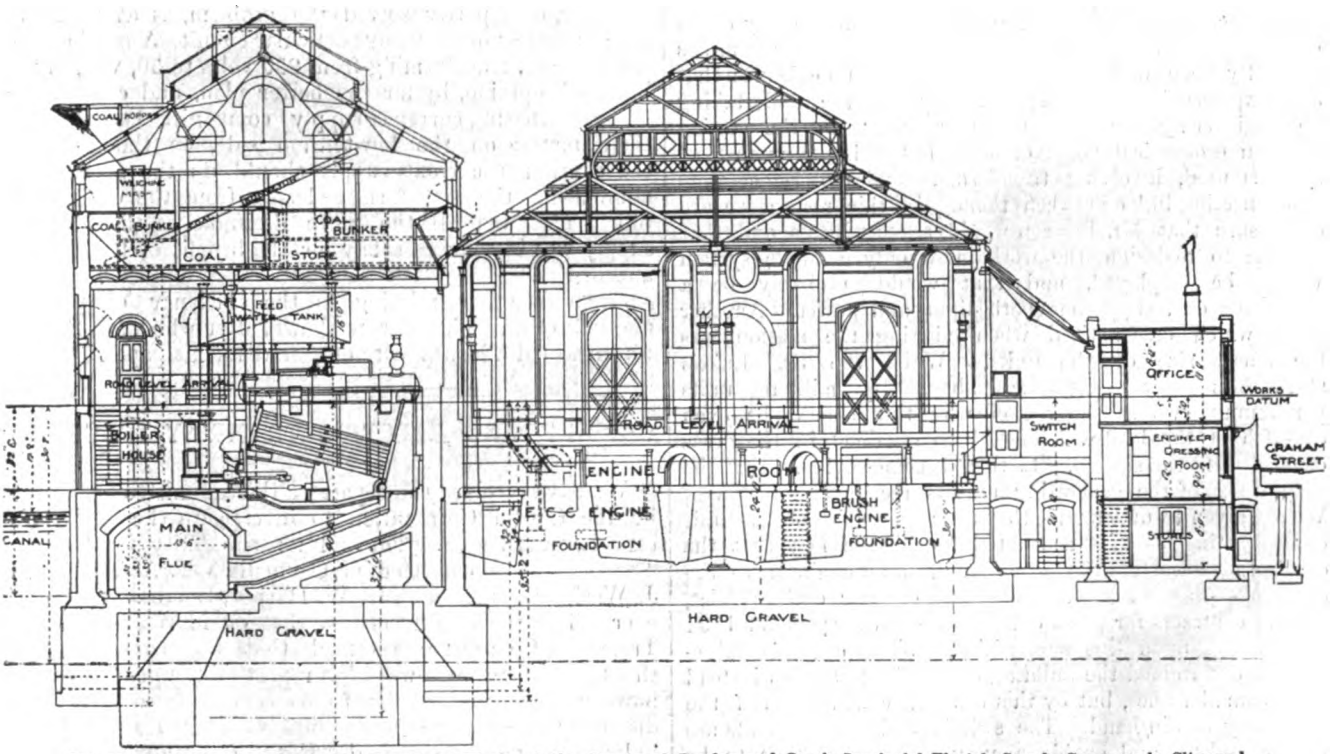

FIG. 11.—Sectional Elevation of the Electricity Works of the County of London and Brush Provincial Electric Supply Company in City-road.

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proposed by the engineer should be carried out by means of alternating arc lamps and pillar transformers, as had been done at Dover under his plans; but subsequently, on the completion of the continuous-current system for power supply to the district, he arranged for the supply of such lamps in groups of 10 each from the continuous-current mains, such groups to be switched on or off at feeding points as might be found convenient. As regards the cables used for the alternating high-tension supply on the north of the Thames, the paper-insulated, lead-covered, concentric, two-conductor cables of the British Insulated Wire Company's make are employed, while for power supply rubber-insulated, two-conductor, concentric cables of the Silvertown Company's make have been used throughout. For the low-tension distribution, which is at 100 volts, Callender jute and bitumen insulated, two-conductor, lead-covered cables are used. On the latter cables two-way house service boxes are provided at the rate of one to every four houses, the outer wire in each having a connecting link or fuse in the street service box, so that in case of necessity any house may be disconnected from the supply mains without entering the premises. In the case of supply for motive power, the service cable is vulcanised on to the rubber-insulated main, and this service cable is carried into a special service box within the consumer's premises. From this box two separate mains are carried to the motors through the usual starting and circuit-breaking appliances.

Some idea of the amount of street work may be gathered from the fact that the length of trenching in the northern districts to date is about 35 miles, the length of pipes laid is 100 miles, the high-tension and power mains about 33 miles, the low-tension cables about 40 miles, whilst the number of transformer boxes is 50. These districts, owing to their being chiefly of a business nature, have very much greater variation of load between summer and winter than the southern districts, which are chiefly residential.

Load on the Station.—During the year the maximum load on the station at any one time was 1,290 kw. The machinery of this station is easily able to negotiate twice this load, and, in fact, during this winter the company has been of considerable assistance to one of the neighbouring electrical undertakings.

Having now reviewed the works, we have to record our impression that everything which has been done has been well done. Great engineering skill is shown in every detail of the station arrangements, and the distribution system has evidently been well thought out. We see no evidence that any expense has been spared to make the undertaking an engineering success. The great fault in the station from an economical point of view is the large number of systems used, involving transformers and motor-generators as connecting links between them. In this respect we are quite sure that Mr. Lawson would agree with us, and that had he to re-design the works now only a single system would be employed, and that would probably be a polyphase one, supplying both light and power. Another point which one noticed when visiting the station was the small size of the units. While the St. Luke's station is now generating about 1¼ million units per annum, we see no reason why this should be even one-fifth of the load which could be obtained in the areas connected to the station. It then becomes evident that the present size of the generating unit is inconveniently small. We are given to understand that the present size of the unit of generating plant is accounted for by the fact that the original idea—before the appointment of an engineer to the company—was to have two stations, one for each district, and the contracts for plant entered into in the spring of 1894 were based upon this supposition. Wiser counsels subsequently determined the building of one large station instead of two smaller ones, but by this time the construction of the machinery was in hand. The switchboard arrangements are very complete, and enable a very constant voltage to be maintained.

Cable to the Cape.—As we go to press we learn that the third cable connecting us to the Cape has just been completed, and that the first message has been received through it. The cable goes *vid* Ascension, and will be a great assistance during the present war.

INSTITUTION OF ELECTRIAL ENGINEERS AT GLASGOW.

The first ordinary meeting of the Glasgow Section was held last Friday, Prof. Magnus Maclean, M.A., D.Sc., in the chair, when a paper on "The Problem of Arc Lighting from 250-Volt Supply" was read by Mr. W. B. Sayers, M.I.E.E. The lecturer began by pointing out the unsuitability of 250-volt supply for arc lighting except where the lamps were five or multiples of that number. The consumer who required a small number of lamps was almost forced to adopt enclosed arcs with their relatively poor light for a given expenditure of energy. Some experiments had been carried out by the lecturer and Mr. Wm. Lackie (assistant chief, Glasgow Corporation electricity department) to determine the relative light-giving qualities of the various sources of illumination used in electric lighting, and a table was shown giving a summary of the results. This we reproduce below, as it may prove useful to our readers. The enclosed arcs had both inner and outer globes of opal glass, the open had an opal globe, while the incandescent lamps were new ones. The light was measured by means of a grease-spot photometer and by the shadow method.

—	Open arc.	Enclosed arcs.		Incandescent lamps.	
				16 c.p.	8 c.p.
Number of lamps	5 in series	2 in series	Single	16	31
Resistance in series ...	4 ohms	12 ohms	—	—	—
Current in amperes.....	10	4	2·75	4·4	4·5
Watts	500	500	680	500	500
Relative amount of illumination, taking open arc as 1	1	·375	·01	·31	·33
Relative amount of illumination, taking 16-c.p. lamps as 1 ...	3·25	1·54	·325	1	1·07

Dealing with the best method of supplying a small number of arc lamps economically from 250-volt supply, Mr. Sayers described what he termed a "ganger switchboard" method, which has been employed by Mr. Langdon for lighting some railway station waiting-rooms; this, however, only partly solved the problem, as at least five lamps must be used on any particular circuit. A small rotary transformer, transforming from 250 volts to 50, was, in the lecturer's opinion, by far the better plan, and considering that alternating-current supply companies had to put their meters on the low-tension side, he thought that the continuous-current supply should do the same, thus eliminating the transformer losses from the consumer's bill. This was all the more desirable, as the 250-volt supply was introduced solely for the benefit of the supply authorities.

Some diagrams relating to the efficiency of various methods of arc lighting were shown, after which Mr. Sayers was awarded a hearty vote of thanks for his paper.

CARDIFF AND ELECTRIC TRAMWAY TRACTION.

We have received the report of the committee appointed by the Cardiff Corporation to investigate the subject of electric tramway traction and its suitability for Cardiff. The committee consisted of Councillors T. Andrews and J. Wesley Courtis and Mr. W. Harpur, the borough engineer. The report informs us that on March 24 last the Tramway Committee resolved that the sub-committee should visit various towns and report on the generation of power for tramway traction from a central station and from district stations, and in accordance with this resolution the following towns were visited. First of these came Dover, at which the tramways are run on the overhead system, and have a gauge of 3ft. 6in. and mileage of 3½. Plymouth is next reported on, the tramway being under construction at the time it was visited. Here, again, the overhead trolley is the system adopted. At Sheffield, also, the tramway was under construction at the date of the sub-committee's visit. Leeds is next described, an illustration

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being given of the generating station. Halifax was also visited, and after this Bradford and Liverpool. The Hull tramways are next considered, after which come Glasgow and Huddersfield. With respect to the Huddersfield trams, the sub-committee reproduce extracts of the report by Mr. K. F. Campbell, the Huddersfield borough engineer, as they bear very largely on the case of Cardiff. In this it is recommended that the tramway power-house should be kept distinct from the lighting, and that span wires be used instead of side poles. The sub-committee of Cardiff, in their general observations, state that they have inspected four different methods of power generation for electric traction. The first of these was, as at Bradford, where energy for light and power is generated by the same plant. The second was where the energy is generated in the same station, but by entirely distinct plant. The third method was that of district generating stations for both light and power, as at Liverpool, and the fourth method was that in which an entirely distinct generating station was used. The committee state that it is not easy to come to a conclusion at to the best method of generating to adopt, but think thas if a large and suitable site could be obtained near the centre of the town, it would probably be best to erect on it one large generating station for all the intended tramways, but as it did not appear probable that this site could be secured, it would be better to use a system similar to that in Liverpool, with district stations. The committee would decide as to whether electric light as well as power should be generated in these stations after visiting Hull, Liverpool, and Glasgow, which the sub-committee suggested they should do at an early date. In the addenda to the report it is stated that the borough engineer called attention to an important matter in the deciding of the type of tramcar to be used. This was the insufficient height of several railway bridges in Cardiff. The minimum allowance for a bridge under which electric overhead double-deck cars could run was 15ft. 6in. The headway under some of these bridges is much less than this, some being so low as 13ft. 5in., while several are only about 14ft. This, it is stated, will necessitate the use of single-deck cars only on most of the routes. Councillors Andrews and Courtis are, however, still of opinion that double-deck cars are much preferable to single-deck cars, and suggest that, if possible, the roadways should be lowered to meet the necessities of the case. It having been impressed upon them that it was hopeless to wish for quick delivery of engines and other plant for the tramways, the above two gentlemen urge the Corporation to forthwith prepare plans and place orders, so that the plant may be obtained as soon as possible. The cost per unit of the energy required is stated to be, at Glasgow $\frac{3}{4}$d., at Liverpool $\frac{9}{10}$d., at Bradford 1d., and at Halifax 2d.

In addition to the above report we have also the report of the borough engineer on the addenda above mentioned. He states that there are only two points in the addenda to which he would call attention. The first of these is the recommendation that the roadways under the bridges should be lowered to admit double-deck tramcars, and the second that plans be prepared and plant ordered forthwith. He has, he says, seen all along that there would be considerable difficulties with the bridges from the Council having adopted overhead electric traction. In the newly authorised tramways, however, only one difficulty would arise owing to a low bridge. With respect to the Bute-street bridge, he states that owing to the road to the north and south of the bridge passing over a canal it would not be possible to lower the road level. It would also be very difficult to alter the sewer draining the bridge pit. The bridge, having a headway of only 13ft. 5in., could not very well have the road lowered under it owing to the very steep gradient which would result. The engineer points out also that during the past 15 years the Corporation has been fighting the railway companies for the purpose of obtaining, amongst other things, that the gradients of new bridges shall not be more than 1 in 30, and states that if the Corporation altered these gradients it would be difficult to obtain better gradients in future from the railway companies. Finally, the engineer, in summing-up the question of lowering the roads under the bridges, except in one case, says emphatically, "don't." He points out, however, that instead of the ordinary double-deck cars, it would be quite possible to have double-deck trailer cars.

As to the second point, he did not see how plans could be prepared and plant ordered forthwith. Very important matters must be settled before this could be done. The first thing to be decided is whether the Tramway Committee would take energy from the Electric Lighting Committee, or would erect its own plant. In the first case, it would be for the Lighting Committee to decide upon a site, in which case the present electrical engineer would probably advise as to the equipment of the line, and in the second case it would be necessary at once to decide who should advise upon the plant and electrical equipment of the lines. Finally, he states that the total length of line now authorised will be 16·64 miles, while with those asked in the Bill now before Parliament the total length would be 30·37 miles.

The construction and conversion of the tramways would take a long time, and the work should be proceeded with cautiously and upon well-thought-out lines.

At a meeting of the Town Council on Monday last, the Tramways Committee recommended that sanction be given the committee to visit Liverpool, Glasgow, Hull, and Bradford, and advise the Corporation as to the best system of generating power for tramway traction, and after the Corporation had decided thereon, that an electrical traction engineer be appointed to carry out the adopted system, at a commencing salary of £500. An amendment was, however, proposed and carried that an electrical traction engineer be first appointed, and that the committee should then advise the Corporation as to the system to be adopted.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

247. In a four-pole dynamo armature (slotted drum type) made for 2,000 amperes at 60 volts, with four sets of brushes, the lugs connecting commutator bars to armature winding are made of iron strip (about ·095 square inch sectional area). What are the probable reasons for using iron as lugs, and of so small a sectional area?—D. T.

248. In wiring over small areas, such as workshops and factories, for electric light and power, what economy is to be expected by the use of a three-wire system of distribution over a two-wire system? Consider a specific case of a workshop 150ft. long by 30ft. wide with 200 volts on the two-wire system, and 400 volts between the outers of the three-wire system.—W. S.

ANSWERS.

Question No. 241.—If a supply company charged its consumers 2d. per unit in the daytime and 6d. per unit at night, would it pay large consumers to charge a battery of accumulators from the supply mains in the daytime and use these accumulators for their own lighting at night?

Answer to No. 241 (*awarded* 7*s.* 6*d.*).—There is no doubt that provided consumers were supplied at the rates mentioned in this question it would well repay many large customers to adopt a storage battery and use it as suggested above, and I think the estimates I give later on fully prove this. Perhaps this method of working would show to most advantage in the case of a large hotel and restaurant. If we consider an establishment such as this, with a yearly lighting bill of £1,000 and a maximum load equal to 500

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16-c.p. lamps for six hours, it will be found that a saving of over 20 per cent. per annum could be affected by the adoption of accumulators. In working out my figures I have assumed that a booster would be used to raise the voltage of the service mains sufficiently to charge a battery of the same E.M.F. as the company's supply. This would be practically the only way of charging the battery, as, if parallel charging were adopted, apart from the well-known disadvantages of this method of working, the cost of the energy which would have to be dissipated in resistances in order to bring the service voltage down to that required by the battery would make this system of lighting more expensive than desirable. One could, of course, put in a sufficient number of cells to suit the voltage of the mains, and discharge at some lower voltage, but this would not be practicable if the circuits in the building were already fully loaded, and in any case it would not be desirable to have one's lamps running at a different pressure to that of the company's service, as it might, and probably would, at some future time be found necessary to run direct instead of through the battery.

With regard to the amount I allow in my estimates for wages, I think the sum shown is a just proportion of the total paid the attendant, as he would, of course, fill in his time on the thousand and one odd jobs which crop up in most large installations. Again, as regards the rent of battery-room, although the sum allowed might not represent the letting value of the room in a district where ground is dear, it would, I think, be quite sufficient as far as its relation to the rent of the whole building is concerned. With these explanations I will now proceed with my calculations:

Estimate No. 1.—Annual consumption, 40,000 units at 6d. = £1,000; maximum load = 500 16-c.p. lamps for six hours; cost of battery, booster, switchboard, and regulating cables to suit this load, about £1,400 delivered and fixed.

Output required	40,000 units		
Losses in booster and battery, say 35 per cent.	14,000 units		
	54,000 units at 2d.	£450	0 0
Interest on capital, 3 per cent. on £1,400		42	0 0
Depreciation of plant, 10 per cent. on £1,400		140	0 0
Wages		50	0 0
Rent of battery-room		75	0 0
Contingencies		43	0 0
		800	0 0
Saving		200	0 0
Annual cost without battery		£1,000	0 0

Estimate No. 2.—Annual consumption and maximum load half that in first estimate. Cost of plant, £775.

Output required	20,000 units		
Losses, 35 per cent.	7,000 units		
	27,000 units at 2d.	£225	0 0
Interest, 3½ per cent. on £775		23	5 0
Depreciation, 10 per cent. on £775		77	10 0
Wages		50	0 0
Rent of battery-room		50	0 0
Contingencies		24	5 0
		450	0 0
Saving		50	0 0
Annual cost without battery		£500	0 0

The foregoing figures show clearly that where circumstances favour this method of working there is a decided gain in adopting it, though even on the basis of above estimates it would be found uneconomical if the annual lighting account were less than about £350. The percentage of saving, it will be seen from the above figures, is much smaller (one-half) in the second estimate than it is in estimate No. 1; and if we were to consider a case having only 13,500 units consumption per annum—*i.e.*, one-quarter of the first estimate—it would be found that there was an actual loss of about 8 per cent. It is impossible to lay down any hard-and-fast rule as to whether it would or would not pay in all cases to put down a battery for large installations, but I think it would often be worth the consumer's while to go into the question of cost for his own particular case and see what economies, if any, could be effected in this way. Even if there were no saving—provided, of course, there were no actual loss—in many cases it would be most valuable to have a battery installed in order to obviate any failure of the light caused by temporary stoppage of the company's supply.—E. E. S.

Answer to No. 241 (*awarded 7s. 6d.*).—As a general rule an affirmative answer can be given to this question, but a good deal depends on considerations that require to be taken into account for each individual installation. First, we must decide what constitutes a "large consumer." For my illustration I have taken 200 16-c.p. lamps as my basis, and any installations of a greater number of lights—other things being equal—will therefore reckon as "large consumers," and the larger the consumer the larger will be the annual saving. It may be mentioned parenthetically that installations of over 450 lights will be much more cheaply supplied by a complete private plant. Where the number of lamps installed is less than 200, the figures advanced in this answer are not so generally applicable, and no saving whatever will be effected where the lamps are as few as 120. Before going any further I may say that I do not know of any station that charges on the basis stated in the question, neither can I at the moment see in what way a supply company would differentiate between the current supplied through the day at the lower rate and that chargeable at the much higher "night" rate. I have not devoted any time to this matter, however, as it is beside the question.

Let us consider practically, therefore, the case of providing for an installation of 200 16-c.p. lamps, where the majority are in circuit during the lighting hours of the year, such as in large shops, warehouses, etc. Such an installation is generally supplied with current at a pressure of somewhere in the neighbourhood of 200 volts, and I have therefore adopted this figure as being the most representative. Taking 200 60-watt lamps, each burning 1,500 hours per annum—that is a fair average for the class of installation under discussion—we would find at the end of the year that our bill for energy supplied at 6d. per unit would be £450. That is the first point. A set of accumulators of sufficient capacity to light the installation would necessitate 108 cells with a capacity of about 450 ampere-hours, and able to give a discharge of 60 amperes for a period of, say, six hours at least. The cost of this, including all switching and regulating gear, cable, etc., and erection of the whole, would amount to, say, £400. But a battery of 108 cells cannot be charged directly off 200-volt mains, and we must therefore have a suitable booster, which will add, say, £150 to our £400 already incurred, making a total outlay of £550. The working costs—*i.e.*, attendants' wages, acid, repairs, etc.—we may put at £100 per annum.

Now comes the cost of energy required to charge the cells. This can only be arrived at approximately, but in estimating costs of this nature we had best err on the safe side by allowing more than seems absolutely necessary. Let us say, then, that we give an eight hours' charge every day during four months of the year, the same charge every second day for other four months, and during the remainder of the year every third day. This is largely in excess of what would be in reality required, but, as stated above, we may as well keep on the right side. At 2d. per unit the cost for charging works out at £123. Adding our working costs, we get a total annual expenditure of £223. But we are not done yet. We must allow for depreciation of the battery, etc., and if we take 10 per cent. per annum we will be about right. This gives us therefore, say, £600. That sum at 5 per cent. per annum for 10 years is £900; let us therefore repay the capital by adding £90 to our annual expenses, making our yearly bill £313. Deduct this sum from what it would have cost to run the lamps direct, at 6d. per unit, and we find we save £137 per annum, and at the end of 10 years have repaid the entire capital with interest.

The other matters to be taken into account in deciding on installing private batteries, are the floor space (often a very serious item) and the prevention of the acid fumes causing damage. On the other hand, we must remember the fact that such an installation is practically exempt from the loss and annoyance caused by the failure and extinction of the lights, as should the battery break down the lamps can be turned over on to the supply mains and run direct, and *vice versâ*.

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There are other ways of working out this question, but I have taken what I think the most practicable. For instance, 80 cells only could be put in, and this would dispense with the necessity of a booster; it would mean using 150-volt lamps, however, and besides being useless for running off the mains the battery could not be so economically and efficiently charged. This example typifies the numerous arrangements that can be thought of for charging in parallel and discharging in series, etc., all being less economical and efficient than using a booster. Taking the answer broadly, therefore, installations of about 200 16-c.p. lamps (or equivalent, as long as large motors are not used) would benefit very appreciably by installing private batteries if the supply companies charged as the question states. Even without the day and night rate, however, I do not see why it is not at present taken advantage of, for surely a booster—as far as the supply company is concerned—is a motor, and therefore chargeable at the low rate so many cities now offer, some even less than 2d. per unit.—J. S. F.

Answer to No. 241 (*awarded* 5*s.*).—It is very doubtful whether it would be advisable under the circumstances to put down a set of accumulators so as to be able to charge during the time of light rates. To take a case by way of illustration, suppose the current is supplied at a pressure of 115 volts, and the consumer is using, say, 30 units per day, in order to get his cells charged he will have to discharge at 100 volts. Hence he will have to buy a greater quantity of electricity, in the ratio of 100 to 115, than he actually requires; or, in other words, while he consumes 30 Board of Trade units per day, he will have to buy 34·5 units. If he uses this current, say, 300 days in the year, he will actually require 9,000 units, or with accumulators 10,350. The 9,000 units will cost £225, while the 10,350 units will cost £86. 5s. Here we have an apparent saving of £139. 15s., but we shall find that this saving will very soon be absorbed. The cost of the cells, delivered and fixed, will be very cheap at £1,000. The maintenance of these would be taken very low at 10 per cent., say £100, while the interest at 5 per cent. will be £50, or a loss on the year's working of £10. 5s. To these charges must be added rent for the room occupied by the cells, and also the cost of a man's wages in attending to them. These items will be found to come to £50 per annum, assuming that the man is only partly occupied in looking after the cells. Tabulating these figures we get:

Running Direct.				Running through Cells.			
9,600 units at 6d. =	£225	0	0	10,350 units at 2d....	£86	5	0
Balance	61	5	0	Maintenance	100	0	0
				Interest	50	0	0
				Labour and rent ...	50	0	0
	£286	5	0		£286	5	0

which shows a loss of £61. 5s. for the year. There is another loss, which is not taken into account, and is hard to calculate—viz., it is a certainty that on many occasions the cells will be overcharged—that is, current will be paid for which is only wasted—so that instead of 10,350 Board of Trade units, the consumer may probably have to pay for 15,000. Larger users would very likely find the balance against the cells lessened, until at last a limit was reached where the balance was on the other side, but long before this was arrived at we should have got to a state where, if the supply station would not reduce its rate, it would be far cheaper for the user to establish an isolated plant, driven either by a gas-engine or high-speed steam-engine.—F. J. A. M.

Question No. 242. How is the efficiency of a live steam injector for boiler-feed purposes determined? Give results of tests if possible.

Best Answer to No. 242 (*awarded* 10*s.*).—The efficiency of the injector is measured by the temperature of the current of feed water as it enters the boiler compared to its temperature before it enters the injector. The less the rise in temperature, the more the energy of the steam is utilised. Theoretically speaking, if we measure the units of heat in the feed water as it enters the boiler over and above the heat before it enters the injector, and subtract the amount from the total heat of the steam used, the result ought to give the useful work which the injector does. The action and efficiency of the injector is as follows: If 1lb. of steam in motion were mixed with 2lb. of water at rest, the result produced would be 3lb. put in motion at one-third the original velocity of the steam. The velocity of water or steam issuing into the atmosphere from the same boiler is equal to that acquired by a falling body in falling through the height of a column of the same water or steam giving the same effective pressure, and since the velocity acquired by a falling body is proportional to the square root of the height through which it fell, it follows that the velocity of the water and the steam would be proportional to the square root of their relative volumes, and as the volume of steam with one atmosphere effective pressure, or 30lb. absolute pressure, 827 times that of water, it would issue with the square root of 827 = 28·76, or, say, 29 times the velocity of the water from the same boiler. Hence the steam issuing would just balance 29 times its own weight of water trying to issue from the boiler. The number of units of heat in 1lb. of steam of 30lb. absolute pressure is 1,159 F., and assuming the original temperature of the feed water at 100deg., the rise of temperature of the feed water would be

$$= \frac{1{,}159 \text{ units steam} - 100\text{deg. water}}{29+1} = 35{\cdot}3 \text{ F.}$$

with steam of one atmosphere effective pressure, or 30lb. per square inch absolute pressure.—TELFORD.

FORTHCOMING EVENTS.

FRIDAY, FEB. 23.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Bearing Springs," by Messrs. B. Humphrey and H. E. O'Brien.

Physical Society.—At 5 p.m., discussion on Prof. Lodge's presidential address on "The Controversy concerning Volta's Contact Force." Description and exhibits of photographs of Sound Waves and Kinematographical Demonstration of the Evolutions of Reflected Wave Fronts; a New Sendoscope; Diffraction Colour Photographs and Artificial Parhelia.

SATURDAY, FEB. 24.

Manchester Society of Junior Electrical Engineers.—At 7.30 p.m., ordinary meeting, at Manchester. Paper on "Destructors and their Application to Electric Light and Power Stations," by Mr. A. Rothwell.

North-East Coast Institution of Engineers and Shipbuilders.—At West Hartlepool, ordinary meeting. Discussion on Mr. S. J. P. Thearle's paper on "The Distribution of Materials in Upper Works of Large Steamers," and a paper on "Some Considerations affecting the Training of Young Engineers," by Mr. W. C. Borrowman, Wh.Sch.

TUESDAY, FEB. 27.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Paper on "Corrosion of Marine Boilers," by Mr. J. Dewrance, and, time permitting, papers on "Economical Railway Construction in New South Wales," by Mr. Henry Deane, and "The Tocopilla Railway," by Mr. Robert Stirling.

WEDNESDAY, FEB. 28.

Society of Arts.—At 8 p.m., ordinary meeting. Paper on "Pneumatic Dispatch," by Prof. C. A. Carus Wilson.

THURSDAY, MARCH 1.

Civil and Mechanical Engineers' Society.—At 8 p.m., ordinary meeting. Paper on "Ventilation of Large Buildings," by Mr. O'Gorman.

Chemical Society.—At 8 p.m., ordinary meeting.

FRIDAY, MARCH 2.

Electro-Harmonic Society.—At 8 p.m., at Café Monico, evening concert (ladies' night).

Physical Society.—At 4.30 p.m., at University College, papers on "The Relative Rates of Effusion of Argon, Helium, and some other Gases," by Dr. F. G. Donnan; "On the Distillation of Liquid Air and the Composition of the Gaseous and Liquid Phases," by Mr. E. C. C. Baly; "The Reversibility of Galvanic Cells," by Mr. T. S. Moore; and "On the Damping of Galvanometer Needles," by Mr. M. Solomon.

Institution of Junior Engineers.—At 8 p.m., at Westminster Palace Hotel, paper on "Electrolytic Zinc as a Protective Metallic Coating for Iron and Steel," by Mr. W. Paddon.

SATURDAY, MARCH 3.

Institution of Junior Engineers.—At 3 p.m., visit to Messrs. Maudslay, Sons, and Field's Boiler Works, E. Greenwich.

Royal Institution.—At 3 p.m., Lecture I. on "Polarised Light," by Lord Rayleigh.

Institution of Electrical Engineers.—At 2.30 p.m., students' visit to the Waterloo and City Railway generating station.

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MUNICIPAL TRADING.

The promise of Mr. Balfour to place the Joint Committee on this question on the paper at an early date is sufficient excuse for reference to it. A careful examination of the actions and proposed actions of municipalities will show that the evil is spreading rapidly. At least, we denominate it an evil till its limits have been defined. The unfortunate condition of affairs is very simple. Those whose business is endangered by what they term municipal trading are alive to the position, but even amongst themselves they are not agreed as to what is and what is not "municipal trading"; hence any combined influence is almost impossible. We have endeavoured in time gone by to indicate the true principles governing municipal action, but found that all parties were agreed upon one point, to accept any principle, or so-called principle, that excluded their particular branch of work, no matter what other branch or branches were included. We venture, then, to prophesy that unless a total change comes over the scene, the proposed Joint Committee will effect nothing, will assert a few platitudes, and the whole thing will collapse, unless, indeed, the latter end of the matter is not worse than the first, and the result be in favour of the extension of municipal actions. The supporters of municipal trading are influential, combined, and know what they want and intend to have it if possible, hence are likely to be successful. Is it too late to urge the necessity of a settled, combined, and temperate programme from those antagonistic to the extension of municipal trading? The common expression, "Parliament will see that no great harm arises," is a consolatory figment in the brain of the lazy man whose toes do not happen for the moment to be trodden on. He sleeps comfortably, not realising that every new departure permitted by Parliament is prohibitive of standing still or going back. If A has permission to trade, why not B, and if A and B, then certainly C, and so on *ad infinitum*. Without harking back upon old ground previously discussed, let us ask whether the whole aim of trading—municipal or otherwise—is not summed up in the phrase "for making profits"? If that be so, cannot the object of the Joint Committee be restricted to the determination of the righteousness and the justness of any authority doing anything for the purpose of making a profit. Thrash that point threadbare, and by so doing bed-rock foundations ought to be obtained. To us the cry, "Relief of the rates," always seems a slim way of deception. The real object in most cases is to obtain extra rates from one branch of the community for the benefit of another class. Our interests being mainly electrical, the examples we require are necessarily those concerned with the prosperity of the industry. What, then, are the directions in which municipal action has injured or restricted the development of this particular industry? This is the question which no doubt will come up for discussion before the Joint Committee. Has the industry formulated and agreed upon its views, or is the evidence to be tendered that of individuals only? If the industry is divided in opinion,

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one moiety agreeing with municipal action, the other moiety deprecating such action, it will be best to know this, while it is more than probable that all agree up to a point about certain things, then diverge. Again, what is this common agreement, and where does divergence begin? Months have passed since the promise of a Joint Committee was first given, yet it would be difficult to say that any real step has been made to prepare evidence. Grumbling there is, and there for the most part it ends. What is wanted is more funds, facts to the purpose, agreement upon objects required, energy to make influence felt, and thorough combination.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ANOTHER STORY ABOUT A VALVE SPINDLE.

SIR,—The genus draughtsman is an interesting study, for besides being able to do such tricks as drawing straight lines and circles, he has also a most wonderful trick of catching anything that is flying about. As an example of his catching powers, a draughtsman once actnally made a drawing of a valve right off his own bat with absolutely no assistance from anybody, and he made the valve spindle 2½in. diameter because he happened to have a parallel rule exactly that width. After a number of valves had been made, the works manager came along one day and said: "Look here, we've run out of 2⅝in. rolled steel bar, but have some which measures 2½in. full, and which will just clean up to $2\frac{7}{16}$in., so we'll make that the standard in future. As trade generally was a bit slack at the time, the draughtsman did not think it worth while risking his berth by saying what he thought, and so the dimension was altered. More valve spindles were made and put into store, and things went on, until one day a powerful Manchester man got regulating an engine and tore the spindle clean in half. He made haste to send for another, and, like so many who send telegrams, just arranged the words that it cost the regulation 6d. Unfortunately, he omitted to give the engine number, and consequently one of the modified spindles was drawn from store and sent off. When it was delivered the Manchester man said a text, and as the works manager was one of his own particular pets, and therefore, of course, infallible, he decided it must be the draughtsman's fault that it did not fit. Indeed, he was so sure of this, and at the same time so annoyed at breaking down his own engine, that he went to an institution and told the harrowing story to an audience composed largely of telegraphists, housewirers, and young men whose parents pay £100 a year to companies requiring money to pay dividends with.

Thus it came about that a draughtsman who, from years of hard practical experience knew more solid engineering than the majority of the audience, was held up as a laughing stock by the funny man of the institution—a man, by the way, who owes most of his fame as an engineer to the plodding, self-sacrificing draughtsman, whose only fault is that he wasn't born with the gift of the gab.

Some appear to think that a draughtsman is paid to design and draw machines, but this is a mistake. The real designing is a complicated affair as it is first done by the managing director. Then come the chief engineer, the superintending engineer, the electrician, the works manager, the secretary, the cashier, and they do it over again. All *agree*, however, that the draughtsman does his part—*he makes the mistakes*. Occasionally a draughtsman turns out something extra special, and then the electrician calls it after his own name, or the engineer gives it a fancy title, such as "patent turtle-back machine." In due course a description appears in the technical journals, anybody's name being mentioned except the one man who has done the work, the poor devil of a draughtsman, whose duty it is to clothe ideas with living, useful mechanism. Let us suppose for a moment that someone comes to a sculptor and suggests an idea for a subject, which the sculptor then proceeds to work at patiently and lovingly until he has created a beautiful statue, a bronze casting being afterwards made from it for exhibition. Now to whom does a discerning public give the credit for turning out such a work? Surely not to the man who suggested the bare idea, nor yet to the moulder who poured the metal into the casting, but *to the sculptor*—to the man whose nearest analogy in engineering practice is a capable draughtsman.—Yours, etc.,

E. KILBURN SCOTT.

194, Victoria-road, Old Charlton, Kent, Feb. 19, 1900.

[N.B.—We do not think that the case put by Mr. Scott at the end of his letter is a parallel one to the relation which exists between a designer and a draughtsman. While bad mechanical detail may damn a good design, the most capable draughtsman cannot make a perpetual-motion machine to go, in spite of the ideas and sketches of its inventor. In any case, there is no need to spread the boiling oil reserved by Mr. Raworth for draughtsmen over the whole of those attending the Institution meetings.—ED. *E. E.*]

AN ELECTROLYTIC CENTRIFUGAL PROCESS FOR THE PRODUCTION OF COPPER TUBES.

SIR,—In regard to Mr. Henry Wilde's letter appearing in your issue of February 16, I should like to state that I quite agree with Mr. Henry Wilde that there is nothing new in revolving a cathode, as this has been practised for a great number of years. Mr. Wilde's letter makes it quite clear that his process has no feature in common with my centrifugal process.

What I claim to have discovered is that if the cathode is revolved at a sufficiently high speed, so as to generate an appreciable amount of centrifugal force, remarkably smooth deposits can be obtained at very high current densities, and the voltage is considerably reduced. I have also observed that there is a critical speed at which excellent copper deposits can be obtained which cannot be obtained at a lower speed.

I am well acquainted with Mr. Henry Wilde's patent in which he claims imparting a rapid whirling or rotating motion to a depositing solution either by means of paddles or revolving the electrodes. I am not aware that Mr. Henry Wilde had discovered that by rotating the cathode at a certain speed that smooth deposits of copper could be obtained at remarkably high current densities even when a very large percentage of free acid is present in the electrolyte. If Mr. Wilde had appreciated the advantages of centrifugal force, why does he state in his patent that a paddle revolved in the electrolyte is a good substitute for revolving the electrodes? The American patent authorities, after carefully studying Mr. Henry Wilde's patent, have decided to grant me a patent for my centrifugal process.—Yours, etc., SHERARD COWPER-COLES.

Grosvenor-mansions, Victoria-street, Westminster,
Feb. 20, 1900.

REVIEWS.

The Commercial and Business Aspects of Municipal Electricity Supply: A Practical Handbook for the Use of Electrical Engineers to Municipal Corporations and Members of Municipal Electrical Committees. By ALFRED H. GIBBINGS, M.I.E.E., past-president M.E.A., etc. Published by the author. Price, 15s.

In a measure it is of set purpose that we have delayed notice of this book. Last year the Government promised a Joint Committee to enquire into the why's and wherefore's of municipal enterprise. The London Chamber of Commerce has a committee watching municipal work, and the forthcoming meeting of the Associated Chambers of Commerce is to discuss the question. The immediate future ought, then, to bring contending factions face to face. Mr. Gibbings, a gentleman of great

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experience and of acknowledged ability, has in this work supplied the notes for the brief of those who assume that municipalities may, if they think fit, trade. The whole book looks at municipal supply from a business point of view—to increase trade, satisfy customers, and earn a good profit while selling at a low price. The work must be judged from that point of view, and when so judged must be pronounced excellent. The experience given is largely the author's own at Bradford. There are a dozen chapters dealing with different phases of the subject, and the majority of the conclusions put forward are justified by the reasoning, when the assumptions are granted. The moral of the first chapter or, as it is called, section is that "the gas committee and the electricity committee should, at any rate, be entirely separate and distinct from each other in every township"; while the next section, on wiring, merely leaves the very strong impression that the author favours it being done by the authority. He sees "there are, indeed, very plausible reasons both for and against such a movement"; but while carefully discussing the requirements and the powers of the authority, he shows how, even if the present powers are insufficient, further powers may be obtained, and gives specimen rulings of books for a wiring department. Section III. is one of the best in the book, explaining the various ways of charging for electrical energy, concluding "that finality is by no means reached, and the problem but incompletely solved as regards this subject." Most of these methods have been from time to time discussed in these columns, so that we need enter into no detail, and merely say we agree entirely with the conclusions of the author. Section IV. deals with electric motive power and contains much valuable information for an electrical engineer, especially in the tabulated details as to the power absorbed by various tools and machines. Of course, the figures given cannot be applied to every case, but may be taken as approximately correct, the necessary differences being allowed for in particular cases. Experimental results are given in some instances, also comparative costs. Of course, all this information is collected and given to show the effect of power demand upon the central station. The three following sections deal respectively with the hiring out of apparatus, free wiring, and the free supply of incandescent lamps. Again, upon the assumption that the municipality runs a business concern, all that the author says is very much to the point. It may be noticed here that throughout this work we have a large number of specimen rulings of books of account, etc., as required in the organisation of a supply station; also the description of various pieces of apparatus, with illustrations where necessary. Sufficient has been said to indicate the character of the work, the later sections of which deal with prepayment, side-street lighting, showrooms, outlying districts, purposes to which electrical energy may be applied, etc., all interesting and useful, though distinctly treating the matters from the one standpoint. From our point of view, holding strongly to the conviction that municipal authorities are overstepping the just bounds of municipal duty when they enter into "trading," as trading is vulgarly understood, we heartily welcome this work as giving us the inner views of those who thoroughly believe in municipal trading and would carry it to its legitimate lengths. It certainly should be read by all those engaged or even interested in municipal work, though we ought to emphasise the fact that the greater part of the information is useful to the profession generally even when not directly connected with municipalities, and may be read with advantage and profit.

Magnetism and Electricity for Beginners. By H. E. HADLEY. Price 2s. 6d. Macmillan and Co.

All books of this class have to be read from a somewhat narrow standpoint. The scholastic mind always has looming largely in its horizon the question of examination; and examiners are a funny tribe. At the end of next century the scholastic mind will have arrived at some conception of the views of the practical mind of to-day. If, then, we accept this book as an elementary school-book we should exclaim, Excellent, excellent; but if we are to ask how far the real development agrees with the pro-scholastic we should say, so so. Thus we do not find anywhere clearly indicated in this or similar books that while magnetic phenomena can stand alone, so far as we know, electric phenomena are in a different category. Energy absorption in the one case is fleeting, in the other continuous. Even from the scholastic view it might be better to treat some questions from another point than is usually done. Take, as an example, magnetic screens, ably treated by the author, but which might perhaps be better treated by starting from a perfect screen, such as concentric spheres of soft iron. In this no external lines are detected; break anywhere, and external lines are detected. The author leads up to the more perfect; we should prefer to lead from it. Probably there is little in the difference. Then distribution of charge is elegantly treated in the usual way, but the pupil will not readily realise that the charge depends in practice far more upon the position of external conductors than upon shape of the charged body. Again, magnetic induction; is it a phenomenon accounted for by simply stating that a second magnetic substance is somehow brought into the field of the first, and thus receives magnetic lines of force? or is there any other explanation, and is its value simply proportioned to the number of lines engaged, other things being constant? If our students are to continue to spend a large part of their time in describing and classifying phenomena, all well and good. This work is not unimportant, and this book is one of the best we have read for that object. It is well and amply illustrated. Its explanations are clear, and its experimental work of a kind calculated to bring out the point required. In other words, accepting the method of treatment adopted, Mr. Hadley has certainly produced a thoroughly good book.

THE EFFECTS OF THE SNOWSTORM.

The effects of the snowstorm and blizzard experienced in England this last week has still further added to the list of damage to the telegraphic and telephonic systems throughout the kingdom. The news as to the actual breakdowns was slow in coming to hand, owing to the fact that telegraphic communication was completely stopped to all the large towns along the East Coast and to most places in Scotland. Thus out of 20 wires connecting London and Glasgow, not one remained in operation after the storm, and only three were working up to mid-day on Saturday last. A notice issued from the General Post Office at Glasgow intimates that the lines were down to all the following places: Innellan, Kirn, Inverary, Kilcreggan, Rosneath, Row, Kilmun, Strone, Blairmore, Cove, Tarbert, Luss, Skelmorlie, Wemyss Bay, Inverkip, Balfron, Island of Bute, Dunoon, Hunter's Quay, Sandbank, Clachaig, Garelochhead, Shandon, Arden, Tighnabruaich, Millhouse, Kames, etc. In fact, practically all connection to the North of Scotland was interrupted, and only two wires going to Liverpool and Manchester out of 12 were available for service. Edinburgh was isolated in a similar way, and communication was first restored *vid* Manchester and Liverpool. On the East Coast the effect of the blizzard was felt particularly. Thus Hull, Scarborough, York, Newcastle, and the surrounding towns were all isolated from each other as far as telephonic and telegraphic communication was concerned, and the local telegraphic services were also disorganised. Similar news comes from some parts of Wales, and from Ireland we learn that at Limerick telegraph poles gave way in various parts of the town, which quite disorganised the service. This town was isolated from Cork and Dublin, but communication was still possible between these two towns. In London a similar state of disorganisation, but to a smaller degree, was to be found. Thus all the connections both of the General Post Office and the National Telephone Company to Gravesend were interrupted, and the Telephone Company also experienced a considerable amount of damage to its system in other suburban districts. The outcome of the whole matter is to emphasise the need of such underground cables as are being laid between London and Birmingham.

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Naturally, a scheme of this kind involves a very large capital outlay and takes time to lay down, but we are glad to know that the Post Office have recognised the need of such underground services, and that the whole of the iron pipe to contain this cable has been laid. The great portion of the cable has also been drawn into this pipe, and we believe that the system would now have been completed but for the disastrous fire which took place some few months back at the works of the Western Electric Company at Silvertown. When this connection is completed, we trust that further extensions will be made until all the large commercial centres in the kingdom have telegraphic and telephonic connections which are independent of the weather.

While on this subject, we may refer to the action the City of London Corporation is taking with the view to safeguarding the public against the dangers of overhead wires in the City. It has been decided to enforce the attachment to all supports of these overhead wires of labels showing to whom they belong. Failure to mark such supports with identifying symbols will entail a fine of £5 on the owner with a further fine of £2 per day for every day after yesterday for every support unlabelled. The Corporation have power under the Act to destroy communications which are not so identified, but we trust that the need for such stringent measures will not arise.

LIGHTNING AND ELECTRIC LAMPS.

In a recent issue of *Nature* Mr. Sydney Webb, of Dover, describes in a letter some most curious lightning effects he obtained by photograph in October last. He was endeavouring at the time to get photographs of lightning, but owing to the limited horizon available from the position of the camera it was not pointed in the direction where the most numerous flashes occurred. It included in its field several of the Brush arc lamps used to light the town. In developing a few of the exposures to see whether the photographs of lightning discharges had been obtained, Mr. Webb noticed some peculiar discharges taking place from the Brush arc lamps to the ground. A series of negatives were then taken, including these arc lamps in the field, and also of others in which the system of incandescent lamps, which are festooned over the streets of Dover in the season, were shown. Mr. Webb's first impression was that the electric discharges of lightning produced corresponding ones from the lamps, but the number of lines seen on the photographs could not be explained in this way. The photographs were accordingly sent to Sir George Stokes, who gives in *Nature* his views at considerable length. He draws attention to the fact that in the photographs showing the discharges from the arc lamps the path to earth of the supposed secondary charge does not take place through the iron column of the lamp-posts, as would be expected. It appears instead striking the ground some considerable distance from the base of the lamp-post. This discharge is also characterised on the plate by a series of dots of lights somewhat similar to the stratification in a vacuum tube. The similarity of the path of discharge from the individual lamp to the earth is excessively curious, and it must also be noticed that in every photo the same similarity is to be seen in the small flashes which take place from lamp to lamp. As regards the stratification which is seen in practically all the lines of discharge, Sir G. Stokes has two suggestions to make. One is that it might have something to do with the way in which the path crossed a series of electromagnetic waves like those of light, except as to the scale of wave length. Another, which seems more probable, is that they are of the nature of a strong discharge in vacuum tubes. He points out that in an ordinary tube it requires a very good exhaust to get strata 1in. thick. In the case in point, under atmospheric pressure the strata was a foot or more in thickness. However, with the Geissler tube the strata are closer in the capillary part, where the current is congested, than in the broad part. He suggests that it is possible that the discharges shown in the photographs, which are unconfined, laterally these wide strata, are possible with a small density of current. He also remarks that the intensity of the discharges decrease as they go from the lamp to the ground, from which it would seem that the current gradually expends itself in electrifying the air. If this is the case, the long discharges represented in Mr. Webb's photographs may not be so dangerous as some of them look. Sir George Stokes concludes that until more is known of the subject it may be well to avoid standing in the proximity of these overhead lamps during a thunderstorm. As Mr. Sydney Webb points out, the details of these discharges are exceedingly confusing to anyone not acquainted with the relative position of the lamps, and a photograph taken in daylight with the camera in the same position as when the night photographs were taken would be of great value in clearing up what actually happened. It seems to us very unlikely that discharges so exactly similar in path should take place round a number of lamps at a considerable distance apart. The effect could be produced optically, only the size figure apparently made by the discharge on the photographic plate precludes this supposition.

LEICESTER ELECTRICITY WORKS.

On the 14th inst. an enquiry was held at Leicester with reference to the application to the Local Government Board for sanction to a loan of £100,000 for the purposes of the electric lighting undertaking. The enquiry was held by Colonel H. F. Turner, C.B., R.E., and there was no opposition raised to the granting of the loan. Mr. Alfred Colson, engineer and manager of the gas and electric lighting department, gave the following interesting evidence in support of the application: In the year 1890 the Corporation obtained a provisional order for the supply of electricity, and in August, 1893, a Local Government Board enquiry was held with reference to the application of the Corporation for a loan for the purposes of carrying out a complete installation for the supply of the electric light. The amount of £42,574 was authorised by the Board in the following September. In the same year contracts were made for the erection of plant and the laying of the necessary cables, and, the installation being sufficiently complete, a supply of current was first given on Dec. 19, 1894. The demand for current was so satisfactory that a second application had to be made in 1897 for additional borrowing powers, and authority was obtained for raising a further sum of £33,719, making a total, together with discount on stock, etc., of £78,207. The whole of this money so authorised has been spent, and the Corporation are now compelled to apply for £100,000 to enable them to extend their central station and provide the necessary plant and cables needed to cope with the rapidly increasing demand for current. The capacity of the present central station is equal to 1,400 kw., or, allowing for a spare machine, say 1,050 kw., with a total boiler capacity somewhat short of this. The maximum demand for electricity this winter has reached 880 kw., leaving a margin of 170 kw. only. The following figures show the growth of the undertaking from the commencement, at the end of 1894, down to the present time:

Date.	Meters fixed.	Lamps installed. 8 c.p.	Maximum load. Kilowatts.	Total output. Units.	Increase per annum.
Dec., 1894.....	42	5,310	66	1,587	—
June, 1895 ...	101	6,574	114	31,379	—
Dec., 1895.....	158	7,554	176	92,101	—
June, 1896 ...	211	14,436	206	95,958	—
Dec., 1896.....	250	16 690	359	147,421	60%
June, 1897 ...	286	17,896	357	145,341	—
Dec., 1897.....	344	27,578	514	204,084	38%
June, 1898 ...	398	31,255	495	224 642	—
Dec., 1898.....	479	38,490	662	302,531	48%
June, 1899.....	555	45,148	649	342,327	—
Dec., 1899.....	632	52,526	880	437,943	45%
Feb., 1900.....	702	54,222	—	—	—

It will be noticed from the figures given in this table that since the last enquiry, in 1897, the demand for current has more than doubled. At that time 5d. per unit was being charged. From June 30 last this was reduced to 4d. per unit for lighting and 2d. per unit for motors. This latter reduction has resulted in 31 motors being fixed, and there is reason to anticipate a rapid increase in this number.

There is every indication that the electric light is becoming more and more popular in the town, the desire for current being never so great as at the present time. There are now being wired 37 premises, representing 3,500 lamps, and in addition there are a large number of other premises under consideration, and which, undoubtedly, will be wired before next autumn. In

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view of the increasing number of lamps installed, together with the strong feeling in favour of the electric light throughout the town, it is clear that a substantial increase of plant and cables must be provided before next winter. This being so, he had recommended a considerable extension of the central station, which, when completed, will contain four additional alternators of 1,000 kw. each. To meet the immediate probable requirements, he had advised the erection of two of these machines and five boilers, together with the necessary auxiliary apparatus. This would bring the capacity of the station up to 3,400 kw., with an equivalent amount of boiler power. He also advised an extension of both high and low tension mains, together with the necessary sub-stations, transformers, etc. The present length of cable laid amounts to—high-tension, 17 miles; low-tension, 19 miles; or a total of 36 miles, all concentric. The whole of the proposed extensions were shown on drawings submitted. The following is Mr. Colson's estimate of the cost of the work referred to:

Engine and dynamo room—superstructure	£6,461	
Boiler-house—superstructure	2,322	
Foundations for building and machinery	8,430	
Chimney stack and flue	770	
		17,983
Engines and alternators (two sets)	20,429	
Exciters (two sets)	1,200	
Boilers (five), steam-pipes, etc.	4,500	
Pumps	421	
Economisers	2,280	
Steam, exhaust, and water pipes	1,577	
Travelling crane	950	
Switch gear	2,500	
		33,857
High-tension mains into town	4,200	
High and low tension distributing cables	10,200	
Pipes and trenching	4,764	
Services	2,500	
Joint and fuse boxes	1,900	
Meters	2,625	
Sub-stations and transformers	7,190	
Switch gear for chambers	1,049	
		34,428
		£86,268
Add amount overspent to June 30 last		13,732
		£100,000

The total cost of these extensions amounts to £86,268, which, together with the sum of £13,732 already overspent on capital account, amounts to £100,000, the sum the Corporation are applying for. The sum of £13,732 referred to as overspent is made up as follows:

Machinery	£3,871
Cables	6,907
Transformers	2,637
Meters	215
Instruments	102
	£13,732

Mr. Colson, in answer to questions, added that within the last 48 hours he had had quite a bundle of applications for the electric light. The figures connected with the department had now been brought up to date, and on the past half-year there was a profit of £1,089, and after paying off the total net loss at the end of June, 1899—namely, £342—there was a net gain of £747. Those figures had not yet been audited, but he did not doubt their accuracy. And that profit was obtained, too, after a reduction in the price of current. He knew of no undertaking occupying so enviable a position as regards capital outlay as their Leicester works, or which got such eminently satisfactory results as regarded expenditure; indeed, experts said the Leicester Corporation undertaking was the most up-to-date and scientific of any in the country. He knew of none to surpass it, and very few to equal it. The capital outlay worked out at only £65 per kilowatt capacity, and there was not another electricity works undertaking in the country that showed anything like so favourable a figure for capital expenditure, and the new station would work out at a still less cost per kilowatt. At the present rate he did not think it would be many years before they would be applying for another loan—he did not think more than three or four years.

DUBLIN UNITED TRAMWAYS.

Last week we gave a condensed report of the half-yearly meeting of the Dublin United Tramways Company. Since that date further information has reached us as to the facts then stated with regard to the power stations of the tramways. Thus it was stated at the meeting that the cars now in operation numbered 180, while it was hoped to have 70 more running by August next. Large savings were looked forward to also in the cost of production of electrical energy in the Ringsend power station. The effect of this station had not been materially felt during last half-year, as, although it was started in August, the whole of the plant had just reached completion. On this subject Mr. Horace Parshall, the engineer to the company, had drawn up a report. The report stated that owing to the demand for power during the horse show week, and the failure of certain machinery at Ballsbridge, the station was started in August before the building was completely enclosed and when but two of the engines out of six had been erected; the condensing and auxiliary plant also were not completed. With the exception of the economisers, the arrangements at Ringsend had only just been practically brought to completion. The results obtained in working prior to this period showed that current could be produced for about one-half of that at which it has been produced heretofore at Ballsbridge and Clontarf, and with the auxiliary plant in a state of completion, with the exception of the economisers, which had not yet been put to work, there had been a further saving in coal consumption of about 30 per cent. Thus the most sanguine views as to the economy to be gained in the working of this station had been fully verified. Apart from the absolute cost of generation of current, in which there would be a saving of about 1d. per unit, the maintenance of the new plant would be considerably less than that of the plant hitherto worked, which was of a high-speed type, and required the greatest attention to keep in working order. The plant was started under difficulties without previous trial, and had been found to be efficient, satisfactory to work, and of capacity in excess of that required in the engineer's specification. When the economiser was put to work the installation would, besides being the most modern in the kingdom, be the most economical to work. The great economy effected in working from Ringsend had led to the closing of the Clontarf station, and arrangements had been made to instal multiphase machinery at Ringsend. When this was completed, the Ballsbridge station would be closed down, and the entire system worked from the single central power station. These statements being correct, a saving of about £25,000 per year would be effected on the 6,000,000 units which the company uses. We also gather that the company would like to supply the Corporation of Dublin with electric light in bulk, and thus save them the expense of building their large station at Pigeon House Fort. The company think that they could sell the electricity to the Corporation at a much cheaper rate from their Ringsend station than the Corporation could produce it, even after spending £150,000 on the new lighting station. In order to show that this was so the chairman of the company instanced the case of Cork, where with a combination of traction and lighting they supplied electricity at 2·98d., or under 3d. per unit, for which the public of Dublin were paying 7d. As to this latter question, we should like to have the views of Mr. Robert Hammond, who, as consulting engineer to the Dublin Corporation, should be able to speak from the other side.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

The seventh annual dinner of this society was held at the Grand Hotel, Manchester, on Friday, Feb. 16. A special interest was attached to the event, which marks the end of the society as a separate organisation, and virtually records its absorption as a local branch of the London Institution of Electrical Engineers. The members and guests present included the following:

Messrs. L. Andrew, J. G. Ames, J. Atherton, T. Browett, A. Brooker, A. Bellamy, D. Bates, R. Blackmore, G. H. Chambers, J. Connolly, J. T. Connolly, S. V. Clirehugh, E. W. Cowan, E. A. Claremont, H. Dickenson, Henry Edmunds, A. Eckstein, A. Ellis, V. A. Fynn, A. Fairley, W. Forster, S. Z. de Ferranti, A. E. Garbutt, F. Gibbons, W. W. Haldane Gee, Geo. Hill, R. Hammond, Dr. Ed. Hopkinson, E. S. Jacob, S. Joyce, S. Hartford, J. Slater Lewis, A. Marr, D. S. Mitchell, G. H. Nisbett, Dr. J. T. Nicolson, T. L. Pescatore, P. Pescatore, J. S. Raworth, P. Rosling, E. S. Shoults, G. Shultz, A. M. Sillar, A. Still, W. Stead, C. L. Turner, A. E. Tanner, James Taylor, Prof. S. P. Thompson, W. H. Vincent, C. H. Wordingham.

The retiring president, Mr. S. Z. de Ferranti, read a letter from Prof. Perry, regretting that he was unable to be present, and expressing the sentiment that "when the peak of the evening load came on at the dinner he wished them good feed, clean fires, with no clinkers, plenty of draught, and a steady pressure."

Prof. S. P. Thompson, in proposing the health of "The President and the Society," said that as president of the institution he was glad to inform them of the enormous growth of the older society. Represented by a curve, he might say that the tangent of the angle of its inclination was on the

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increase. As a Yorkshireman he was proud of what the North had done, and specially alluded to the gain of engineering and science in Parliament by the elections of Mr. Wm. Mather and Sir Michael Foster.

In reply, Mr. FERRANTI said that he had supported the merging of the Northern Society into the Institution, because he thought that it would be likely to improve the position of the profession. They were now the Manchester branch of the Institution of Electrical Engineers, the vote having been almost unanimous.

Mr. HENRY EDMUNDS, in proposing "The Profession," reminded the meeting that union is strength, and that it might be a good thing to standardise the members of the electrical profession.

Mr. ROBERT HAMMOND, as an electrical pioneer, responded to the toast, and gave various personal definitions of the term "profession." He considered that the generation, distribution, and utilisation of electrical enery was a noble task.

Mr. J. S. RAWORTH, in toasting "The Guests," as usual said some bright things. In the amalgamation with the Institution they would be in the position of the wise child, and the Institution in that of the happy father.

Prof. S. P. THOMPSON, in replying, mentioned that there were now five branches of the Institution—namely, Newcastle, Dublin, Glasgow, Cape Town, and Manchester. This summer there would be an important meeting in Paris, and in Whitweek, 1901, they hoped to accept the invitation of Mr. Rathenau, the managing director of the German General Electric Company, to go to Berlin. There was an important programme of papers to be read before the Institution this session, including one by Dr. Taylor Jones on electro-therapeutics, one by Mr. C. E. Groves, of the Thames Ironworks, on the electrical equipment of a man-of-war, one by Prof. George Forbes on long-distance transmission, and one by Mr. Mordey on dynamos.

Dr. EDWARD HOPKINSON, the new president of the Manchester branch, proposed "Technical Education," coupled with the name of Dr. J. T. Nicolson, who, he said, had helped to found the engineering school at Cambridge, and after some time spent at the McGill University, in Canada, had come to Manchester to take charge of the engineering department of the municipal technical school of Manchester. He assured Dr. Nicolson of their very hearty support.

In thanking the meeting Dr. NICOLSON wished the laboratories of the new school should be practically useful in solving trade problems, and great attention was being given to their equipment. In electrical engineering he and Mr. Gee, who were responsible for the work, would be glad of the help of any interested in special branches.

GLASGOW AND WEST OF SCOTLAND TECHNICAL COLLEGE SCIENTIFIC SOCIETY.

The seventh annual dinner of the above society was held on Saturday evening last in the Bath Hotel, Glasgow. The president of the society, Mr. David Howe Morton, M.I.C.E., M.I.M.E., occupied the chair, supported by Mr. Wm. Arnot, M.I.C.E., M.I.E.E., and ex-Provost William Shanks, of Barrhead. After dinner the President addressed the company, and the programme was then proceeded with. This was interspersed with the usual toasts, "The Queen" being proposed by the President in a few well-chosen words, and meeting with an enthusiastic response.

Mr. FRANK B. LEA, B.A., A.M.I.E.E., proposed "The Army, Navy, and Auxiliary Forces," eulogising in a smart speech the gallant deeds of these forces in South Africa.

Lieutenant ANDREW M. DOWNIE, B.Sc., replied, drawing attention to the growing importance of the engineer in every branch of the service, and pointing out that the mountings of the 4·7in. naval guns from H.M.S. "Powerful," which had enabled Ladysmith to hold out so well, were designed and fitted by the engineers of that vessel.

"The Lecturers" was proposed by the HON. SECRETARY (Mr. Andrew Stewart, A.I.E.E.), and responded to by Ex-Provost SHANKS, who spoke of the great value of societies such as the one they were connected with in broadening the views of the senior students. He referred to the fact that we as a nation were inclined to ignore the advantages to be secured by the aid of science, preferring to depend on our innate common-sense and muscular development. This was the case not only in the keen struggle for commercial supremacy, but in many other directions. We were inclined to despise many of our Continental and other rivals, but events in the South African war proved that even a comparatively ignorant and narrow-minded people could, if backed by scientific skill and able leaders, do far more than had been anticipated. Speaking of the progress made by Continental nations, particularly Germany, Provost Shanks referred to the developments of applied science not only in the large cities, but in what we should in this country term small provincial towns, streets were lighted by electricity, and electric tramways linked several towns together in a manner we had not even the faintest notion of in this country. Mr. Andrew Carnegie had predicted the decline and fall of this nation as a great centre of industry; its trade would be transferred to America, whose almost unlimited mineral wealth had scarcely been touched, while ours was becoming exhausted, but he (Mr. Shanks) had a better and a happier vision. It was not proved that the industrial prosperity of the future lay with the nation having the greatest natural resources, and there were in our country modifying circumstances—Mr. Carnegie had admitted there was—which would, the speaker felt sure, counterbalance the absence of great mineral resources. This country would yet awake to greater things, the restless activity and scientific training of our young men would be utilised to a much greater extent than hitherto, and our national commerce would attain a level which had no parallel in the world's history. The conclusion of Mr. Shanks's eloquent speech was received with a tumult of indescribable enthusiasm.

During one of the intervals an illuminated address was presented to Mr. R. A. Raphael, the late honorary secretary, in recognition of his valuable services to the society during his term of office. The concluding toast of "The Society," was proposed by Mr. DAVID POLLOCK, M.I.N.A., who dealt with the growth of the society, particularly during the last few few years. It was responded to by Mr. WILLIAM DICK MACLEAN, vice-president.

COMPANIES' MEETINGS AND REPORTS.

CENTRAL LONDON RAILWAY.

The ninth ordinary general meeting of this Company was held on Wednesday last in Westminster Palace Hotel, S.W., Sir Henry Oakley presiding.

In moving the adoption of the report, the Chairman said that practically all the capital of the Company had been called up and it had been all paid. They had not raised any of the loan capital, as they had been advised that they would get a much better price for the 4 per cent. bonds after the railway was opened. There was only one point in the accounts to notice, this being an item of £10,028 for additional land at the Marble Arch. This was necessary in order to have plenty of room for ingress and egress at that busy point. The superstructure over this station was expected to bring in a substantial sum as rent when let. As regarded the superstructure over the stations the directors did not intend to go on with this work until the underground work was finished. As to the completion of the railway, during the past few months their attention had been specially directed to this point. He had hoped that before that date the line would have been opened, but the difficulties met with in the tunnelling, etc., had necessarily made the progress slow in the lower levels. When this had, however, been completed, steps could be taken to fit up the shafts. The underground work from Mansion House to Shepherd's Bush was practically completed, except the laying of the third rail, which was under construction. By the arrangement of the electric machinery, two or three sub-stations had to be fitted up, and these were all likely to be speedily finished. The third rail had to be insulated and bonded, and when this was done the whole of the work would be completed. The work at the Bank had been completed without any disaster occurring, and in January they had opened the subway for the public at that point. The lifts were all well in hand, six or seven being completed, and once these were all completed the railway could be used. At the Shepherd's Bush shop three of the large engines had been worked, and as soon as the third rail was finished an experimental train would be run. This train they hoped to run very shortly after the end of this month. They could look, therefore, for an early opening of the line. All the work was progressing satisfactorily, but, of course, they had had one or two obstructions. For instance, one of the rotary converters on order was lost owing to the ship foundering, and great delay was caused. One of the shafts was also found to be faulty. With respect to the delay in opening, Sir Benjamin Baker, the engineer, had reported that it was not reasonably possible to say when the line would be ready to open until he had tried the machinery. When this was done, however, they would not be long before the line was commonly used. As to the Bill they had promoted in Parliament, at the special meeting after this one they proposed to alter the fares for the workmen's trains, and instead of having a 1d. fare in each direction as stated in the Bill to have a return fare of 2d., the return being used by any train during the day. This would prevent the filling of whole trains with workmen at a later period of the day to the inconvenience of other passengers. The directors had seen fit to appoint a general manager, by name Mr. Granville C. Cunningham. This gentleman had had a very large experience, and seemed in every way fitted for the post he was to occupy.

The report was seconded by Lord Colville of Culross, K.T., and carried unanimously.

The following is the report of the engineers, Messrs. Fowler and Barker, on the work presented to the Board, and affixed to the

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balance-sheet: "Very little work now remains to be done to complete the railway except that connected with the electric equipment. The station buildings are now all complete to the first floor, and the booking hall and office fittings are being proceed with at all points. At the Bank, with the exception of the two entrances in front of the Royal Exchange, the public subways are finished, and have been opened for the use of the Waterloo and City Railway. The electric lifts are now practically complete at seven out of the thirteen stations. At the depôt the erection of the electric plant has proceeded rapidly, and two of the large main generating engines are complete, and have been under steam. Twelve miles of cable have been laid, and the first sub-station at Notting Hill-gate is so far advanced that we hope to run an experimental train by the end of this month. All the electric locomotives have been delivered and erected."

WESTMINSTER ELECTRIC SUPPLY.

The ordinary general meeting of this Company was held on Wednesday last at Eccleston-place, S.W.

Lord Suffield, in moving the adoption of the report, congratulated the shareholders on the steady and satisfactory progress being made by the Corporation. Last year he had stated that the Board had no reason to expect any falling off in demand, and, as shown in the report, the number of lamps added last year was greater than in any year since they commenced business. They had also found that a large number of lamps had been added to the main in excess of what they were aware of, these having been gradually added by customers to meet their convenience. Although the cost of steam coal continued very high, the profit for last year showed a large increase, and the directors therefore felt justified in recommending an increase in dividend of 1 per cent. The cost at the works also, as well as management expenses, compared very favourably with previous years, owing to the increased output. In his certificate, the Government auditor took exception to a sum of £1,582 for which they had taken credit in the net revenue account. This sum was for interest on advances they had made to the Central Electric Supply Company, and the auditor was of opinion that, as that company was owned by this Corporation and the St. James's Company, and was not at present earning any income, it would have been better not to take the item into account. The directors, however, thought it necessary to introduce the item to show the correct position of the Corporation; but the amount was not included in dividend, but simply carried forward. The Corporation had now come to the end of its capital, and the directors were considering how best to raise more. When they had decided what to do, due notice would be given to the shareholders.

Mr. R. Boulnois, M.P., seconded and the report was adopted, a dividend being declared at the rate of 16 per cent., making, with the interim a total distribution for the year of 13 per cent., and carrying forward £3,773.

BRISTOL TRAMWAYS AND CARRIAGE.

The ordinary general meeting was held last week, at which the directors' report and statement of accounts (published in our last issue) was adopted. In the absence, through indisposition, of Mr. W. Butler, the chairman, the chair was occupied by Mr. C. H. Low, vice-chairman.

The **Chairman** said that everything was going on satisfactorily, and that they anticipated being able to open the whole of the reconstructed lines, together with the extensions, some time during the ensuing summer. In the meantime it was satisfactory to know that the additional electric lines which were opened last year had been working very smoothly indeed, and with the greatest possible satisfaction to the citizens generally, and he had no doubt that when the complete system was in working order a very large accession of traffic would ensue. For this they had provided by having ordered a good supply of electric cars, so as to be able to cope with the maximum traffic.

Mr. W. Butler was re-elected as a director of the Company, and Mr. Solomon Hare was again chosen auditor.

BRITISH INSULATED WIRE.

The report of the directors for the year ended Dec. 31, 1899, to be submitted to the shareholders at the fourth ordinary general meeting, to be held at the offices of the Company, Prescot, Lancashire, to-day, Feb. 16, 1900, at 3.15 p.m., states that the gross profits for the year amount to £92,653. 15s. 5d., from which has to be deducted administration, legal expenses, fees on patents, and interest on debentures, amounting in all to £22,192. 19s. 5d., leaving a balance of £70,460. 16s. This amount has been charged with depreciation of buildings, plant and machinery, according to scale, £10,987. 12s. 3d.; amount written off patents, £5,000; leaving a balance of £54,473. 3s. 9d. Adding to this the balance of £1,994. 5s. 11d. brought forward from last year's account, and the transfer fees of £90. 4s. 6d., there remains a balance available for dividend of £56,557. 14s. 2d. The following dividends have already been paid—viz.: dividend on preference shares, £10,124. 19s. 7d.; and interim dividend for the half-year ending June 30, 1899, on the ordinary shares at the rate of 10 per cent. per annum, £10,000; leaving a final balance of £36,432. 14s. 7d. The directors recommend that a dividend of 15 per cent. on the ordinary shares be declared for the year, which, after deducting the interim dividend, will leave a balance of 10 per cent. to be now divided. This will absorb £20,000, and leave a balance of £16,432. 14s. 7d., out of which the directors recommend that a bonus of 5 per cent. be also paid to the ordinary shareholders, and the balance of £6,432. 14s. 7d. carried forward. During the year 12,500 preference shares, completing the authorised capital, have been offered and subscribed at £6 per share. The buildings of the new copper wire works are completed, and are very nearly equipped with the necessary plant and machinery, and are expected to be working within the next few weeks. This extension will afford greater facilities for the rapid execution of orders. The results of the year's working have been most satisfactory, and it will be seen that there have been great additions during the year to the purchases and output of the business, the buildings and plant, and the amount of capital employed. Having regard to the greatly-increased volume of business in hand, and offering, and to the capital required in the copper mills, it is absolutely necessary to provide a large amount of additional working capital, which can at once be profitably employed. Mr. J. B. Atherton and Mr. S. Z. de Ferranti, who are the retiring directors, being eligible, offer themselves for re-election. Messrs. Chalmers, Wade, and Co., the auditors, also retire, and offer themselves for re-election.

NORTHAMPTON ELECTRIC LIGHT AND POWER.

The annual report of the Northampton Electric Light and Power Company, Limited, states: "In the last annual report the directors announced that they had determined to adhere to the policy of reducing the price of current, 'whatever might be the immediate effect on profit and loss.' The course taken has been fully justified by the result. During the past year the additional lamps fixed (at 8 c.p.) have been 5,667, and motive power supplied equivalent to 1,035 lamps—total, 6,702; as against 1,977 for the previous year. There is now the equivalent of 19,763 lamps fixed. The balance of the revenue account is £1,714. 5s. 8d., as compared with £1,258 10s. 7d. In pursuance of the line of policy above indicated, the tariff for motive power has been reduced to 1½d. per unit for current used after a three hours' daily maximum demand. The acquisition of land referred to in the last report has now been carried into effect, with the result that the Company are in possession of a large and compact freehold estate with three important frontages. The Company's mains have been extended in various directions, 2¼ miles in all, making a total of 6 miles 18 yards. With regard to coal, the directors have been obliged to pay an increased price of 15 per cent., but as they entered into a new contract last autumn, it is hoped that the great rise which has taken place this year will not affect the Company. It has been decided to raise the pressure of the Company's supply, which will conduce to more economical working and a better service. The change to the higher pressure is now being almost universally adopted throughout the country. With reference to the application of the balance of revenue, it will be seen that a further sum of £350 has been carried to the depreciation account, making a total of £2,000, and that £43 has been written off preliminary expenses. Dividends on the preference shares will be paid for the year ending Dec. 31, 1899—viz., 6 per cent. fixed, £232, and 5 per cent. fixed, £261. 11s. 8d. It is proposed to pay 2 per cent. on all the ordinary shares, which will require £368. 17s. 9d., and to carry forward £178. 13s. 6d. Messrs. S. L. Seckham and R. Cleaver retire from the Board in rotation, and Mr. Cleaver only offers himself for re-election."—*Northampton Mercury.*

NATIONAL ELECTRIC SUPPLY.

The directors of the National Electric Supply Company, Preston, have just issued their report and statement of accounts for the year ending Dec. 31, 1899. In it they state that the business of the Company has made satisfactory progress during the year. One hundred and seventy-five new consumers, representing a total of 9,252 8-c.p. lamps, have been connected to the mains. Nearly seven miles of mains have been laid, including extensions in Ribbleton-lane, Ashton, Fulwood, Cadley, Avenham district, etc., and additions have been made to the machinery at the works. The expenditure on capital account for the year has been £15,390; £10,250 in 4 per cent. preference shares has been issued during the year. The increase in revenue for the year over that of 1898 is 21 per cent. Owing to the rapid growth of the Company's business an extension of the works in Bushell-street is urgently required. Land adjoining the works has been purchased, and a new engine and boiler house put in hand. This has been carefully designed on the most modern lines, and when completed will be one of the best equipped in the kingdom. The gross profits for the year is £7,253. 8s., which, with the balance from last year, makes a total of £7,271.—*Preston Herald.*

W. T. HENLEY'S TELEGRAPH.

The report of the directors for 1889, to be presented at the meeting on the 28th inst., states that there is a net profit of £46,037. Out of £54,840 available for distribution, the directors have transferred £10,000 to the reserve account, and the following dividends are recommended: on the preference shares at the rate of 4½ per cent.; on the ordinary shares at the rate of 15 per cent.; which, including the interim dividend of 4 per cent., leaves £18,853 to be carried forward.

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NATIONAL TELEPHONE.

The twenty fifth ordinary general meeting of this Company was held yesterday at Cannon-street Hotel, E.C., Mr. J. Staats Forbes presiding.

The **Chairman** said that practically the whole business of the meeting was contained in paragraphs 1 to 5 of the report. Thus the income for the half-year amounted to £663,523 as compared with £573,707 for the corresponding period of 1898, being an increase of £89,815. The working expenses for the half-year amounted to £359,302 as compared with £312,462 for the same period of 1898, being an increase of £46,840. After deducting the Post Office royalties, amounting to £64,176, the net result for the half-year was a profit balance of £240,044 as compared with £206,888 for the corresponding period of 1898, or an increase of £33,155. The rentals carried forward for unexpired terms of running contracts were £631,590 as compared with £536,654 for the similar period of 1898, being an increase of £94,936. Out of the available balance of £199,950 shown by the net revenue account a dividend at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares, 5 per cent. per annum, less income tax, on the third preference shares, and 6 per cent. per annum, free of income tax, on the ordinary shares was recommended. The Board also proposed to transfer £80,000 to the reserve fund, carrying forward the balance of £6,200. The sum of £369,821. 19s. 8d. had been expended during the half-year in the erection of 10,000 additional exchange and private lines, and in the construction of underground lines. The same figures were shown perhaps even more clearly in the accounts and were compared with the results of previous years. As to the matter of the Post Office, the Government had intimated that they would deal with the Company with the most scrupulous fairness. He thought it monstrous, however, that they had that year been compelled to pay the Post Office a sum equal to 21 per cent. on their net income. Those who complained at having to pay high prices for their telephones, should think that if it were not for the Government tax something might be done towards cheapening them. As to the extension of the Company, he said that in 1894 they had 73,000 lines, in 1895 they had 82,000, in 1896 94,000, in 1897 106,000, in 1898 120,000, and in that, the record year, they had gone up to 140,600.

The report was seconded by **Lord Harris**, and adopted.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY.

Directors: William Francis Fladgate, Esq., Craig's court, S.W. (chairman); G. H. Brougham Glasier, Esq., St. James's-street, S.W. (vice-chairman); Stefano Gatti, Esq. (A. and S. Gatti), Strand, W.C. (managing director); John M. Gatti, Esq. (A. and S. Gatti), Strand, W.C.; Richard Chadwick, Esq., St. Martin's-lane, W.C. Secretary: Edwd. Wilmot Seale, Esq. Engineer-in-chief: W. H. Patchell, M.I.C.E., M.I.E.E., M.I.Mech.E.

Report of the directors (with abstract of accounts) to be presented to the ordinary general meeting of the Corporation to be held at the offices, 15, Maiden-lane, Covent-garden, W.C., on Tuesday, Feb. 27, at 12 noon:

In submitting the accounts for the year ended Dec. 31, 1899, the directors are pleased to report that the progress of the business has been very satisfactory. The Maiden-lane, Lambeth, and Short's-gardens stations, and the plant and machinery, have been maintained in a high state of efficiency. The equivalent of 48,453 additional 8 c.p. lamps, nearly double the number added in 1898, have been connected up to the mains of the Corporation during the past year, making a total of 182,689 lamps now connected. There have been 24½ miles added to the mains laid, making altogether 125¾ miles. The sales of current from the stations of the Corporation have increased by 615,897 units during the year. The further extension of the Lambeth station is being carried out, and will shortly be completed, affording accommodation for an additional 2,500 h.p., and the requisite machinery and plant have been ordered. The installation in Short's-gardens is being proceeded with, and supply is now being given from that station. The large increase in the business during the past year, and the prospective requirements of the several districts supplied, will necessitate an increase of capital. A special meeting of the shareholders to consider this will therefore be convened at an early date. The provisional order to supply electric energy within the City of London, referred to in the directors' report for the year 1898, was granted to this Corporation by the Board of Trade, and the order confirmed by Parliament. Some mains have already been laid in the western portions of the City, and supply given from the existing stations of the Corporation. The directors have made arrangements for acquiring 7½ acres of freehold land at Bow. The greater portion will be devoted to the purposes of the City provisional order, which provides that a separate station shall be erected for the purposes of supplying the City. They, however, propose to reserve sufficient space to enable them to erect a separate installation should they find it expedient for the other purposes of the Company. A Bill is being promoted in the present session of Parliament seeking statutory powers to lay mains from Bow to the City, and to enable the Corporation to connect up with their stations, and to supply electric energy in bulk to such of the local authorities *en route* as may desire it. The City provisional order further provides that separate accounts be kept of all receipts and expenditure. The directors are taking measures to comply with these requirements, and to enable them satisfactorily so to do it will probably be necessary either that separate capital be created in the existing Company for the purposes of this order, or that another company be registered. The matters will be dealt with at the proposed special meeting. It will be seen from the accounts that the debenture debt has been reduced from £70,000 to £24,200, and the temporary loan of £57,500 has been paid off. The directors also point out that the total reserves of the Corporation now amount to £137,267, nearly 40 per cent. on the total share capital. The net earnings, as shown in the revenue account, have amounted to £27,677. 17s. 11d. A sum of £3,451. 5s. 7d. has been paid in respect of interest on debentures and temporary loans up to Dec. 31, 1899, and £6,708. 9s. 5d. was distributed as interim dividend at the rate of 8 per cent. for the half-year ended June 30, 1899. There remains a sum of £17,518. 2s. 11d., which, added to the undivided profit of £3,292. 1s. 5d. from the preceding year's account, makes £20,810. 4s. 4d., which the directors propose to deal with as follows: to provide for dividend on 4½ per cent. preference shares (apportioned to Dec. 31, 1899), £4,500; to pay a dividend at the rate of £10 per cent. for the half-year ended Dec. 31, 1899, on the ordinary shares (making with the interim dividend paid in August, 1899, £9 per cent. for the whole year), £11,768. 10s. 6d.; and to carry forward £4,541. 13s. 10d. Mr. Geo. H. Brougham Glasier and Mr. John M. Gatti are the directors who retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. O. R. Johnson and Son, also retire, and offer themselves for re-election.

Revenue Account, Year ending Dec. 31, 1899.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including carriage	£13,766	6	9			
Oil, etc., and engine-room stores ...	929	7	10			
Proportion of salaries	740	17	0			
Wages and gratuities	4,874	13	5			
Repairs and maintenance as follows:				20,311	5	0
Buildings.....	250	2	10			
Engines, boilers, dynamos, etc....	3,695	11	1			
Accumulators and accessories.....	275	8	2			
				4,221	2	1
				£24,532	7	1
Distribution of Electricity.						
Proportion of salaries	945	15	5			
Wages and gratuities	180	18	7			
Repairs, testing, maintenance, and renewals of mains	877	15	8			
Repairs, maintenance, and renewals of meters, etc., on consumers' premises	379	9	5			
Wayleaves and licenses	805	11	11			
				3,189	11	0
Rents, rates, taxes, and insurances				2,730	1	3
Management Expenses.						
Directors' remuneration	1,050	0	0			
Salaries.....	2,464	4	1			
Stationery and printing	196	17	8			
General establishment charges	400	2	5			
Auditors of Company	75	0	0			
Auditor.....	75	0	0			
				4,261	4	2
Law costs and expenses				206	16	5
Other professional charges.....				58	18	6
Accident compensation claims				130	11	9
Depreciation in respect of plant, machinery, etc...				8,000	0	0
				43,109	10	2
Rents, repairs, rates, and taxes payable in respect of property not in occupation.....				130	0	0
Total expenditure.....				43,239	10	2
Balance carried to net revenue.....				27,677	17	11
				£70,917	8	1
Cr.				£	s.	d.
Sales of current, less rebates and bad debts.....				69,701	2	10
Rentals of meters, etc., on consumers' premises ...				994	1	9
Transfer fees and sundry receipts.....				52	3	6
				£70,747	8	1
Rents receivable in respect of property not in occupation				170	0	0
				£70,917	8	1

General Balance Sheet, Dec. 31, 1899.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	374,200	0	0
Sundry creditors for debenture interest due Dec. 31, 1899, £584. 16s. 8d.; preference dividend apportioned to Dec. 31, 1899, £1,656. 11s. 1d.; various credits, £2,277. 15s.; sundry tradesmen and others, £17,855. 2s. 8d.....	22,374	5	5
Balance at credit of net revenue account, £27,518. 13s. 9d.; less preference dividend to Dec. 31, 1899, £4,500, and less interim dividend paid in August, 1899, on ordinary shares, £6,708. 9s. 5d.	16,310	4	4
Depreciation fund account, £28,000; leaseholds depreciation fund account, £5,000; share premium account, £85,000; reserve fund (capital) account, £19,267. 7s. 8d.	137,267	7	8
	£550,151	17	5

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Cr. Assets.	£	s.	d.
Capital account—amount expended for works	498,174	5	7
Expenses of and in connection with obtaining City of London provisional order	8,325	14	8
Leasehold premises not occupied by the Company.	400	0	0
Stores on hand at Dec. 31, 1899: coal, £687. 4s. 7d.; oils, waste, etc., £76. 7s. 7d.; general stores, cables, etc., £2,827. 11s. 2d.; stationery, £139. 4s. 6d.	3,730	7	10
Sundry debits for payments on account of contracts in course of completion	9,778	7	5
Sundry debtors for current supplied to Dec. 31, 1899	22,141	0	4
Other debtors	2,012	16	7
Cash at bankers and in hand	5,589	5	0
	£550,151	17	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		4,788,498
Quantity sold { Public lamps	24,679	3,862,128
Quantity sold { Private consumers by meter	3,837,449	
Quantity used on works		903 142
Total quantity accounted for		4,765 270
Quantity not accounted for		23,228
Number of public lamps		13
Total maximum supply demanded (kilowatts)		2,512

BRITISH INSULATED WIRE.

The fourth ordinary general meeting of the shareholders of this Company was held last Friday at the offices of the Company, Prescot, Lancs., Mr. W. Marriner Brigg presiding.

The **Chairman**, in moving the adoption of the report and balance-sheet, said that he had to congratulate the shareholders on the continued growth and success of the business. He thought the shareholders hardly realised what this continued growth and increase meant. Probably all had played at the game of the horseshoe by taking the first nail and doubling it, and the second nail, etc., and found the large amount it came to when multiplied continuously all the way through by the number of nails in a horse's shoe. He did not say they had gone on in that proportion, but they had gone on in half that proportion, and he wanted the shareholders to grasp this particular fact because this brought them to the fact that they were asking for an increase of capital. Since the Company started in 1892 he was glad, indeed, to say that the increase, on the average, had been 50 per cent. on the year previous. They could quite imagine that when that got up to, say, £1,000,000, and they suddenly found they reached £1,500,000, it made a very great difference in the calculations and in the working of the business. It might go on for one year or two years, but to go on continuously, as this business had done, showed the business in itself was good, and the goods sent out were of the best quality, and that the demand was gradually increasing. The orders which they had in hand justified them in thinking that their increase for the present year was going to be at about the same rate. Turning to the balance-sheet, they would notice that the profits were about £20,000 more than last year, or £92,000, as against £72,000 last year The administration and other expenses were necessarily higher because they were doing a much larger business, but the directors did not think those expenses were beyond the ratio in which they should be extended, according to the business which had been done. They could not tell till the end of the year what the increased capital had done for them, but they had every reason to believe that the money which they then asked for could be very profitably spent, and the orders which they had on the books were equal to the whole of the turnover for a year about a year or two ago. He hoped that 15 per cent. and the bonus of 5 per cent. would be agreeable to the shareholders, and that they would sanction what the directors had done.

Mr. E. K. Muspratt, in seconding the adoption of the report, stated that the increase of the business and the increase in the price of materials necessitated the asking for extra capital.

The motion was then carried.

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The report of the directors, to be submitted to the thirty-sixth ordinary meeting to be held on Tuesday, Feb. 27, 1900, at 1 p.m., states that the accounts for the year show a net profit of £82,828. 4s. 1d., after charging the interest on the debentures. To this sum must be added £38,205. 2s. brought forward from last year, making a total of £121,033. 6s. 1d. From this amount is deducted the interim dividend of 5 per cent., paid July 18, 1899, amounting to £22,410, leaving £98,623. 6s. 1d. to be dealt with. Of this sum the directors propose to distribute a dividend of £1. 4s. per share, absorbing £44,820, being at the rate of 10 per cent, and making, with the amount already paid, a total dividend for the year of £1. 16s. per share, or 15 per cent., free of income tax, leaving £53,803. 6s. 1d. to be carried forward to the next account. The business of the Company has been satisfactorily maintained during the past year. The factories have been fully occupied in the manufacture of submarine telegraph cables and of insulated wire, whilst the Company's steamships have been actively engaged in the laying of cables, as well as on repairing operations. The factories at East Greenwich and Wharf-road and the Company's steamships are in a thoroughly efficient condition. The directors propose to add a further sum of £5,000 to the pension fund established last year for the benefit of the Company's staff. The retiring directors are Sir Robert G. W. Herbert and Sir James Pender, who, being eligible, offer themselves for re-election. The meeting will have to appoint auditors for the ensuing year. Mr. John Gane (of the firm of Messrs. Gane, Jackson, Jefferys, and Wells), and Mr. Patrick A. Glegg (of the firm of Messrs. Welton, Jones, and Co.), who retire, offer themselves for re-election.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY.

Directors: Alderman T. G. Gibson, J P. (chairman); Dr. J. T. Merz; Dr. Robt. Spence Watson; Colonel F. F. Sheppee; J. Tennant, Esq.; J. H. Armstrong, E-q.

Report of directors (with abstract of accounts) submitted to the twelfth general meeting of the shareholders held at the offices of the Company, 50, New Bridge-street, Newcastle, on Feb. 22:

The directors have pleasure in stating that the units sold show an increase for the year of 163,309, the total being 967,098, as against 803,789 in the year 1898. The total profits of the year's trading amount to £8,177. 16s. 10d., against which have been written off special expenditure on the reconstruction and enlargement of dynamos £800. 9s. 11d., and costs incurred on parliamentary matters £875. 16s. 11d., leaving a balance of £6,501. 10s. Adding to this the balance brought forward from last year of £994. 0s. 2d., there is a sum to be dealt with of £7,495. 10s. 2d. Out of this amount an interim dividend of 4 per cent. was paid in July last, and the directors now propose to pay a further dividend at the same rate, making in all 8 per cent. per annum, and absorbing £5,341. 12s. 8d., and to increase the reserve and depreciation account by a further sum of £342. 16s., carrying forward to next year a balance of £1,811. 1s. 6d. The reserve account, after dealing with the above amount of £342. 16s., and also the premiums received on shares issued during the year, will stand at £20,000. The necessary expenditure on capital to keep pace with the demand for current during the year, and to provide for a continuous-current service, has amounted to £28,518. 1s. 2d. The continuous-current service referred to in last year's report is nearing completion. A Bill is being promoted in Parliament, which has been approved by the shareholders at extraordinary meetings, held on the 25th ult. and 12th inst., by which further powers will be conferred on the Company with a view to the necessary extension of its operations. A provisional order for supplying Gosforth with electricity is also being applied for. In order to meet the expenditure already incurred, and that which will be required to carry out the above schemes, the sanction of the Company will be asked to increase the nominal capital by £200,000, the new capital to be issued from time to time upon the terms of the resolution, which will be submitted to an extraordinary general meeting in accordance with the articles of association. The retiring directors are Mr. T. G. Gibson and Mr. J. H. Armstrong, who are eligible and offer themselves for re-election. The auditor, Mr. Thomas Harrison, also retires, and is eligible for re-election.

BALANCE-SHEET.

Capital and Liabilities.	£	s.	d.
Nominal capital—20,000 shares of £5 each	100,000	0	0
Issued and allotted—12,497 shares, fully paid	62,485	0	0
5,964 shares, £3. 15s. called up	22,365	0	0
	84,850	0	0
Calls paid in advance	4,676	5	0
	89,526	5	0
Loans	18,100	0	0
Creditors on sundry accounts	7,223	17	1
Reserve account at Dec. 31, 1898, £10,704. 3s. 7d.; premium on issue of 5,964 shares at £2 per share, etc., £11,957. 4s.; less transfers to capital expenditure suspense account, £3,004. 3s. 7d.	19,657	4	0
Balance on profit and loss account, £994. 0s. 2d.; profit for year to date, £6,501. 10s.; less interim dividend at 8 per cent. per annum for half-year, £2,222. 6s. 10d.	5,273	3	4
	£139,780	9	5

Property and Assets.	£	s.	d.
Capital expenditure—Buildings and plant at Dec. 31, 1898, £71,426. 9s. 4d.; additions to date, £19,244. 4s. 1d.	90,670	13	5
Meters, transformers, etc., at Dec. 31, 1898, £14,079. 2s. 5d.; additions to date, £3,603. 16s. 1d.	17,682	18	6
Land purchased at Dec. 31, 1898, £10,998. 1s. 5d.; additions to date, £5,428. 5s.	16,426	6	5
Cost of provisional order	659	14	11
Gosforth provisional order—cost to date	80	2	10
General bill—cost to date re new works	161	13	2
	125,681	9	3
Loose plant and tools	957	12	4
Office furniture	342	5	6
Special expenditure on new offices at Dec. 31, 1898, £91. 0s. 7d.; less one-half written off, £45. 10s. 3d.	45	10	4
Stocks at valuation	3,373	12	6
Debtors on current supply and for work done, etc.	7,187	15	0
Cash in bank and in hand	2,192	4	6
	£139,780	9	5

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Dr.	Profit and Loss Account.	£	s.	d.
Station charges—salaries, etc., and maintenance...		4 709	15	9
Street charges—salaries and maintenance		607	19	3
Rents, rates, taxes, and insurance		605	11	2
General charges — directors' remuneration, £262. 10s. ; office salaries, stationery, etc., £1,751. 5s. 1d.		2,013	15	1
Balance carried down		9,395	16	6
		£17,332	17	9
Special expenditure on dynamo reconstruction, etc., during year		£ 800	s. 9	d. 11
Costs incurred on parliamentary matters		875	16	11
Interest on debentures, £817. 6s. 9d.; on purchase price of land, £201. 5s. 7d. ; on loans, £132. 16s. 5d.; on bank overdraft, £11. 11s. 9d.; on calls in advance, £98. 2s. 2d.; less interest received, £43. 3s.		1,217	19	8
Balance carried down		6,501	10	0
		£9,395	16	6
Cr.		£	s.	d.
Current supply—Household		16,019	19	11
Public lamps		581	0	0
		16,600	19	11
Apparatus rental		720	4	6
Profit on sale of lamps.....		0	18	4
Transfer fees		10	15	0
		£17,332	17	9
		£	s.	d.
Balance brought down, being gross profit for year		9,395	16	6
		£9,395	16	6

WESTMINSTER ELECTRIC SUPPLY.

Directors: The Right Hon. Lord Suffield, K.C.B. (chairman); the Right Hon. Lord Ampthill; Captain Edmund I. Bax; Edmund Boulnois, Esq., M.P.; W. Hayes Fisher, Esq., M.P.; J. Browne Martin, Esq.; R. W. Wallace, Esq., Q.C. Engineer-in-chief: Prof. Alex. B. W. Kennedy, LL.D., F.R.S., M.I.C.E. Manager: L. H. Hordern, Esq. Secretary: Frank Iago, Esq.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the ordinary general meeting to be held at the offices, Eccleston-place, S.W., on Wednesday, Feb 21, at 11 a.m.:

The supply of current on Dec. 31, 1898, was provided for the equivalent of 339,986 lamps of 8 c.p. On Dec. 31, 1899, there was on the books an equivalent of 421,445 lamps. The actual additional lamps applied for and connected during the year was 54 691. The balance of 26,768 lamps represents the results of a re-examination of consumers' connections which has been made during the year, and which showed that the number of lamps connected was, to this extent, in excess of those which had been originally applied for. At the present time there are on circuit the equivalent of 427,322, and applications have been received for a further 8,951 lamps of 8 c.p. The length of roadway in which mains have been laid now exceeds 51 miles, making about 208 miles of ways, into which upwards of 176 miles of copper (strip and cable) have been drawn. Notwithstanding the continued high price of Welsh steam coal, there is again an increase in the net profits for the year owing to the very large number of lamps added during the 12 months, the greatest number in any year since the Corporation commenced business. Referring to the change of pressure alluded to in the last report, 99 per cent. of the consumers are now supplied at 200 volts, and the Board hope to complete the work during the present year. While these consumers have received a reduction in price in consideration of the alteration, the Corporation cannot obtain any advantage until the entire change has been completed. The Bill for a joint supply station outside the areas of the St. James's and Pall Mall Company and this Corporation (acting under the title of the Central Electric Supply Company, Limited) promoted for the purpose of obtaining a central station for supplying energy in bulk to both companies, received the Royal assent in August last. This has become necessary because of the rapid increase of the business of the Corporation. Considerable progress has been made in acquiring and developing the site, and building operations will shortly commence. This Corporation and the St. James's and Pall Mall Company each hold a half interest in this undertaking. An interim dividend at the rate of 10 per cent. per annum for the half year ending June 30, 1899, has been distributed. After allowing for depreciation, sinking fund, etc., the net balance available for dividend is £34,668. 1s. 6d. The Board, therefore, recommend the payment of a dividend at the rate of 16 per cent. per annum, less income tax, for the past half-year, making 13 per cent. for the year ending Dec 31 last, carrying forward a balance of £3,773 8s. 2d. The directors have to record with extreme regret the death during the past year of their colleague, Sir Douglas Galton, K.C.B. In accordance with Article 127 of the articles of association, they have elected Captain Bax, late manager of the Corporation, to fill the vacancy, and Mr. Hordern, assistant manager, has been appointed manager. In accordance with the articles of association, two of the directors (J. Browne Martin, Esq., and Lord Ampthill) retire, but, being eligible, offer themselves for re-election.

Revenue Account.

Dr.	Generation of Electricity.			£	s.	d.
Coal, carriage, unloading, etc.	£17,709	16	3			
Oil, waste, water, and engine-room stores.....	2,144	19	10			
Proportion of salaries of engineers and officers	2,323	17	1			
Wages, etc., at generating stations	5,650	8	2			
Repairs and maintenance: buildings, £700. 4s. 5d.; plant, £2,963. 11s. 6d.; instruments, £38. 7s. 11d.	3,702	3	10			
				31,531	5	2
	Distribution of Electricity.					
Repairs and maintenance of mains: materials, etc., £589. 8s.; proportion of salaries of officers, £160; wages, etc., £448. 9s. 7d...	1,197	17	7			
Repairs and maintenance of meters: materials, etc., £1,102 9s. 5d.; salaries and wages, £904. 16s. 5d.	2,007	5	10			
				3,205	3	5
	Rents, Rates, and Taxes.					
Rents.....	1,086	10	4			
Rates and taxes	5,559	11	2			
				6,646	1	6
	Management Expenses.					
Directors' fees.....	3,000	0	0			
Salaries of manager, engineer-in-chief, secretary, clerks, etc.	7,026	1	10			
Stationery and printing	486	13	8			
General charges and office expenses	670	9	9			
Wages of meter readers, inspectors, etc.	889	17	11			
Depreciation on office furniture.....	62	0	0			
				12,135	3	2
General law charges and parliamentary expenses				324	14	9
	Depreciation, etc.					
Sinking fund	2,500	0	0			
Depreciation account	16,952	0	0			
				19,452	0	0
	Special Charges.					
Insurance	649	5	9			
Board of Trade audit.....	85	0	0			
Cost of supplying steam	1,492	14	9			
Experiments and cost *re* smoke abatement	92	8	5			
				2,319	8	11
Total expenditure.....				75,613	16	11
Balance to net revenue account.....				58,818	17	11
				£134,432	14	10
Cr.				£	s.	d.
Sale of current by meter.....				128,211	2	6
Sale of current by contract				5	2	0
				128,216	4	6
Less bad and doubtful debts.....				641	16	4
				127,574	8	2
Rental of meters, etc., on consumers' premises ...				5,144	3	8
Transfer fees				57	17	6
Supply of steam				1,656	5	6
				£134,432	14	10

General Balance-Sheet.

Dr.	£	s.	d.
Capital account.....	649,500	0	0
Amounts received on founders' shares cancelled ...	500	0	0
Sundry creditors	13,575	7	5
Deposits by consumers.....	94	10	0
Debenture interest accrued, £4,375; less income tax, £145. 16s. 8d.....	4,229	3	4
Depreciation account	60,280	1	4
Sinking fund	12,171	15	11
Reserve fund	9,779	4	9
Net revenue account, £53,977. 4s. 10d.; less interim dividend to June 30, 1899, at the rate of 10 per cent. per annum, £19,975; and income tax, £665. 16s. 8d.....	34,668	1	6
	£784,798	4	3
Cr.	£	s.	d.
Capital account.....	683,568	1	7
Stores in hand: coal, £702. 12s.; stores, £213. 16s. 2d.; general, £192. 15s. 2d.	1,109	3	4
Sundry debtors for current supplied to Dec. 31, 1899	43,943	12	3
Other debtors.....	3,135	9	7
Cash at bankers (Messrs. Barclay and Co., Limited)	6,236	2	5
Cash in hand	25	17	3
Deposits with vestries, etc.....	676	19	0
Central Electric Supply Company, Limited, outlay on freehold site, etc.....	26,946	6	5
Advances under house-wiring agreements	367	19	1
Investments at cost	14,788	13	4
Cost of redemption of 5 per cent. and 4½ per cent. and issue of 3½ per cent. mortgage debentures, £5,617. 2s. 6d.; less written off, £1,617. 2s. 6d...	4,000	0	0
	£784,798	4	3

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STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Board of Trade units generated			7,361,745
Quantity utilised	Sold to consumers	6,329,544	6,392,224
	Used on works for lighting, meter testing, etc.	62,680	
Quantity expended in distribution	In batteries	28 042	817,654
	In feeders	789,612	
Total quantity accounted for			7,209 878
Quantity unaccounted for			151,867
Number of lamps on circuit, Dec. 31, 1899			421,445

NOTTING HILL ELECTRIC LIGHTING.

Directors: Sir William Crookes, F.R.S. (chairman); Arthur Ellis Franklin, Esq.; Alexander Howden, Esq.; James Thomas Jervis, Esq. Trustees for debenture-holders: Sir William Crookes, F.R.S.; Richard Biddulph Martin, Esq., M.P. Engineer and manager: G. Soltau. Secretary: R. G. Rawkins.

Report of the directors (with abstract of accounts) for the year ended Dec. 31, 1899:

The expenditure on capital account at the date of the last balance-sheet stood at £128,003. 19s. 4d., and during the past year a further sum of £9,346 14s. 3d. has been expended, of which £7,850. 10s. 6d. was on new mains and meters, and £1,000 in the acquisition of the buildings erected on the freehold land belonging to the Company in Victoria-gardens. This brings the total expenditure to £137,350. 13s. 7d., which is £6,350. 13s. 7d. in excess of the capital received. The only additional sum received on capital account was the £5,000 balance of instalments due on debentures issued in 1898. The following table shows the progress of the Company:

1891	Lamps	6 056	Loss	£554	18 6
1892	,,	9,438	Profit	112	6 1
1893	,,	12,153	,,	1 481	7 1
1894	,,	15 669	,,	2 101	17 8
1895	,,	20,307	,,	3,227	14 10
1896	,,	25,716	,,	4 736	9 8
1897	,,	33,000	,,	6 854	1 2
1898	,,	46 066	,,	7.251	13 7
1899	,,	59 154	,,	10,360	17 4

The number of consumers is now 1,012, and of these all but 15 per cent. are supplied at 200 volts. The cost of coal shows an increase of £430, or 30 per cent. over the amount of last year, whilst the amount realised by the sale of current shows an increase of 35 per cent. The pressure of the current at the same time has been kept up to its proper standard, and uniformly steady throughout the year. In accordance with the powers given to the directors on March 1, 1899, application was made to Parliament for an Act authorising the Company, in conjunction with the Kensington and Knightsbridge Electric Lighting Company, to purchase land and erect a joint station for the purpose of economically generating electricity in bulk. This Act received the Royal assent on July 13, and a committee consisting of Messrs. A. E. Franklin and J. T. Jervis, representing this Company, and Sir Frederick Bramwell and Mr. Granville R. Ryder, representing the Kensington and Knightsbridge Company, in conjunction with the engineers and secretaries of the two companies, have been engaged during the year in making arrangements for the erection of the necessary buildings, and their equipment with the most modern description of machinery. It is estimated that the expenditure on these joint works will amount to between £80,000 and £100,000, and it is proposed to raise the necessary capital by a loan to be redeemed by a sinking fund in the year 1931, when the property of this Company is liable to be purchased by the local authority. The two companies have entered into a mutual agreement to take current from the station in accordance with their several requirements, and to contribute each year, in proportion to the current taken, such amount as may be required for the working expenses and upkeep, together with the interest and sinking fund of the borrowed capital. In the year 1931 the property will revert, free of encumbrances, to the two companies in proportion to the respective amounts contributed. The directors anticipate that the result will be not only a greatly increased power in the production of electricity, but also that the shareholders will possess a reversion of considerable value, to accrue at the time when their present property is liable to expropriation, thereby constituting a large reserve fund, securing them against possible loss in case of undervaluation. In conjunction with the new works the directors propose to make considerable extensions in districts in the Company's area not hitherto supplied, where they have every reason to believe that remunerative business will be obtained. Should it be possible, as anticipated, to make these extensions during the current year, additional capital will be required, and as the present powers of the directors in this direction are limited to the issue of £19,000 of debentures at present unissued, it will be advisable to provide for an increase of capital. Should this contingency arise, a special meeting will be called in due course, when the details of the proposals will be brought forward for consideration and approval. Of the £10,360. 17s. 4d. profit, the directors have set aside £1,500 for depreciation and reserve fund, bringing the total amount up to £6,000. This they consider sufficient, partly in consequence of the arrangements detailed above, but especially in view of the fact that the whole of the capital expenditure of the Company, with the exception of the £3,833. 19s. representing the cost of provisional order and the purchase of patents, etc., is entirely represented by visible assets at prime cost. All repairs and renewals have been paid for out of revenue. After paying the debenture interest, amounting to £1,183. 6s. 11d., and 6 per cent. on the preference shares, amounting to £1,798. 16s., there is a balance of £5,827. 18s. 7d., out of which the directors recommend a dividend of 6 per cent. on the ordinary shares, amounting to £3,871. 4s., leaving a balance of £1,956 14s. 7d. According to the articles of association, one-half is credited to the holders of the founders' shares, and out of the other half, including the amount brought forward from last year, it is proposed to pay a further dividend of 1 per cent. on both the preference and ordinary shares, making 7 per cent. for the year, and leaving a balance of £64. 14s. 9d. to be carried forward. An interim dividend of 3 per cent. was paid on July 1, and the balance of 4 per cent. will be paid forthwith, together with a distribution of £1. 16s. per share to the founders' shares. The directors desire to place on record their appreciation of the services of the engineer and manager, secretary, and staff generally. It is with deep regret that the directors have to announce the death, in his eightieth year, of their esteemed colleague, Mr. Francis Radford, whose business capacity and important local influence greatly contributed to the success of the Company. The directors retiring in rotation are Messrs. A. E. Franklin and J. T. Jervis, who, being eligible, offer themselves for re-election. The shareholders' auditors, Messrs. Fox, Sissons, and Co., retire, and, being eligible, offer themselves for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel	£1,901	13	4			
Oil, etc., and engine-room stores	254	18	10			
Wages and gratuities	646	7	5			
Repairs and maintenance as follows:						
Buildings	4	12	10			
Engines, boilers	322	2	1			
Dynamos	47	5	9			
Other machinery, instruments, and tools	9	1	0			
Accumulators	493	19	6			
				3 680	0	9
Distribution of Electricity.						
Repairs, maintenance, and renewals of mains	165	4	8			
Wages of meter readers, etc.	35	16	8			
				201	1	4
Rates and taxes				649	11	10
Management Expenses.						
Fees to directors, trustees, and salaries	2,336	8	6			
Stationery, printing, and general establishment charges	222	16	4			
Auditors of Company	52	10	0			
Auditor appointed by Board of Trade	37	0	0			
				2 648	14	10
Special Charges.						
Insurances	99	14	11			
Law costs	15	1	8			
Costs of debenture issue	18	15	0			
				133	11	7
Connecting installations, and sundry stores				261	16	6
				7 574	16	10
Balance carried to net revenue account				10,360	17	4
				£17,935	14	2

Cr.	£	s	d.
Sale of current (665,129 units), less discounts and bad debts	16 423	3	2
Rental of meters, etc., on consumers' premises	654	8	11
Connecting installations, sale of stores, etc.	574	11	1
Rents receivable	273	1	0
Transfer fees, etc.	10	10	0
	£17,935	14	2

GENERAL BALANCE SHEET.

Dr.	£	s.	d.
Capital account—amount received	131,000	0	0
Sundry tradesmen and others	2 915	3	1
Sundry creditors	1 434	3	1
Depreciation, renewal, and reserve fund account	6,000	0	0
Founders' shares undivided profit account	31	7	6
Preference and ordinary shares undivided profit account	31	7	5
Balance at credit of net revenue account, £7,626. 14s. 7d.; less interim dividend on ordinary preference shares, £899. 8s.; interim dividend paid on ordinary shares, £1,935. 12s.	4,791	14	7
	£146,203	15	8

Cr.	£	s.	d
Capital account—amount expended for works, including cost of provisional order	137 350	13	7
Sundry debtors for current supplied, etc.	6,731	8	8
Other debtors	99	5	11
Stores on hand: coal, £24. 15s.; general, £367. 18s.	392	13	0
Stock (movable plant and tools)	241	9	11
Cash at bankers and in hand	388	4	7
Preliminary expenses, compensation, etc.	1,000	0	0
	£146,203	15	8

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

South Shields.—The Corporation invite tenders for cables. Tenders by March 11.

Blackburn.—The Corporation invite tenders for feeder cables. Tenders by 26th inst. Details in our advertisement columns.

Birkenhead.—The Corporation invite tenders for the supply and laying of feeder and distribution mains. Tenders by March 1.

Wasmes (Belgium).—The Municipality are open to receive tenders for the electric lighting of the district. Tenders by May 31.

Wimbledon.—The Urban District Council invite tenders for the supply of lamp-posts for incandescent electric lamps. Tenders by 26th inst.

Craiova (Roumania).—The Municipality invite tenders for the construction and working of tramways in that town for 45 years. Tenders by March 12.

Leeds.—The Tramways Committee invite tenders for one, two, or three steam dynamos. Tenders by March 21. Details in our advertisement columns.

Rochdale.—The Corporation invite tenders for the supply and delivery of electricity meters. Tenders by 28th inst. Full particulars in our advertising columns.

Bournemouth.—The Corporation invite tenders for cables, arc lamps, wiring, switchboards, fittings, etc., for the electric lighting of pleasure grounds. Tenders by March 3.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for 130 car bodies, trucks, and electric equipment. Tenders by March 2. Details in our advertising columns.

Aberdeen.—The Tramways Committee invite tenders for the supply of four electrically-equipped tramcars and other material. Tenders by Feb. 28. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the reconstruction of the Glasgow tramways and the construction of new tramways. Tenders by March 2. Details in our advertisement columns.

St. Annes-on-the Sea.—The Urban District Council invite tenders for battery and accessories and meters and demand indicators. Tenders by 26th inst. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the extension of the electric lighting at Shrubhill tramway power station, Edinburgh. Tenders by March 5. Details in our advertisement columns.

Gloucester.—The Corporation invite tenders for the wiring of the guildhall, public baths, and electricity works; also for the necessary electric light fittings for these buildings. Tenders by 27th inst.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for (A) one 50-ton electric crane; (B) one 25-ton hand-crane; (C) one 6-ton electric crane; and (D) one 2-ton hand crane. Tenders by noon on March 5.

Sunderland.—The Corporation invite tenders for the supply of steam, exhaust, feed, and other pipes, and two steam-driven induced-draught fans and accessories. Tenders by March 2. Details in our advertising columns.

Poplar.—The Board of Works are prepared to consider schemes for the fixing-up of consumers' houses for electric lighting free of all initial cost to the Board or the consumer. Tenders by March 1. Details in our advertisement columns.

Paris.—The Under Secretary of State for Post and Telegraphs invites tenders for about 230,000 yards of electric cable (india-rubber insulated). Tenders are to be addressed to that department, Rue de Grenelle, No. 103, by March 8.

Wigan.—The Corporation invite tenders for steam-piping, steam feed pumps (Weir), steam circulating pumps (Weir), feed-water heaters, feed-water piping etc. The whole in one tender. Tenders by March 3. Details in our advertisement columns.

Walthamstow.—The Council is prepared to receive tenders for the supply and erection of electric and Dowson gas plant (including cooking apparatus) at its isolation hospital, Chingford. Tenders by March 2. Details in our advertisement columns.

Shoreditch.—The Vestry invite tenders for the supply of various material and works for the electricity department and for street lighting. Samples can be inspected at the Town Hall, Old-street, E.C., or at the Coronet-street lighting station. Tenders by the 27th inst.

Keighley.—The Corporation invite tenders for the supply and erection of switchboard and balancer, 10-ton overhead travelling crane, storage battery, mains, conduits, arc lamps and posts, ejector condensers, exhaust pipes and tanks, and main, steam, and feed-water pipes. Tenders by March 1. Details in our advertising columns.

Salford.—The Corporation invite tenders for the supply and delivery and erection of electrically-driven mechanical stokers, economisers and fittings, jet condensers and pumps, with steam, exhaust, and water pipes, electrically-driven feed pumps and feed pipes, and travelling crane. Tenders by 28th inst. Details in our advertisement columns.

Farnworth.—The Urban District Council invite tenders for the supply, delivery, and erection of the following: Lancashire boilers, economisers, condensing plant, feed pumps, steam and exhaust pipes, etc., three 100-kw. steam dynamos, lighting switchboard, traction switchboard, accumulators, underground cables, travelling crane, and recooler tower. Tenders by March 7. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of tramways switchboard. Specifications and forms of tender can be obtained of Mr. J. F. C. Snell, borough electrical engineer, at his office, Dunning-street, Sunderland, on payment of two guineas. Tenders to Mr. Fras. M. Bowey, town clerk, by 12 noon on 26th inst. Details in advertisement columns.

Durban (Natal).—The Corporation are prepared to receive tenders for the supply and delivery at Durban of 1,900 tons steel girder rails, 64 tons fishplates, the necessary quantity of fishbolts, nuts, tie-bars, and electric bonds, 407 loads Australian hardwood stringers, the necessary quantity of dog-spikes, etc. Tenders by March 8. Specification, etc., may be obtained from Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation.

Lancaster.—The Committee of Visitors of the County Asylum, Rainhill, invite tenders for the supply and erection of three Lancashire boilers and superheaters and one Green's economiser; three 175-b.h.p. steam dynamos, with booster, switchboard, feed pumps, piping, tanks, cranes, and other accessories; secondary battery (1,200 ampere-hours capacity) and accessories; feeder mains (solid system); and wiring of buildings. Tenders by March 22. Details in our advertisement columns.

Horsham.—The Urban District Council invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, &c., pipework, etc., in engine and boiler house, two steam dynamos (vertical enclosed high-speed engines), and motor boosters, storage batteries, main switchboard and connections, six-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed type) and posts, station lighting. Tenders by March 1. Full particulars in our advertising columns.

Melbourne (Victoria).—The Corporation invite tenders for the supply and delivery of the necessary plant, and the superintendence of its erection, and of the carrying out of the work in connection with the electric lighting of the city, to specifications as follows: (1) boilers (dry-back or water-tube type, with superheaters) and economiser; (2) steam-engines, dynamos, equaliser, booster, and switchboard; (3) feeders, mains, and arc light leads, with all bitumen or insulating material; (4) accumulators. Specifications, etc., can be obtained from the Agent-General for Victoria, 15, Victoria-street, Westminster, London, S.W., on and after the 28th instant, on payment of £1. 1s. for each specification, to be returned on receipt by the Corporation of a bona fide tender. The specifications and drawings may be seen at (but not obtained from) the office of Dr. Alex. B. W. Kennedy, 17, Victoria-street, Westminster, London, S W. Tenders by March 1. Full particulars appear in our advertising columns.

RESULTS OF TENDERS.

Walsall.—The tender of the Babcock and Wilcox Company for a boiler has been accepted at £510.

Tanfield.—The Urban District Council have accepted the tender of the Co-operative Wholesale Society to instal another wire from Burnopfield to the church, Leazes, at £31. 18s. 6d.

Edinburgh.—The Council have accepted the tenders of Messrs. Mather and Platt for two 1,200-h.p. steam dynamos, at £12,319, and of Mr. G. Sinclair, Leeds, for four boilers, at £4,800.

Glasgow.—The Corporation have accepted the tender of Messrs. D. Bruce Peebles and Co., Edinburgh, for three 350-h.p. generators, direct coupled to Willans engines, for the contract sum of £7,500.

Hackney.—The Hackney Vestry have accepted the tender of the Tudor Accumulator Company, Limited, 16, Victoria-street, S.W., at £7,665, for the accumulators required for the municipal electricity works.

Newcastle.—The Tramways Committee have recommended the acceptance of the tenders for one 2,000-h.p. and two 1,000-h.p. generators of the Westinghouse Company, and the tender of Mr. F. S. Davidson, Heaton, for the laying of the foundation of the car-sheds at Byker. The tender of a Manchester firm has been accepted for the tramway track.

Luton.—Contracts with the following firms have been completed:

Tinkers, Limited (Section A)	£2,300
W. H. Allen and Co. (Section B, parts 1, 2, 5, and 6)	4,380
Nalder Bros. and Thompson, Limited (Section B, parts 3 and 4)	863
J. Wright and Co. (Section C, part 2)	1,162
Chloride Electrical Storage Syndicate (Section D)	1,725

Hastings.—The Town Council have accepted the following tenders: Electric Construction Company, Limited, Wolverhampton, for supply of 12 transformers at £49 each, £588; Cowans, Limited, Salford, switch gear, etc., required for eight sub-stations, £1,548. 16s. (and any additional switch gear the Council may require during the current year at the prices quoted); Higginbottom and Mannock, West Gorton, Manchester, overhead travelling crane, £313; Edison and Swan United Electric Light Company, Limited, to supply at the present time 5,000 200-volt incandescent lamps at the following prices: 8-c.p., 16-c.p., and 25-c.p. lamps, 1s. 1d. each; 32-c.p. lamps, 1s. 3d. each; 50-c.p. lamps, 2s. 6d. each; 100-c.p. lamps, 4s. 8d. each—less 2½ per cent. discount for cash in one month; extra for frosting, 9d. per dozen net (and to supply any additional lamps the Council might require during the current year at the same prices and on the same terms).

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BUSINESS NOTES.

TRACTION.

Nelson.—The Town Council is opposing the Burnley Tramway Bill.

Sowerby Bridge.—The Council are still negotiating with Halifax.

Elland.—A ratepayers' meeting has decided in favour of the Halifax Council's Bill.

Govan.—The Commissioners have appointed a sub-committee to make enquiries about electric traction.

Christchurch.—A satisfactory arrangement has been arrived at between the Council and the Electric Traction Company.

Blackpool.—The Town Council have refused to allow the Lytham and St. Annes Tramways Company to enter the borough.

Nerden.—The District Council have decided to support the Rochdale Tramway Bill and to oppose the Lancashire Electric Power Bill.

Hull.—The total cost of the electric tramways up to date is £109,360, and the results so far prove this to be an excellent investment.

Ilford.—The District Council have received official sanction for the borrowing powers for the installation of electric light and electric tramways.

Imperial Tramways Co.—The directors have decided to recommend a dividend for the half-year ending Dec. 31, 1899, at the rate of 8½ per cent. per annum.

Liverpool.—The consideration of various proposals for reduced fares on the tramlines has been postponed until the completion of the electric tramway system.

Renfrew.—On account of the decision of the Paisley Council to reconsider the Glasgow tramway scheme, the Renfrew Council are very much inclined to follow suit.

Clydebank.—The Commissioners have agreed to a proposal from Mr. Lee, of the British Electric Traction Company, asking them to meet with him to discuss terms.

Paisley.—After various decisions one way or another, the Town Council on the 19th inst. decided to consent to the Glasgow and District Tramways Company's Bill.

Bridlington.—Correspondence is taking place between the promoters and the Council with regard to the route of a proposed tramway from Driffield to Hornsea.

Cleethorpes.—All arrangements for doubling the lines in Grimsby-road have been completed, and the laying of the new rails will be commenced almost immediately.

Halifax.—The vote of the ratepayers and owners of Halifax on the Corporation Tramways Bill has resulted as follows: 8,700 votes in favour of the Bill to 2,351 against.

Swansea.—Application is to be made to the Light Railway Commissioners for an order authorising 10 tramway sections, for which the surveyor is now preparing plans.

Bristol.—In consequence of a difficulty arising out of the tenders to put Stewart-street in order the engineer has been authorised to proceed with the work with his own staff.

Bolton.—After considerable wrangling, the Town Council have negatived the motion for calling in expert advice with regard to the tramways, to which we have already drawn attention.

Broxbourne.—The promoters of the light railway scheme have withdrawn the application with respect to so much of the proposed line as was in the parishes of Hoddesdon, Wormley, and Broxbourne.

Ince.—At the last meeting of the District Council it was stated that the Council's instructions with regard to the South Lancashire Tramways Bill had been carried out, and the different clauses they asked for had been inserted in the Bill.

Bromley.—The portion of the South-Eastern Metropolitan Tramways Company's Bill relating to new tramways has been withdrawn, they having been unable to obtain the consent of the London County Council, who were the road authority for two-thirds of the proposed line.

Dumbarton.—The Town Council have decided that in the event of the Glasgow District Tramways Bill passing the Standing Orders of the House of Commons an expert be appointed to advise the Corporation on the effect of the works proposed by the Bill, and also to lodge a petition against the Bill.

Brighton.—The Council have declined to comply with the request contained in a memorial from certain owners and residents of houses in Gloucester-place, Marlborough place, and Grand-parade, requesting that the terminus of the tramways might be by the fountain at the south end of St. Peter's Church.

Teddington.—A petition is being prepared against the United Tramways (Extensions) Bill, but in the meantime the residents along the proposed tramway route will be afforded an opportunity of stating, yes or no, whether they are in favour of the overhead trolley system for supplying the cars with the electric current.

Central London Railway.—The daily Press is just now very busy with announcements to the effect that this line is to be opened in the near future. However, at Wednesday's meeting of the company, a report of which appears in another column, no mention was made of the date on which this happy event is to take place.

Finchley.—The Light Railway Commissioners will hold a public enquiry at Westminster on March 7 into the expediency of granting the application made to them by the Urban District Council for an order authorising that authority to construct light railways in their district.

Bury St. Edmunds.—On Wednesday afternoon a meeting was held at the Angel Hotel, Bury St. Edmunds, of those who are opposed to the proposed light railway from Attleborough and Diss to Thurston, and in favour of a direct line to Bury St. Edmunds. It was decided to canvass for signatures to a memorial stating the objections in detail.

Ilkeston.—The Electricity Committee have requested the engineer (Mr. V. B. D. Cooper) to prepare and forward all drawings, estimates, and descriptions of works as quickly as possible, so that the Corporation might be in a position to take the necessary steps to get sanction to borrow the money for the execution of the works.

Ashton.—At the District Council last week it was proposed that the resolution passed on Dec. 7, 1899, and all subsequent resolutions accepting the principle of the Wigan tramways or light railways going through the township, be rescinded. A long discussion followed, and finally an amendment that the Council adhere to the decisions previously arrived at was adopted.

Kingston.—The Surrey County Council last week, after a long discussion, adopted the following amendment with regard to the proposed tramway: "That the construction and the working of light railways in this county had best be left to private or local enterprise, under the strict supervision and control of the County Council, especially where the same are on county roads."

Ipswich.—The negotiations between the Council and the Ipswich Tramway Company have come to an end, and the matter will now go on until July next, when it will be competent for the Council to serve notice upon the tramways company requiring them to sell and convey to the Corporation their undertaking, the price to be settled by arbitration under the Tramways Act, 1870.

Moss Side.—The Urban District Council have agreed to a resolution that the scheme of tramways should include a line along Moss-lane East and Moss-lane West. An alternative scheme for constructing a line along Great Western-street is also under consideration. Petitions against the Lancashire Electric Power Bill and the Manchester Corporation Tramways Bill have been sealed.

Port-Glasgow.—Another conference was held on Monday between the Tramways Committee of the Police Board and the directors of the Greenock and Port-Glasgow Tramways Company, with reference to the offer made by the company for the leasing of the tramways system within the burgh. No agreement was come to. The committee are to meet Mr. Murphy, another of the offerers, next week.

Farnborough.—Messrs. Power and Traction, Limited, have agreed to alter the proposed gauge from that of the railway gauge—viz., 4ft. 6½in. to 3ft. 6in.—to meet the views of the local authorities on the points. The company also state that they have no present intention of carrying animals or minerals over the railway, except in the case of minerals required at the generating station.

Surbiton.—A committee has been appointed to deal with the Council's application for a provisional order for tramways, and of all the negotiations with the various public bodies and companies which have presented or may present memorials to the Board of Trade against the Council's order, and also of all the oppositions directed by the Council against various public bodies and companies.

Clerkenwell.—The Vestry have received a report from their Works Committee upon an application of the London County Council to run tramlines down Rosebery-avenue, and recommending that this be not granted until the London County Council had given an undertaking to widen Goswell-road, though they thought the question of the improvements in St. John-street-road might be dropped for the present.

Essex.—The West Ham Town Council and the East Ham, Ilford, and Leyton District Councils have tramway schemes in hand, some of which are already commenced, which, when completed, will form a network of municipal electric trams, extending over the major portion of South Essex—from Seven Kings, through Manor Park, East Ham, Forest Gate, Upton, Plaistow, Canning Town, Stratford, and Leytonstone and Leyton.

Rawtenstall.—The last report of the Electric Lighting Committee contains a recommendation to the Town Council to a petition in opposition to the Lancashire Electric Power Bill, 1900, and also states that a deputation from the Rossendale Valley Tramways Company, Limited, had attended before the committee and conferred with them as to the question of converting the Rossendale Valley steam tramways to the electric system.

Beetle.—A part of the new lines proposed by the Liverpool Overhead Railway Bill will come within this borough. No action will be taken by the Town Council, but they have resolved to petition in opposition to the Lancashire Power Bill. With regard to the electric tram service, it is stated that the line has been passed by the inspectors of the Board of Trade, but the Liverpool committee are not ready to put on the cars.

Anstey.—The Light Railway Commissioners have held an enquiry into an application for an order to authorise the construction of the Leicester, Anstey, and Newtown Linford Light Railway. At the conclusion of the enquiry Lord Jersey said the Commissioners were quite willing to recommend the Board of Trade to grant an order authorising the construction of the line to Anstey, but they reserved their decision with regard to the remaining portion of the scheme.

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Grimsby.—On the tramways report being discussed at the Town Council on the 20th inst. an amendment was proposed as follows: "That the Council considered the report of the committee altogether insufficient and inadequate to justify them in taking over the tramways, and considered that the negotiations with the company should be reopened, with a view of releasing under favourable conditions." After considerable debate the Council adjourned until Monday, when the discussion will be resumed.

Huddersfield.—It appears that a serious difference has arisen between the Huddersfield Town Council and the District Council of Linthwaite. We learn that, although Huddersfield has decided to make an annual payment to Linthwaite of £1,125 a year for right of way, the latter demand from the Corporation a rent of £75 per annum for three yards of street required in the proposed Marsden extension. Is now appears the former resolution to use overhead traction on that line has been abandoned in favour of steam haulage.

Yarmouth.—The Tramways Committee having opened tenders for the supply of 800 tons of steel girder rails and other materials for the proposed lines, recommended that as prices had increased 50 per cent. since the estimates were made, and in view of the probable increased rate of interest on loans, the work of laying the tramways should be deferred, and fresh tenders invited when the metal and money markets are easier. When the matter was discussed at the last meeting of the Town Council the resolution was referred back to the committee as being premature.

Sunderland.—At a meeting of the Tramways Committee of the Corporation on the 19th inst. it was reported that it was expected that the purchase of the company's undertaking would be completed by the 28th inst., the missing title having been discovered. On the suggestion of the electrical engineer, Mr. J. F. C. Snell, it was decided to recommend the Council to invite tenders for an electric snow-plough, which in the winter time would keep the lines free from snow, and which could also be used either as a brush, for pouring water on the lines, or as a general road-watering agent.

Stretford.—The Light Railway Commissioners have authorised the construction of freight railways between Barton-on-Irwell and Stretford. The title of the company will be the West Manchester Light Railways Company. The capital of the company will be £50,000 in 5,000 shares of £10, and the lines to be constructed as set forth in the order will be, roughly, three miles in length. The company may at any time within five years from the commencement of the order purchase by agreement from the Trafford Park Estates Company the tramway owned by that company, and about three miles in length.

Southampton.—It has been decided that the Electricity Committee undertake the maintenance of the entire electric equipment of the tramways at a charge of ¼d. per Board of Trade unit sold to the Tramways Committee; and, further, that the Electricity Committee provide a man to attend at the tramway depôt during the hours of running of the cars. The maintenance to include all ordinary repairs to car equipment and renewal of car lamps and overhead work, but no other renewals; and the necessary staff for the carrying out of this work to be supplied by the Electricity Committee.

Wolverhampton.—On the 20th inst. Sir Frederick Bramwell, arbitrator appointed by the Board of Trade, sat to hear evidence and determine the price to be paid by the Wolverhampton Corporation to the Wolverhampton Tramways Company, Limited, for the purchase of so much of their undertaking as lies within the borough. The proceedings were expected to extend over several days, but they suddenly collapsed on the two parties agreeing to the purchase of the tramways by the Corporation at an agreed figure of £22,500. It was also agreed that the Corporation should take over the tramways on May 1.

Heaton Norris.—The Parliamentary Committee of the District Council have recently decided to consult Messrs. Boote, Edgar, and Co. with reference to the various Tramway Bills—viz., the Lancashire Electric Power Bill, the Stockport Corporation Tramways Bill, the Manchester Corporation Tramways Bill, and the Withington District Council Tramways Bill—affecting Heaton Norris. Messrs. Boote, Edgar and Co. stated that there was nothing in any of the Bills which necessitated a petition against any of them. The District Council have, nevertheless, resolved that the Parliamentary Committee should have power to petition against any of these Bills if they were so advised.

Aberdeen.—The Road Sub-Committee's report, which has been adopted by the Town Council, states that the sub-committee regretted that, with every desire to assist the Town Council in their scheme of tramway extension, they could not see their way to recommend the District Committee to agree to the construction of the tramway as proposed. It was recommended, however, that the clerk be instructed, in communicating this decision to the town clerk, to state that the District Committee would be prepared to consider any other proposals which the Town Council might make, provided adequate precautions were adopted for the safety of the public. The Harbour Board will next week deal with a report on the proposed tramways.

Birkenhead.—Sir F. Bramwell has reserved his decision on the arbitration between the Wirral Tramways Company and the Corporation of Birkenhead. The arbitration is to decide, under Section 6 of the Birkenhead Corporation Act, 1899, the amount to be paid by the Corporation for the unexpired term of 16¼ years of the company's lease of tramways within the borough, the property of the Corporation; of 548 yards of tramway in the urban district of Lower Bebington; and of the stables, land, and buildings belonging to the company. The valuers on behalf of the company claimed from £30,083 to £30,485 as the value of the company's undertaking. The valuation of Mr. William Eve (William Eve and Son, surveyors and valuers, of Union-court, Old Broad-street), who said he had valued so much of the undertaking as the Corporation had to purchase under Section 6 of the Act, came to a total of £12 125, and, adding 5 per cent., £12,731.

Lowestoft.—The following proposal is being considered with regard to the East Anglia light railway—namely: "That the Council do withdraw its opposition to the confirmation of the company's order, the company to enter into an undertaking to construct the lines within the borough forthwith, and to pay a rental therefor of £150 per mile per annum. That the Council should apply for powers to construct the tramways from the Harbour Hotel to the northern boundary of the borough, and when these powers are acquired the Council should lease those powers to the company at a rental of £150 per mile per annum, the street widenings provided for in the agreement of May 12 last to be carried out by the company as therein provided, and the electricity required for motive power throughout the whole system to be supplied by the Council as provided by the agreement, and the agreement of May 12 last to be confirmed as far as applicable to the present arrangement."

Hythe.—Among the conditions under which the Town Council will assent to the Folkestone, Sandgate, and Hythe Tramways Bill is one which states that the company shall not, except with the consent of the Corporation, generate electricity within the borough, except for the purpose of supplying motive power for the trams, or sell or dispose of any such energy for use within the borough. Another stipulation is that the company shall not carry goods on the trams within the borough except between the hours of 10 p.m. and 10 a.m., or such other time as may be agreed upon between the Corporation and the company. The works are to be constructed under the superintendence of an officer appointed by the Corporation, and it is furthermore demanded that the company shall not construct any tramways within the borough unless and until they are in a position to construct new streets and street widenings as shown upon the plans, and that they should concurrently with the construction of the tramway make up and metal all the channels and gullies, and kerb and pave the footways.

Hyde.—At the last meeting of the Town Council it was reported that at a meeting held between the sub-committee representatives of Hyde, Stalybridge, Dukinfield, and Mossley Corporations, it was resolved to recommend the General Committee to appoint Mr. Robert Hammond, of Westminster, as engineer to report upon the feasibility of the proposed joint electric tramways and the provision of electrical lighting in connection therewith. This recommendation was deferred for further consideration at a later meeting, but the sub-committee were empowered to inspect any works they may deem advisable. A meeting has also been held between representatives of Hyde, Ashton, Stalybridge, Dukinfield, and Mossley Corporations and the Hurst Urban District Council, when the subject of a joint electric scheme was considered, but the matter being deferred to enable the representatives of the Ashton Corporation to report to their General Purposes Committee, the Electricity Committee of the Hyde Corporation approved the suggestion of the parliamentary agents that a private Bill be promoted by the Corporations of Hyde and Dukinfield. The report was adopted.

Southend.—It is proposed to adopt a 4ft. gauge and basaltic lava for the paving between the lines and on either side, with the exception of the distance between the Middleton Hotel and the G.E.R. Station, which will be woodpaved. Tenders are to be obtained under three separate heads for the cars—viz.: (1) for the bodies, (2) for the trucks, and (3) for motor and electrical equipment—and the successful tenderer for the latter is to put the whole together ready for street running at the car-shed of the Corporation; and instructions have been given accordingly with a view to tenders being submitted to the Council as soon as practicable. The report, which recommended the above, further states: "As to the number and carrying capacity of the cars, your committee proposes to invite tenders for six to carry 43 passengers each, to be delivered by March 15, 1901; four similar cars to be delivered by May 1, 1901; two to carry 67 passengers each and two to carry 20 passengers each, to be delivered by June 1, 1901; the latter alone to be of the single-decked variety. Your committee have instructed the borough surveyor to prepare plans and specifications with a view to tenders being invited for the erection of a car-shed to hold 20 cars, and also house adequate for boilers, engines, dynamos, and plant for the generation of electricity; the latter to be capable of future extension. It is intended, as already decided by the Council, to erect these on part of the Corporation's land at the rear of London-road (adjoining the new depôt), and for this purpose it will be necessary to obtain the sanction of the Local Government Board. Your Committee therefore recommend (c) that application be made to the Local Government Board accordingly. Your committee have also instructed tenders to be invited for all electrical equipment required in connection with the generating station and cars according to drawings and specifications prepared by Mr. Mitchell."

Ealing.—The *Uxbridge Gazette* gives the following extracts of the agreements between the Ealing District Council and the London United Tramways Company which have been exchanged recently: The company is to reimburse the Council the cost (but not exceeding £900) of its opposition to the London United Tramways Bill, 1898, and also to pay the costs of the Council in

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connection with the now abandoned application for a tramways provisional order and any costs the Council may incur in protecting its interests under the company's present Bill. There is to be an annual payment of £500 from the company to the Council, in addition to the ordinary rates, which are estimated to amount to between £300 and £400 a year. The tramways are to be paved with hard wood, and the design and position of the poles which will carry the overhead wires—and, indeed, most of the details of construction—are to be subject to the approval of the surveyor to the District Council. The ordinary fares are to be as follows: From Shepherd's Bush to Acton, 1d.; Acton to the Railway Hotel, 1d.; Railway Hotel to Hanwell, 1d.; but not more than 1d. is to be charged wholly within the district of Ealing. Workmen's cars are to be run at convenient hours morning and evening, and the fare by these cars is to be 1d. from Kasner's-corner, West Ealing, to Shepherd's Bush. The company's trolley poles are to be available for lighting purposes, the effect of this being to enable the Council to use the present lamp standards elsewhere if it desire to do so. The company undertakes to complete the construction of the section of the tramway from the north end of the Mall to Christ Church within 14 days, and to construct the West Ealing section in the shortest possible time. The company gets—what it has so long desired—permission (subject to the assent of Parliament) to connect the existing tramway at Acton with the authorised light railway from Hanwell to Uxbridge, and it also scores in securing the adoption of the overhead system of electric traction.

LIGHTING AND GENERAL.

Battersea.—A loan of £5,147 will be taken up for arc lamps and posts.

Buxton.—The electric light works will probably be ready by Easter.

Cardiff.—The Corporation are opposing the South Wales Electric Power Bill.

Bangor.—A loan of £10,000 has been obtained for the electric light works.

Bristol.—The Electrical Committee have been empowered to complete trading contracts.

Islington.—The Vestry on Friday adopted the recommendation given in full in our last issue.

Leamington.—Alderman Bland has been appointed chairman of the Electric Lighting Committee.

Harrogate.—The Town Council have received sanction to borrow £140 for an electric motor at their farm.

Walthamstow.—The Local Government Board have approved of the Council's electric lighting scheme.

Finsbury.—The electric light was switched on for the first time last week by Mr. T. Sparkes, electrician.

Whitehaven.—The Town Council have fixed the charge for electric current for motive power at 2d. per unit.

Arkley.—The Parish Council are renewing their application to the Postmaster-General for a telegraph office at Arkley.

Alfreton.—The Urban District Council have decided to apply for an electric lighting order for public and private supply.

Stirling.—It is reported that the electricity works are so far progressing that the opening will take place within the next two weeks.

Ryde.—Messrs. Kincaid, Waller, and Manville have been appointed consulting engineers in connection with the electric lighting scheme.

Liverpool.—The City Council have received sanction to the borrowing of the sum of £300,000 for purposes connected with the supply of electrical energy.

King's Lynn.—Application is to be made to the Local Government Board for power to borrow a sum not exceeding £10,000 for electricity works extensions.

West Ham.—The Electricity Committee have recommended the Council to purchase 25 series lamps at £355 net from the British Thomson-Houston Company.

Chester.—The Chester Corporation decided on Wednesday to apply for sanction to borrow £35,000 for carrying out an extension of the electric lighting scheme.

Ilford.—We learn that as a result of the deputation to the Local Government Board a loan of £68,500 for traction and lighting purposes has been granted.

Barnard Castle.—The Urban District Council have approached the Electric Lighting Committee with a view to supplying power from their proposed dust destructor.

Deal.—The question of jointly consulting an engineer for the proposed installation at Deal and Walmer has again been discussed, but no decision has yet been arrived at.

Woking.—The National Telephone Company's application to lay some of their mains underground will come before this week's meeting of the Urban District Council.

Leatherhead.—The Urban District Council are in correspondence with Messrs. Handcock and Dykes *re* the acquisition of the Council's electric lighting provisional order.

National Telephone Co.—The *Financial Times* learns that arrangements have practically been completed by the National Telephone Company for further issues of capital as follows: £500,000 4 per cent. second mortgage debentures and £500,000 in ordinary shares.

Bradford.—Mr. H. P. Boulnois held an enquiry on Wednesday into the application of the City Council to borrow £10,000 for the extension of the Corporation electric lighting and power stations in Valley-road. Of this amount £4,100 is for buildings and £5,100 for machinery and plant.

Omagh.—At an adjourned meeting on the 19th inst., Mr. D. A. Clements (chairman of the Electric Lighting Committee) said that the members of the committee had visited the Leap Mills falls along with a prominent engineer, and when there it was ascertained, although it was freezing at the time, that there was 70 h.p.

Brighton.—It appears that the Town Council are seriously considering the establishment of a municipal telephone exchange, and they have retained the services of Mr. A. R. Bennett, M.I.E.E., telephone engineer to the Corporation of Glasgow and other municipalities, who is to prepare a preliminary report as to the practicability and cost of introducing a municipal telephone service in Brighton.

Cardiff.—At the last Town Council meeting an estimate was submitted by Mr. N. Appelbee, electrical engineer, for the period ending March 31. 1900, in respect to the electrical department, which came to £5 833. 9s. 6d., to which must be added the estimated expenditure of £4,336, as against £3,347 in 1900 under the heading of loan charges account. The engineer estimates the revenue at £9,969 from the sale of electrical energy and £50 for work done for other departments.

British Insulated Wire Co.—With regard to the issue referred to by us last week of 30,000 6 per cent. cumulative preference shares and 30,000 ordinary shares, both of £5 each, we are informed that the former have been issued at £5. 10s. and the latter at £10, which in each case is less than the market price of the hitherto existing shares. The issue has been to shareholders only, who thus receive the benefit of the difference between the market price and the issued price. The issue, with the premiums, provides additional working capital of £465,000, which the directors are satisfied can be profitably employed.

London County Council.—The Council on Tuesday agreed to the Blackheath and Greenwich District Electric Light Company's notice of intention to lay wires of high and low tension along May's-buildings-mews, Greenwich; also similar notices from the Charing Cross and Strand Electricity Supply Corporation to lay mains along the east side of Savoy-street, from the Strand, across the Victoria-embankment, and along the subway in that thoroughfare, as far as the western boundary of the City, and of the Notting Hill Electric Lighting Company of intention to lay mains along a portion of Pitt-street.

London Gazette.—A receiving order has been made out *re* A. R. Earle, Norwich, on debtor's petition.—The first meeting in the estate of B. Symmons, Brighton, will be held on Feb. 28, at 2 p.m., at the Official Receiver's Offices, 24, Railway-approach, London Bridge, S.E., and the public examination on March 1, at 11 a.m., at Court House, Church-street, Brighton.—A dividend of 20s. per pound has been decided *re* the London Provincial Electrical Company, Limited.—The last day for sending in proofs in the estate of the Continental Water and Electrical Power Syndicate, Limited, is March 25. Mr. H. Meredith, of 95, Finsbury-pavement, E.C., official receiver.

Appointments Vacant.—The Swinton and Pendlebury Urban District Council are prepared to receive applications for the position of electrical engineer.—Applications are invited for the following posts at the Bury St. Edmunds Corporation electricity works: switchboard attendant, cable jointer, and engine driver.—There is wanted, for the Midlands, gentleman who knows the electrical accessories trade thoroughly, capable of drawing up a catalogue.—A switchboard assistant is required at Chester, and main superintendents at Barrow-in-Furness and West Ham. The latter borough also require a shift engineer. Full particulars will be found in another column.

Parliament.—In the House of Lords the following Bills were read for a second time on Feb. 16: Ipswich Corporation Tramways, Manchester Corporation Tramways, Lincoln Corporation Tramways; Feb. 19: Rawmarsh Urban District Council Tramways. In the House of Commons on Feb. 19 the following Bills were read a second time; Croydon Tramways and Improvements, Huddersfield Corporation Tramways, Manchester and Liverpool Electric Express Railway, North Metropolitan Electric Power Supply, Reading Corporation Tramways, Southport Extension and Tramways, Stockport Corporation Tramways; Feb. 21: Charing Cross and Strand Electricity Supply, London County Tramways.

Stock Exchange.—The Stock Exchange Committee have appointed Feb. 28 as a special settling day for the Hampstead Electric Supply Company's 6 360 ordinary shares of £5 each, fully paid, Nos. 1 to 2,652, 2 853 to 4,416, and 4,471 to 6,614; 8,038 5 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 5.330, 5,431 to 6,000, 15,763 to 16,912, and 16,918 to 17,905; 5,433 vendors' ordinary shares of £5 each, fully paid, Nos. 6,615 to 12,047; and 9,862 vendors' 5 per cent. cumulative preference shares of £5 each, fully paid, Nos. 5,331 to 5,430, and 6,001 to 15,762. The committee have also ordered the undermentioned securities to be quoted in the official list: London Electric Supply Corporation—further issue of £150,000 4 per cent. first mortgage debenture stock (redeemable); National Telephone Company—further issue of £670,529 3½ per cent. debenture stock; British Aluminium Company—15,000 7 per cent. cumulative preference shares of £10 each, fully paid, Nos. 1 to 15,000. Application has been made to appoint a special settling day in and to grant a quotation to the British Aluminium Company's 5 per cent. first mortgage debenture stock.

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Hetton-le-Hole.—On the account of the small support received the Telephone Company have refused to establish the connection asked for.

Guildford.—At the meeting of the Guildford Electricity Supply Company the Council's application as to the cost of the electric light being provided in certain streets was discussed.

Beckenham.—The Urban District Council have granted the Telephone Company an extension of time of six months for substituting the underground cables for overhead wires.

Ayr.—The lamp connections for the last month amount to 363 8-c.p. lamps. The consideration of Mr. Fuller's report as to the switchboard has been adjourned till the month of July.

Southend.—Mr. Mitchell, the borough engineer, having obtained another appointment, vacated his office on the 18th inst. Applications for the appointment of a successor are to be invited.

Books Received.—We have received from Messrs. E. and F. N. Spon a copy of a new work by Prof. Silvanus P. Thompson, entitled "Polyphase Electric Currents and Alternate-Current Motors."

Hampstead.—The Vestry's engineer has been authorised to obtain feeder panels, arc cable, meters, indicators, and other stores detailed in a report submitted to the committee, at an estimated cost of £397. 12s.

Cape Electric Tramways, Limited.—The dividend due will be paid to holders of warrants on presentation of coupon No. 5 at the offices of the Company, 55 and 56, Bishopsgate-street Within, E.C., on or after Feb. 26, 1900.

St. Albans.—The City Council are petitioning against the North Metropolitan Electric Power Supply Bill, 1900, the principal grounds of objection set forth being that the city would be injuriously affected by the Bill.

Uxbridge.—The Rural District Council have been approached with a view of obtaining a waiver of the limitations made by them on the Uxbridge Electric Lighting Syndicate's scheme, but they have decided not to alter their former decision.

Ilford.—A deputation is about to wait on the Local Government Board to obtain sanction for a loan to carry out the undertaking of the electric lighting and tramway scheme. Tenders are to be advertised for for the erection of buildings, etc.

Grays.—At the meeting of the Urban District Council last week it was decided to postpone the sealing of a tender for the erection of a refuse destructor until the Council had some more definite information of the prospects of the electric lighting scheme.

Rhyl.—The Board of Trade have consented to the Council's scheme for lighting the town by electricity. The Urban Council have applied to the Local Government Board for power to borrow the amount required for the electric light scheme and dust destructor.

Brighton.—At the last meeting of the Town Council the General Purposes Committee were criticised for helping the Lancashire Corporations to oppose the Lancashire Electric Power Bill, 1,900. An exception to the step was moved, but was defeated by a large majority.

Jarrow.—At a special meeting of the Town Council in committee to consider the applications of electrical companies to supply electricity for lighting and motive purposes to the borough, it was decided to support the application of the Durham Electric Power Company.

Electrical Regulating and Lighting Syndicate, Limited.—This Company has been registered, with a capital of £75,000 in £1 shares, to acquire patents and to carry on the business of electrical and mechanical engineers, etc. The subscribers reside at Bradford, Levenshulme, and London.

Chiswick.—The *Acton Gazette* says: "We sincerely hope the Chiswick District Council will be able to arrange for the lighting of the High-road by electric arc lamps. At present the terms of Messrs. Kincaid and Co. are too high, but a reasonable offer from this company may be expected in the long run."

Disley.—The question of making an application to the Board of Trade for an order to provide electric lighting for the district has been discussed by the Rural District Council. Enquiry is to be made as to the initial and other expenses likely to be incurred. A special meeting will be called to consider the subject.

Hove.—It is stated that the majority of the Town Council are very averse to adopting the electric light. As is known, the Town Council parted with their powers to a company, since which various experiments, on a restricted scale, have been made by the Lighting Committee, and these, it is said, have turned out indifferently.

Brush Electrical Engineering Co.—The directors, after placing the sum of £2,500 to depreciation reserve, have decided, subject to audit, to recommend payment of a dividend at the rate of 6 per cent. per annum on both the preference and ordinary shares of the Company for the half-year ended Dec. 31, 1899, carrying forward a sum of about £5,000.

Surbiton.—The negotiations with regard to the acquisition of the proposed site in the Beaconsfield-road for a generating station having proved unsatisfactory, a sub-committee has been appointed with authority to obtain from the consulting engineers and others statistics and particulars with regard to the suitability of the Council's land adjoining the offices as a site for the generating station.

Electrical Power Bills.—Owing to the strong opposition which has already been shown to these Bills, it has been agreed to postpone the second reading until probably March 9. The Bills referred to are the South Wales Electrical Power Distribution Bill, the Lancashire Electric Power Bill, the Tyneside Electric Power Bill, the Durham Electric Power Supply Bill, and the Dublin Electric Lighting Bill.

Rugeley.—In commenting upon the concessions made by the gas company the local paper points out they might have made a few more, and that those who are gas consumers have the remedy in their own hands, while in respect to the public lighting, if the Council wish to maintain their reputation for wisdom, they will lose no time in taking into consideration the question of electric lighting.

Buenos Ayres and Belgrano Electric Tramways Co.—The issue of £120,000 5 per cent. second debenture stock (part of a total authorised issue of £200,000) at a price of £97. 10s. per cent. is announced. The proceeds of this issue are required to complete the electric equipment of the Company's system, to provide for expenditure on new lines and increased rolling-stock, and for the general purposes of the Company.

Ashton.—Addition generating plant is required, and a report is being prepared on the subject. The Electricity Committee have resolved that the current supplied to incandescent lamps on the tramway company's poles in Trafalgar-square and other parts of the town be charged at the same price as to ordinary consumers, and that the cost of repairing the cables and wires leading to the lamps be dealt with in the usual way.

Grimsby.—Mr. R. H. Bicknell held an enquiry on the 19th inst. into the application of the Corporation for sanction to borrow £11,500 for purposes connected with the supply of electric power in the borough. The Borough Engineer (Mr. M. Petree) said the additional expenditure included an engine of 350 h.p., which with boilers, dynamos, etc., would cost £6,000, and £1,677 was required for consulting electrical engineers' charges.

Hartlepool.—The Town Council have instructed the borough engineer to prepare a scheme for electrically lighting the town in conformity with the provisional order, and have empowered him to obtain such electrical assistance as he may find necessary. They are taking steps with a view to opposing the Bill by which the County of Durham Electric Power Supply Company seek power to supply electricity within the union of Hartlepool.

Leadgate.—At the last meeting of the District Council a letter was read stating that a company was being formed for putting down electric works in the neighbourhood of Annfield Plain, and offering to supply electricity at 30s. per 16-c.p. lamp per season of 1,200 hours. Several councillors expressed the opinion that an improvement was wanted on the present system of lighting, and the matter was referred to the Lighting Committee.

Stirling.—Advertisements are to be issued for an assistant engineer, an engine-driver and fitter, two stokers, a switchboard assistant, a clerk and collector. The Telephone Company have received permission to erect a number of telephone poles, or, alternatively, lay the wires underground at Park-place. The Council have also agreed to allow the postal authorities to erect poles and wires between Port of Monteith Station and the Forth.

Yarmouth.—According to the quarterly electric light statement the gross income was £2,216. 5s. 9d. and the expenditure £1,189. 16s. 2d. After allowing £650 for repayment of capital, interest, etc., there was a net profit of £376. 9s. 7d. for the quarter, making the profit for the past three quarters £466. The number of lamps connected have increased from 5,800 in 1895 to 19,500. An increase of £50 per annum has been granted to Mr. Gordon Bryant, the electrical engineer.

Teddington.—At the District Council meeting last week, it was proposed to apply for an electric lighting provisional order. It was suggested that the Council should adopt a scheme similar to that which had been adopted at Beckenham, and also that a destructor be erected in connection with the installation. An amendment was proposed to the effect that the matter be referred back to the Electric Lighting Committee, and was carried on the chairman's casting vote.

Yeovil.—An electric plant has lately been completed at the skin-dressing yards and factory of Messrs. Ewens and Johnson, glove manufacturers. The plant consists of a Taunton dynamo, 65 16-c.p. lamps, and a ½ h.p. motor. The current, which is generated at the dressing yards, is transmitted to the factory by an underground concentric cable 200 yards long. Andrews's patent concentric system of wiring has been used, the whole of the work being carried out under the direction of Mr. W. H. C. White, of Yeovil.

Walsall.—The total number of consumers supplied on Jan. 31 last was 156. The total units generated at the station during the month of January were 44,967. The annual balance-sheet and profit and loss account of the electric lighting undertaking shows a profit, after paying interest and sinking fund, of £61. 13s. 5d. for the year ending Dec. 31, 1899. The money received for current during the year was £3,768. 16s. 10d., but the expenses have been £2,232. 15s. 9d., and the interest and sinking fund for the one year amounted to £1,474. 7s. 8d.

Nantwich.—At the last meeting of the Urban District Council draft answers and observations of the Council to the objections of the Nantwich Gas Company, Limited, to the proposed application of the Council for a provisional order for electric lighting were considered. A letter from the parliamentary agents on the same subject was also read. It was resolved that it be recommended that the answers be approved, and at the same time the parliamentary agents be informed that the Council might be willing to treat with the gas company for the purchase of the works at a fair price.

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Limerick.—Mr. Fraser, the engineer of the Shannon water and electric power scheme, attended the last meeting of the Council and explained the scheme. Finally, a resolution was passed referring the matter to a committee of the whole house, and that an expert be engaged, to be approved of by the promoters, to report as to the effect which the carrying out of the scheme might have on the waterworks. Mr. Fraser gave a verbal undertaking that the fee for an expert would be paid by the promoters, the charge not to exceed 100 guineas.

Lowestoft.—The question of applying for a municipal telephone license has been deferred for the present, but Mr. Hawtayne has been directed to lay a 4in. pipe for telephone purposes in the same trenches in which the electric light cables will be laid, and also to report upon the probable cost thereof. A deputation consisting of five members of the Council is to be appointed to visit other towns where the electric lighting is in operation, to examine the working thereof, and enquire as to the charges for the same, and report thereon to the committee. Improved "Prism" globes are to be fixed on the electric light arc lamps and posts, at an extra cost of £6. 8s.

Prescot.—A number of extensions have been made during the last two years in the works of the British Insulated Wire Company, Limited, including the reorganisation of the electric lighting station, the doubling of the railway siding, the putting down of condensers from motives of economy, and, most important of all, the building and equipment of the copper-rolling and wire-drawing plant. When the latter are in working order, probably this month, most of the wire required will be made on the premises. The amount now used in making the cables is 20 tons per day, worth £2,000. Some £60,000 was spent at the Prescot works last year in making extensions.

Rowley.—At a meeting of the District Council on the 19th inst. a special committee reported that they had considered the electric lighting question, and found that by the provisional order obtained the Midland Electric Corporation had secured the powers within the district of the Council, and might light some of the streets, if not all, with electrical lamps. The committee also considered the question of establishing destructors for house refuse, the generating of electricity by them, and recommended that the matter be deferred for a month or two. It is significant that they recommended that no action be taken at present to provide extra gas lamps. The recommendations were agreed to.

Gateshead.—The Town Council have adopted a report of the Electric Lighting Committee, recommending that as the Corporation already had an agreement with the Electrical Power Distribution Company, and that company had had a provisional order granted in respect of the whole area of the borough, the interests of the Corporation would be adversely affected if the Bill of the Tyneside company became law, and, therefore, they recommended that the Council petition against it. They also recommended that, subject to the County of Durham Electric Power Supply Company amending their Bill in such manner as may be considered necessary by the town clerk, the Council support that Bill.

"English Illustrated Magazine."—The March number of this magazine has been issued, and is pleasantly different from the fellows of its tribe as we meet them on the bookstalls at present. The editor has apparently realised the feeling of surfeit of articles warlike and military from which the British public is suffering just now. The morning papers are full of them, the evening papers ditto, the weeklies no less, and lately nearly every article of every monthly came under the same category. So he has wisely refrained from ringing the changes on soldiers and guns, and has produced a number containing short stories and a few excellent articles of general interest which one can sit down and quietly enjoy.

Bristol.—The Sanitary Committee on the 15th inst. again discussed the lighting of Chantry-road, White Ladies'-road. There was a suggestion that it should be lighted with incandescent electric lamps, instead of gas lamps, as it was thought it would be an interesting experiment if carried out as far as possible on conditions similar to those applied to gas. The Electrical Committee reported that the cost of erecting the electrical lamps and fittings would be the same as for gas—£16. 5s. The cost for gas lighting per annum would be £14. 12s. 6d. with lamps of 15 c.p., as compared with £13. 4s. 3d. for incandescent lamps of 16 c.p., £20. 14s. for 32 c.p., and £27. 13s. 10d. for 80 c.p. It was agreed to make the experiment of having the 16-c.p. electrical lamps, which would cost £13. 4s. 3d., as against £14. 12s. 6d. for gas.

Taunton.—At last week's meeting of the Town Council the Electric Lighting Committee presented the statement of accounts for the past year, showing a credit balance of £603 on the year's working after paying all charges, including interest and payment to sinking fund. This, with the balance of £794 brought forward from the 1898 account, makes £1,398 to be disposed of. The committee recommended the carrying of £904 of this surplus to the renewal account, the application of £300 towards the reduction of the general district rate, the setting aside of £100 for payment of principal of temporary loan, and the carrying forward of £94 to the current year's account. These recommendations were adopted, and it was unanimously decided to promote a presentation to Alderman Potter, the chairman of the committee, in recognition of the strenuous efforts he had put forth for the last seven years to make the undertaking a financial success.

Edison and Swan United Electric Light Co.—An extraordinary general meeting of this Company will be held at the Westminster Palace Hotel, Victoria-street, on Feb. 27, at 12 noon, for the purpose of considering, and if deemed desirable, of passing, a resolution authorising the directors to create and issue debenture stock providing for the payment of principal sums not exceeding £300,000 and carrying interest at a rate not exceeding 5 per cent. per annum, such debenture stock to be secured in such manner (subject to the existing debenture stock already issued by the Company to the amount of £350,000) and to be issued to such persons and on such terms as the directors shall think fit. The directors have issued a circular to the shareholders in which they explain that this step is taken in consequence of the rapidly increasing business in lamps, fittings, and the numerous accessories involved in electric lighting.

Personal.—We learn that, owing to the death of his brother in consequence of an accident in the hunting field, Mr. C. E. Hodgkin has been compelled to resign his position as works manager at the Falcon Works of the Brush Electrical Engineering Company, Limited. On terminating his duties at the Falcon Works, Mr. Hodgkin will join the Board of the Brush Company.—We are also advised that Mr. Frederick Theodore Eggers having tendered the resignation of his position as managing director and secretary of the British Schuckert Electric Company, the same has been accepted, and his connection with this company ceased entirely as and from Feb. 15. Mr. Arthur George Seaman has been appointed manager and Mr. H. J. Clement Wells secretary to the company.—Mr. A. J. Lawson, late engineer and manager of the County of London and Brush Provincial Electric Lighting Company, has been the recipient of a silver inkstand with the following inscription: "Presented to A. J. Lawson, Esq., M.I.E.E., by the engineering staff of the County of London and Brush Provincial Electric Lighting Company as a mark of their esteem."

The "Practical Engineer" Pocket-Book.—We have received a copy of the "Practical Engineer" electrical pocket-book for 1900. The book contains an immense amount of information on electrical subjects, and is very well got up. The book starts with the usual tables on various subjects, such as wire gauges, square roots, and the circumferences of circles. Explanations of electrical units and terms are then given and resistances of various metals and alloys. Farther on in the book, however, we notice that a great deal of space is taken up in describing various meters and instruments. These things are rather more suitable for a text-book than a pocket-book, and their omission would leave a much larger space for the diary. This diary is on quadrille ruled paper, and would be very useful to the engineer wishing to make a rough sketch or put down figures. As it is, however, the space for each day is so extremely limited that very little could be put down. We, however, apart from this, do not see anything else to criticise adversely, and think that except for the defect mentioned the book is well worth the price charged for it, and we can recommend it to all electrical engineers.

Glasgow.—Following up the receipt of the license received by the Corporation to inaugurate a telephone service in Glasgow, the committee in charge of the scheme are, according to the *Dundee Advertiser*, actively engaged in carrying it out. They have had a conference with their telephone engineer, Mr. Bennett, London, and it is expected that a complete installation of telephones will be in working order within the next 12 months. In regard to the suggestion that intercommunication should take place between the Corporation and the National Company's telephones, it is pointed out that that could have been done had their license extended to 1919 instead of till 1913, as arranged. In that case, of course, the company could also have got their license extended, and the committee therefore thought it advantageous that the competition should cease at the earlier period. The service will accordingly be an independent one, and the twin-wire underground system will be adopted, by which, of course, subscribers will not be able to overhear conversations not intended for their ears. The committee are confident that if they can supply this improved method for £5. 5s. a year, instead of £10, which is the rental at present, they will soon have a larger number of subscribers than the Telephone Company now have.

Bath.—According to the *Guardian*, Mr. Metzger has proposed two schemes of allowing discount: (1) That consumers using current to the annual value of from £20 to £35 be allowed 5 per cent. discount; from £35 to £50, 7½; from £50 to £65, 10; from £65 to £80, 15; from £80 to £100, 20; over £100, 25. Had these rates prevailed last year it would have reduced the income by £150. 4s. 2d. (2) From £20 to £30, 5; from £30 to £40, 7½; from £40 to £50, 10; from £50 to £70, 15; from £70 to £100, 25; over £100, 33⅓. This would have reduced last year's income by £278. 7s. 1d. In the event of all consumers being supplied at 4½d. per unit, the reduction in revenue would be £754. 16s. 6d., and having heard that the committee recommended the following rates: distinctly private houses to be charged 4½d.; prices for business premises to be, under £30, 5d.; above £30 and under £100, 4½d.; above £100, 4d. The reduction of income under this last scheme would be £726. 11s. 8d. Our contemporary understands that the following amendment to the report has been carried: "Inasmuch as the difference between the recommendation of the Works Committee and a uniform charge of 4½d. would not exceed £28 per annum, resolved that a uniform charge of 4½d. per unit be made for current consumed for lighting, and that discounts of 10 per cent. be allowed on all accounts of £100 and over, such discounts to be allowed on the four quarterly accounts in each completed year, and that such alterations be made as from June 30 next."

Catalogues.—We have received from Messrs. Thos. Parker, Limited, of Wolverhampton, the third edition of their pocket price-list of dynamos, motors, etc. The list gives some very useful general information with reference to continuous-current dynamos and motors, such as the magnet windings, magnets, bed-plates, bearings, armatures, commutators, brush gear, etc. We notice

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also that throughout the whole list good illustrations are given of the various motors, dynamos, electric locomotives, switches, and resistances. The firm evidently believe in standardisation, as all their machines are described as standard patterns, and for all these the voltages, dimensions, and weights are given. At the end of the book is a list of five towns to which Messrs. Parker, Limited, have supplied plant of the continuous-current type.—We have also received from Messrs. Heathman and Co., of Endell-street, W.C., a list of the ladders manufactured and supplied by them. These ladders are of the usual type, but we notice that the firm make a speciality of telescopic ladders, similar to those used for the cleaning and repair of street electric arc lamps.—From Messrs. Edison and Swan we have received one of their "Ediswan" blotters. This contains several pages of blotting paper, interleaved with pages containing illustrations of the various types of lamps supplied by the firm. A calendar is given on the front page. On the last leaf we notice some very apt Shaksperian quotations applicable to the "Ediswan" lamp.

Chester.—At Wednesday's meeting of the Town Council the following recommendation of the Lighting Committee will be considered: "That the committee be authorised to have an extension of the electric light works carried out, and to authorise application being made to the Local Government Board for sanction to borrow the further sum of £35,000 to defray the cost and provide for the extension of mains, services, lamps, etc., as required, and to authorise the mayor to affix the corporate seal to any documents which may be necessary to give effect to this recommendation." Mr. H. Beswick, architect, has presented a report upon the proposed extension of the existing buildings estimated at £7,220. The engineer (Mr. F. Thursfield), in a report on the subject, says that nearly the whole of the plant at the works has been in regular use each evening this winter. The present works contain engines of 1,350 h.p. The demand for electric lighting during the last three years has been such that the whole of the machinery, with the exception of a margin for casualties, has been brought into daily use. And as the applications for lighting and power continue to come in as rapidly as ever, if not more rapidly, it is evident that provision must be made for considerable extra power. In the extensions proposed allowance has been made for an extra 1,800 h.p. The main principles of the existing plant have been copied, and the extensions have been drawn out on the lines provided for in the original scheme. It is proposed to make such arrangements that the whole of the new machinery may be rapidly isolated from the old and worked quite independently in case of accident. In this way it is hoped to partially combine the security afforded by two separate works with the economy gained by concentration. The only parts which will not be in duplicate are the main flue, the chimney, and the switchboard. Mr. Thursfield proceeds to deal with the alterations and additions he suggests, which he states will cost approximately £11,000. This sum includes £3,165 for the engine and dynamo already ordered, and £360 for two mechanical stokers and motor if desired.

PROVISIONAL PATENTS, 1900.

FEB. 12.

2734. Improvements in apparatus for signalling the approach of electric trams operated on the overhead system. Wesley Ralph Stearns, Fairfield, Kingston-on-Thames.

2742. Improvements in apparatus for firing submarine mines by means of Marconi's wireless telegraphy. Felix Mayländer, 31A, Alte Luisenstrasse, Potsdam, Germany. (Complete specification.)

2755. Improvements in collectors for electric trams on the overhead system. George W. Bolser, Fairfield, Kingston-on-Thames.

2767. Improvements in long-distance relay magnetic telephones. Jacques Nessel and Jean Frederic Gouin, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2783. Improvements in electrical arc furnaces. James Yate Johnson, 47, Lincoln's-inn-fields, London. (The Deutsche Gold und Silber Scheide Anstalt vorm. Roessler und Birger Carlson, Germany.)

2797. Improved telephonic receiver for messages sent by means of electromagnetic oscillations and signs of the Morse alphabet. Alexander Stephanovich Popov, 70, Chancery-lane, London. (Complete specification.)

FEB. 13.

2842. Improvements in and relating to thermostatic circuit controlling apparatus. Alfred George Brookes, 55, Chancery-lane, London. (Edward Francis Woodman and Henry Anthony Fiske, United States.) (Complete specification.)

2843. Improvements in clips or devices for holding electric lamps or the like. Robert Hacking, 111, Hatton-garden, London.

2850. An improved device for adjusting the height of electric lamps or fittings. Conrad Krauss Falkenstein, 67, Lanercost-road, Tulse-hill, Surrey.

2857. Improvements in or relating to phonographs and like instruments for recording and reproducing sound. Thomas Bennett Lambert, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2862. Improvements in electric traction motors. Charles Richter and Richard Theodore Eschler, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2880. Improved system of and means for regulating electric machines. William Henry Cooley, 55, Chancery-lane, London.

2897. Improvements relating to electric railways. William Chapman, 322, High Holborn, London.

FEB. 14.

2929. Improvements in electrolysers. William Thomas Chapman and Walter Elliott Batt, 5, John Dalton-street, Manchester.

2948. Improvements relating to fuses for electric circuits. George Whittaker Holt, of the Imperial Electrical Engineering and Stamping Company, 18, Southampton-buildings, Chancery-lane, London.

2951. Improvements in the methods of insulating electrical conductors. John Frederick Wakelin, Charles James Weston, and William Bunn, 5, Tottenham-street, Tottenham Court-road, London.

2952. Improvements in the methods of insulating and fixing electrical conductors. John Frederick Wakelin, Charles James Weston, and William Bunn, 5, Tottenham-street, Tottenham Court-road, London.

2964. Improvements in and apparatus for the manufacture of pipes or conduits for electrical conductors or for conveying liquids or gases or for analogous purposes. Albert Harris Howard, 47, Lincoln's-inn-fields, London.

2987. Automatic phonograph. Karl Löschner and Otto Wilhartitz, 99, Cannon-street, London.

2994. An improved process for the electrolytic deposition of nickel or its allied metals. Moritz Kugel, 6, Lord-street, Liverpool.

FEB. 15.

3013. Electrical displacement switch. James Cusworth, 41, Park-road, Newcastle-on-Tyne.

3021. The automatic trolley pole arrester for electric tramcars. James Thomas Hale and Frederick George Hale, 24A, Park-place Machine Works, Liverpool.

3031. Improvements in electricity meters. Charles William Godson Little, Heckington, Lincolnshire.

3033. Improvements in and connected with electric accumulator plates or electrodes. Francis Louis Berners and James Arnold Smith, 297, Queen's-road, Battersea, London.

3043. Improvements in voltmeters and ammeters. Carl Raab, 6, Lord-street, Liverpool.

3056. Improvements in electric meters. Victor Isidore Feeny, 60, Queen Victoria-street, London. (Allgemeine Elecktricitäts-Gesellschaft, Germany.) (Complete specification.)

FEB. 16.

3063. An improved method of controlling trolleys of electric cars. Robert Arthur Bolton, Sylvan House, Belmont-avenue, Donnybrook, Dublin.

3081. Improvements in electrical apparatus for signalling from passengers in a moving train to the engine-driver and guard. Aubrey Ernest Radbourne, 128, Colmore-row, Birmingham.

3104. Improvements in magnetic locking devices for miners' lamps. Franz Müller and Franz Eumes, 57, Barton-arcade, Manchester. (Complete specification.)

3105. Improvements in systems of electrical distribution and safety apparatus therefor. Lyman Coleman Reed, Warren Bettison Reed, and Edgar Howard Farrar, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3106. An automatic electric circuit breaker. Lyman Coleman Reed, Warren Bettison Reed, and Edgar Howard Farrar, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3107. An improvement in isolated alternating low-tension systems of electrical distribution. Lyman Coleman Reed, Warren Bettison Reed, and Edgar Howard Farrar, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3108. Improvements in arc lamps. Walter Claude Johnson and Adolph Wunderlich, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

3120. Improvements in means for regulating pressure in electric mains. Herbert William Butler, 47, Lincoln's-inn-fields, London.

3124. Methods of and apparatus for manufacturing movable coils for use in connection with electrical measuring instruments. Edward Weston, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3142. Improvements in or relating to electric relays. Edward William Brown, 111, Hatton-garden, London.

3144. Improvements in or relating to telephones. Edward William Brown, 111, Hatton-garden, London.

3145. Improvements in or relating to telegraphic instruments. Edward Wiliam Brown, 111, Hatton-garden, London.

3150. Improvements in trolley poles and standards for electric traction. Robert Price Strachan, 70, Chancery-lane, London.

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3174. Improvements in and connected with long-distance telephony. Morris Clinton Mengis, 70, Market-street, Manchester. (Complete specification.)

3192. Electric battery and its arrangement in connection with electric motorcars. Angel de Castro and Henry Wilhelm Schlomann, 322, High Holborn, London. (Complete specification.)

3196. A new or improved telegraphic apparatus. Louis Wojniewicz, 8, Quality-court, Chancery-lane, London. (Complete specification.)

3200. Improvements in and in the process of manufacturing filaments for electric incandescence lamps. Victor Thomas, 53, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 8, 1899, being date of application in France.)

3203. Improvements in interruptors for electric circuits. Jean Lecarme and Louis Lecarme, 78, Fleet-street, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published March 10.

1899.

3469. Primary battery. Encausse and Encausse.

3869. Coin controlled and registering telephone apparatus. Cranston and Williams.

4941. Governing of electric motors. Eck.

5392. Controlling switches for electric motors. Earle.

5486. Electric incandescence lamps. Allingham and Fennell.

5647. Secondary batteries. Gladstone and Beckett.

5657. Apparatus employed in wireless telegraphy. Marconi and Wireless Telegraph and Signal Company, Limited.

6473. Electrical apparatus for igniting gas-burners from a distance. Bollé. (Fitzlaff.)

7364. Means for controlling and indicating the supply of electrical energy. Kunkelmann, François, and Loubery.

7584. Electric switches and cut-outs. Crompton and Co., Limited, and Dix.

7681. Electrical apparatus for diminishing the apparent self-induction of alternating-current circuits and capable of being used in lieu of condensers. Abel. (Soc. Anon. pour la transmission de la Force par l'Electricité.)

7800. Fusible electric cut-outs. Calthrop. (Peebles.)

8052. Means for controlling electric circuits which will allow a circuit to be broken and completed from another circuit. Edmunds.

8053. Device for automatically effecting the breaking of an electric circuit after a predetermined time. Edmunds.

9009. Apparatus for breaking high-tension circuits. Sprecher.

11436. Rheostats. Flohr and Dietze.

18776. Arrangement of driving mechanism for connecting electromotors to machinery. Gibbs.

21742. Electric railway rail bonds. McTighe. (Date applied for under International Convention, May 24, 1899.)

21780. Electric relays. Lake. (Nixon.)

23829. System for the generation of electric currents at constant potential. Koppelmann.

24148. Electric furnaces for making glass and other analogous substances. Lühne.

24184. Electrically-propelled vehicles. Newman and Ledwinka.

25011. Primary electric battery. Thompson. (Fontaine.)

1900.

147. Electric water-filters. Tetes and Heany.

675. Electric batteries. Lake. (McCartney.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Feb. 17	3,569	2,924	− 355	27,022	26,206
Blackpool-Fleetwood	,, 17	99	178	− 79	969	1,060
Bradford City Trams	,, 11	295	263	+ 32	25,947 *c*	—
Bristol Tramways Co.	,, 16	2,217	2,594	− 377	—	—
City & South London	,, 18	1,160	1,087	+ 73	7,898	7,858
Dover Tramways	,, 17	131	147	− 16	1,028	1,000
Dublin U.T., elec. cars	,, 16	2,710	905	+1,805	—	—
Dublin S.D. Electric	,, 16	529	639	− 90	—	—
Halifax Corporation	,, 18	467	324	+ 143	26,927 *a*	9,126 *b*
Hull Corporat'n E.S.	Jan. 13	682	—	—	—	17,711 *e*
Liverpool Corporat'n	Feb. 10 *d*	5,912	5,753	+ 159	39,008	34,456
Liverpool Overhead	,, 18	1,243	1,297	− 54	10,140	9,053
Sheffield Corporation	,, 18	1,643	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1, 1899. *b* Since June 29, 1898.
c Total receipts. *d* Partly electrical. *e* Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Tuesday.
Commercial and Industrial.—		
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¾-⅞
British Insulated Wire, Ord., 1-40,000	5 ..	13-14
—— 6 per cent. Cum. Pref., 1-27,500	5 ..	6-6¼
—— 5 per cent. Mortgage Debentures	100 ..	98-103
British Electric Works, Ordinary, 50,001-95,000	1 ..	15/10-1 1/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	⅞-1
—— 4½ per cent. First Mortgage Debentures	103 ..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¼-5¼
Brush Electrical Engineering, Ordinary	2 ..	1¾-2¼
—— Non. Cum., 6 per cent. Pref.	2 ..	2¼-2⅜
—— 4½ per cent. Debenture Stock	100 ..	110-115
—— 4½ per cent. 2nd Debenture Stock	100 ..	102-105
Callender's Cable, Debentures	100 ..	110-115
—— Ordinary	5 ..	13½-14½
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	3 ..	3¾ 4
—— 5 per cent. Debentures	— ..	98-101
Edison and Swan United, Ordinary	3 ..	2-2¼
—— 5 per cent. Debentures	5 ..	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100 ..	93-95
Electric Construction	2 ..	2¼-2¼
—— 7 per cent. Cumulative Pref.	2 ..	2¾-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	103-106
Giffre Electro-Chemical and Power, Ordinary	1 ..	¾-1⅛
W. T. Henley's Telegraph Works, Ordinary	5 ..	13½-14½
—— 4½ per cent. Preference	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	111-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-22
—— 4 per cent. Debentures	100 ..	100-104
Telegraph Construction and Maintenance	12 ..	37-41
—— 5 per cent. Bonds	100 ..	102 105
Telegraph Manufacturing, Ordinary	5 ..	9-10
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	9½-10½
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	104-106
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 4½ per cent. Cum. Pref.	10 ..	10-11 xd
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	8¼-9½
Charing Cross and Strand	5 ..	10-11
—— 30,001-50,000	5 ..	10-11
—— 4½ per cent. Cum. Pref.	5 ..	5⅞-6½
Chelsea Electricity Supply	5 ..	7¼-8¼
—— 4½ per cent. Debentures	100 ..	110-112
City of London, Ordinary	10 ..	10½-11½
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-127
County of London and Brush Provincial, Ordinary	10 ..	9½-10½
—— 6 per cent. Cum. Pref.	10 ..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	— ..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	4½-5½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	8 ..	8-8½
London Electric, Ordinary	3 ..	1¾-2¼
—— 6 per cent. Pref.	5 ..	4¾-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	101-103
Metropolitan, Ordinary	10 ..	14-15
—— 62,501-85,000	10 ..	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100 ..	95-97
Notting Hill Electric Lighting	10 ..	16-17
Oriental, 1879	1 ..	1¼-1⅜
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	6¾-7½
River Plate Electric Light and Traction, Deb.	100 ..	75-85
Royal Electrical Company of Montreal	1½ ..	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
South London, Ordinary	3 ..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	15-16
—— 40,081-52,080	5 ..	15-16
—— 7 per cent. Pref.	5 ..	9-9½
Westminster, Ordinary	5 ..	14-15
Electric Railways.—		
Central London, Ordinary	10 ..	9½-10
—— Pref. Half-Shares	5 ..	4⅝-5
—— ,, ,, deferred	5 ..	4⅜-5
City and South London, Consolidated Ordinary	100 ..	58-61 xd
—— ,,	5½ ..	4-5
—— 4 per cent. Debenture Stock	100 ..	125-130
—— 5 per cent. Pref. Stock '91	100 ..	140-145 xd
—— ,, ,, '96	100 ..	132-137 xd
Liverpool Overhead, 5 per cent. Pref.	— ..	13-13½
Waterloo and City, Ordinary	100 ..	101-104 xd
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10 ..	17½-18½
Brisbane Tramway	100 ..	104-106
British Electric Traction, Ordinary, 1-30,000	10 ..	16-17
—— 60,001-75,000	10 ..	15½-16½
—— 6 per cent. Cm. Pf. 30,001-60,000	10 ..	13½-13⅝ xd
—— 5 per cent. Perpetual Debenture Stock	100 ..	125-128
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5 ..	4¼-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4-4½
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
Costa Rica Electric Light and Traction, 5 per cent. First Deb., 1-1,000 of £100 and 1,001-1,600 of £50 each	— ..	75-85
Isle of Man Electric Power, 1-95,000	1 ..	⅞-1
—— 6 per cent. Preference, 100,001-170,000	1 ..	⅞-1
Kidderminster and District Lighting and Traction, Pref.	8 ..	8-8½
New General Traction, Ordinary	5 ..	3¾-4
—— 6 per cent. Cum. Pref.	5 ..	4¼-5¼
North Staffordshire Trams	6 ..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	18-19
—— Preference	10 ..	10⅞-10⅞
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11½-12⅝
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	10-11 xd
Telephones.—		
Consolidated Telephone Construction and Maintenance	½ ..	⅛-¼
National Telephone, Ordinary	*b* ..	5¼-5½
—— 6 per cent. Cum. First Pref.	10 ..	14-15
—— 6 per cent. Cum. Second Pref.	10 ..	14-15
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5⅝-5⅞
—— 3½ per cent. Deb. Stock, Red.	100 ..	97-100
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

Lecture.—We are informed that Mr. A. A. Campbell Swinton will lecture at the Camera Club on March 8, on the subject of "Steam-Turbines, Land and Marine."

Review.—In reference to our review of Mr. A. H. Gibbings's book on "Municipal Electric Supply" we are informed that Messrs. Whittaker and Co. have now the publication of this volume entirely in their hands.

Telegraphs to Central Africa.—Reuter states that the Uganda railway telegraph line reached the Nile at Ripon Falls on the 18th ult., and was carried across the river in two spans on the 19th ult., thus establishing communication between London and the Victoria Nyanza.

The Send-Off Dinner.—The definite arrangements have now been made for the "send-off" dinner to the active service contingent of the Electrical Engineers (R.E.) Volunteers, which will take place at 7.15 for 7.30 p.m., on Saturday, March 3, at the Prince's Restaurant, Piccadilly. As stated last week, the chairman will be Lord Kelvin.

Electric Tramway in Mandalay. — We gather from *Indian Engineering* that the scheme submitted by the Burma Electric Works Syndicate, Limited, has, with some modifications, been accepted by the Mandalay Municipal Committee. The scheme provides that the tramway is to be commenced within one year, and completed in three years from the date of the order.

St. Marylebone Lighting. — We notice on the agenda for yesterday's meeting of the St. Marylebone Vestry a motion to the effect that the Vestry should instruct the Parliamentary Committee to take the necessary steps to bring about an immediate reduction of the exorbitant prices charged by the Metropolitan Electric Supply Company for current in the parish.

Electric Instruments on Indian Railways.—We are pleased to see that the introduction of Winter's electrical block instruments has been sanctioned by the Government of India on the South Indian Railway. It is intended that the sections between Egmore and Pallavarum will in future be provided with these instruments, as also between Tanjore and Trichinopoly junctions.

Leeds Association of Engineers. — Prof. J. Goodman, at the monthly meeting of this association last week, read a paper on "Some Points in the Design of Governors." He described in detail various forms of governors, dealing in a lucid manner with the various points to be observed in their design, and showed that in the case of a "hunting" governor, or one that is too sensitive, the remedy was to increase the load in a greater ratio than the centrifugal force, but he deprecated the use of dashpots for this purpose. On the other hand, where a governor was too stable, the reverse method should be adopted.

Clocks on Tramways.—We understand that the Milwaukee Electric Railroad Company, when issuing transfer tickets from different parts of their system, enter a time limit in which these should be available. We presume that this is to prevent these transfers being used by others than those to whom they were issued. In order to preclude any dispute as to the correct time of issue, they have decided that 300 of their cars are to be equipped with clocks which are specially constructed to withstand the jarring and vibration of the cars. Apart from the use which they will be to the conductor in checking transfers, such standard clocks will be of great value to the travelling public, always providing that the quality of the clocks comes up to the description of the same which appears in our New York contemporary, *Electricity*.

The Power Bills.—The Association of Municipal Corporations is circularising all the members of Parliament giving reasons for the rejection of the Durham, Lancashire, South Wales, and Tyneside Electric Power Bills, on the motion that was to be made last night for the second readings of these Bills. The reasons given we have reviewed before, as they are practically those drawn up after the conference at Manchester in opposition to the Lancashire Company's Bill. Great stress is made of the harm which would be done to municipal electrical undertakings should the Bills be allowed to pass, but no mention is made of the advantages small outlying districts would derive from the cheap power promised by the promoters of the Bills in question.

Fatal Accident.—We regret to have to call attention to the death of Mr. S. R. Havard, which occurred at the works of the Blackheath and Greenwich Electric Lighting Company on Wednesday last week. The deceased, who until recently was an articled pupil with Messrs. Johnson and Phillips, was killed by an electric shock. From the information which we have received we gather that the floor in front of the high-tension switchboard was not completely laid, and that the deceased stumbled over one of the projecting iron supports at the base of the switchboard. In trying to save himself his hand came in contact with the metal parts of the switchboard which were in connection with the high-voltage system, and death took place instantaneously. An inquest is being held, at which fuller details will be brought out.

Electric Lighting in the Transvaal.—The finding of a complete electric lighting plant in the Boer entrenchments at Colenso, coupled with the additional statement by Laffan's Agency that it and the searchlight apparatus were new and were supplied by Messrs. Ransomes, Sims, and Jefferies, of Ipswich, has led many to conclude that the above firm have helped to equip our enemies. The truth of the matter is that the engine only was supplied by the firm, and evidently it and the electrical apparatus had been commandeered by the Boers from some mines in the Transvaal. The mining districts are quite as well equipped with electrical plant as any district in Great Britain, so that the Boers have a good reserve of electric plant to draw on for their military operations. Mr. J. R. Jefferies has naturally denied that his firms has supplied the Boers with a complete searchlight plant, which denial was hardly needed by those who know the members of the firm.

Electrocution.—The energetic correspondent of the *Morning Leader* who is stationed in New York announces a serious blow to electrocution. While we do not desire to cast any reflections on the veracity of this gentleman, we think he would do well to read a short story by Conan Doyle on the subject he has now taken up. This correspondent states that on Monday last "considerable sensation has been caused by the circumstances attending the electrocu tion of a murderer at Sing-Sing to-day. An Italian barber of herculean frame and dulled intellect named Ferraro was placed in the chair, and the electric currents of immense voltage sent through him at intervals caused death only after the fifth application. The horrible scene was intensified by an Italian priest, overcome by emotion, endeavouring each time to arouse the condemned man. The incident is considered a serious blow to electrocution. Molineux, who is the inmate of a cage in 'Murderer's Row," remained gaily indifferent while Ferraro was being executed." From what we remember of Conan Doyle's production, the murderer was subjected to

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three times the usual voltage, which rendered him quite proof against death in any form.

The Royal Meteorological Society.—We notice that this society will attain its jubilee on April 3, it having been founded on April 3, 1850, and it is proposed to observe this fiftieth anniversary in a special manner. The council have arranged for a commemoration meeting to be held at 3 p.m. at the Institution of Civil Engineers, at which the president will deliver an address, and delegates from other societies are to be received. In the evening a conversazione is to be held at the Royal Institute of Painters in Water-Colours. On the following day, April 4, the Fellows will visit the Royal Observatory, Greenwich, and in the evening will meet at dinner at the Westminster Palace Hotel. In view of this jubilee celebration, we are informed that Mr. G. J. Symons, F.R.S., was elected president at the annual meeting of the society on Jan. 17, but owing to illness he has since been obliged to resign this office. Under these circumstances the council have appointed Dr. C. Theodore Williams as president.

Load Factor.—We have recently had brought before us another scheme for lighting a small town within the Arctic Circle. The scheme is not unlike one we reviewed some year or two back for lighting the capital of Iceland. There is no doubt that the place is an ideal one from the electrical engineer's point of view, because the load would be required continually in the winter. In the summer time the engineer could shut down his plant and go for a holiday with his well-earned profits, as no lighting whatever would be then required. Unfortunately, there are drawbacks even to electrical schemes for lighting purposes in the Arctic Circle. The chief objection is that the trade is practically stagnant in the winter, and that the spending power of the population is low. There are even hints to the effect that while the light would be supplied in the winter the company would have to wait till the summer for payment. Even then it may be mostly in kind, and the engineer would have to determine the weight of codfish corresponding to one Board of Trade unit supplied.

The Brush Provincial Bill.—The Bill promoted by the County of London and Brush Provincial Electric Lighting Company to enable the various districts in which the company has powers to supply electrical energy to be more closely connected by mains, was rejected on Tuesday by the House of Commons. Mr. Pickersgill, in moving the deferring of the second reading of the Bill for six months, pointed out that the Bill gave power to break up streets in six districts in which the company had no *locus standi*. These districts were Islington, Shoreditch, Battersea, Lambeth, Bermondsey, and Whitechapel. A similar Bill was rejected by a committee last year. Mr. Kimber contended that the reasons stated afforded no ground upon which the House should depart from its ordinary principle of referring such a Bill to a Select Committee. He defended the breaking up of the streets as a means of carrying out the supply of an authorised commodity in as economical a way as possible. Other members opposed the powers sought being granted on the eve of the new London municipalities coming into existence. On division the House rejected the Bill by 147 against 105.

Electric Headlights.—Six locomotives on the Delaware, Lackawana, and Western Railroad, in the United States, have recently been equipped with electric headlights. The superintendent of machinery on that line, Mr. J. F. FitzGibbon, writing to the *Electrical Review* of New York, says that he has found these lights exceedingly useful on the line. They require, of course, rather more looking after than the ordinary type of headlights, but they are said to be a great safeguard against collisions and accidents. The arc light in question is said to have a light of 6,000 c.p., and to throw a beam such that a newspaper can be read one-third of a mile away. Electric lights are also provided in the cab of the engine and underneath the running part and boiler, so that the engineer and fireman can clean the engine and make repairs without using an oil lamp or torchlight. The current is supplied from a combined engine and dynamo, which is placed over the boiler just outside the rear end of the cab. It would seem to us that while such lights are useful in sparsely-populated districts, they would be a great nuisance in ordinary railway work. Also, if a good block system is employed, they could hardly add to the safety of the lines.

The City and South London Railway.—On Saturday last Sir Francis Marindin, on behalf of the Board of Trade, inspected the new section of the City and South London Railway. This section runs from the south side of the river to Moorgate-street, with an intermediate station at the Bank, under the Church of St. Mary Woolnoth. The new tunnels join the old section of the line at a point just behind the London Bridge Station. The old section under the river, which connected up to the station under King William-street, is to be used in future for a new line running to Clapham Clapham. The inspection was quite satisfactory, and the line was accordingly opened for traffic on Monday last. We are glad to note that in this case practically all the machinery (or considerably over 90 per cent. of it) has been supplied by English electrical firms. No less than four of our large manufacturing companies have made locomotives for the South London line, and the tests caried out by Mr. Peter McMahon show that the locomotives so produced are able to hold their own with any of American manufacture. This section, now open, will afford convenient connection between the Central London line and the district south of the Thames. The next extension to be made by the City and South London Company will be to Islington, the work for it being now well in hand.

Tidal Power.—A scheme is now before the Canadian Government asking permission for exclusive privileges to establish works and buy land near Vancouver in order to generate motive power from the tides. The details of the scheme are more or less in the air at present, except that the actual positions of the proposed power station and canal have been determined. The coast round the port of Vancouver is very much divided up by waterways, and owing to the restricted entrances to some of these a difference of head exists at most states of the tide in the water-level on the two sides of a narrow isthmus. On one side of this isthmus is the Pacific Ocean, while on the other side the tide has to traverse about six miles of strait. The proposal of the syndicate is to cut a passage through from one side to the other. We have no information before us as to the head of water which would thus be obtained, and the situation is further complicated by the fact that the flow of water would be in different directions at different states of the tide. Local conditions naturally alter the difference of level between high tide and low tide, and without these being known one cannot speak as to the feasibility of the scheme. It would seem, however, that if the syndicate succeed in getting their concession, they will then have to solve a number of engineering problems which are likely to involve heavy capital expenditure.

Rival Illuminants.—Mr. T. N. Ritson, who is the new president of the Manchester District Institution of Gas Engineers, delivered his presidential address on Saturday last. He reviewed the present standing of gas companies in the United Kingdom, showing that out of 661 authorised undertakings, 222 were run by

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local authorities. There were besides these over 1,000 undertakings working without statutory powers. Mr. Ritson took a higher view of the competition between gas and electricity, stating that, notwithstanding the competition, the demand for gas was steadily increasing. He added that, while electricity was an exceedingly keen competitor, statistics proved that gas and electricity could and did flourish side by side, and there could be no doubt that the new illuminant had aroused gas authorities to a sense of their duty, and the results of the spirit of enterprise thus brought about had been an increased output of gas and increased profits, while the public had benefited by cheaper gas and improved methods of lighting, both privately and publicly. Notwithstanding the enormous development of the supply of electricity, no fewer than 77 gas undertakings had been purchased by local authorities from private gas companies since the year 1882, and several applications for transfers of works were to be considered during the present session of Parliament.

Electric Power in Venice.—We gather from the report of the United States consul at Venice that a company is under construction for the supply of electrical energy in bulk to Venice. The company have two schemes under consideration. The first is to take 10,000 h.p. from the waterfall on the Cellina, a distance of 59 miles from the town. At the other point in question a fall of 328ft. is available, and it is stated that the Government is ready to grant the concession. The other scheme involves taking the power from the Piavè. In this case the works will be situated only 43 miles from the town, and 27,000 h.p. would be there available. This would be obtained from two falls having a combined head of 738ft., while if a third fall was utilised, a further 8,400 h.p. would be available. A most valuable point in this last plan is the utilisation of the Lake Santa Croce, which will act as a reservoir. A storage capacity of water which can be conveniently used of over 700 millions would be available, and would enable the output of the stations to be very largely increased for a short time. The names of the prime movers in the enterprise are as follows: Counts N. and A. Papadopoli, Commendatore Guiseppe da Zara, and engineers Ernesto Breda, Milani, and Colle. We are glad to note that English capitalists are likely to be interested in the undertaking, and in this case hope that English engineers will also have a voice in the matter.

Telegraph Subsidies.—In the House of Commons on Tuesday, Sir E. Sassoon asked the Secretary to the Treasury what subsidies were paid during 1898-99 to the Eastern Telegraph Company by the Imperial and Colonial Governments. Mr. Hanbury, in reply, presumed that the hon. member referred not to the Eastern Telegraph Company alone, but to the group of which it formed the centre. From Imperial funds £19,000 was paid in 1898-99 to the African Direct Telegraph Company, and £63,000 to the Eastern and South African Telegraph Company, but £18,000 was repaid to the Exchequer in respect of the latter subsidy (£10,000 from India, £7,000 from Mauritius, and £1,000 from Seychelles), and £5,000 in respect of the former from various West African colonies. From Colonial funds £15,000 was paid to the Eastern and South African Telegraph Company by the Cape Government, and £5,000 was paid to the same company by the Natal Government; £32,400 was paid by Australasian Governments to the Eastern Extension Telegraph Company in respect of the duplicate cable subsidy (which finally ceased in October, 1899), and £4,200 in respect of the Tasmanian cable subsidy, besides a payment of £2,632 on a traffic guarantee for New Zealand cables which could hardly be reckoned as a subsidy. He also understood that the Government of the Straits Settlements paid £400 to the Eastern Extension Company in respect of a telegraph to Malacca.

Passenger Communication on Railways.—The Board of Trade issued last week a pamphlet giving all the correspondence which has passed between its railway department and different railway companies with reference to the means of communication between passengers and the guards of trains. It will be remembered that in July, 1898, we published a circular issued by the Board of Trade Department to the general managers of the railways calling attention to the report of the committee, which committee favoured the use of electric systems of communication, or of some system in which the brake was automatically applied to the wheels when the passengers wished to communicate with the guard. In reply to the Board's request, practically all the large lines have given their views on the question. The great majority of the companies state that they will adopt a practical system of communication, arranged so that the brake is only partially put on. The Great Eastern Railway Company are making a trial of an electric system, and also of the brake system. The London, Brighton, and South Coast Company propose to adhere to the electric system which has been used for many years on their line, and which has proved eminently satisfactory. The South-Eastern and Chatham Railway Companies also propose to keep to their electric system, which they have carefully developed. A few companies only using carriages of the corridor type have expressed the view that no system of passenger communication is required on their trains.

Electric Lighting Powers.—The London Chamber of Commerce held a meeting on Tuesday last to consider what steps should be taken in view of the opposition of the municipalities to the second reading on Thursday, March 1, of the various Bills for the provision on a large scale of "power" for manufacturing and other purposes in various industrial districts in England and Wales, the following resolutions, moved by Lord Avebury, and seconded by Mr. H. Seton Karr, M.P., were unanimously adopted: "(*a*) That this meeting regrets the action of the representatives of municipalities and local authorities in opposing the second reading of Bills promoted by companies for the distribution of 'power in bulk' for industrial and general purposes in various districts in England and Wales, and urges upon Parliament the desirability of allowing such Bills to be read a second time and referred to a committee in order that they may be examined in detail on their merits. (*b*) This meeting further urges that in view of the promise of the Government to appoint a joint committee to enquire into the whole question of municipal trading in competition with, and to the exclusion of, private enterprise, the consideration of all provisions in the various Bills and provisional orders promoted by municipalities and local bodies authorising municipal trading be deferred pending the conclusion of the said enquiry. (*c*) That a petition be presented to Parliament praying Parliament to pass the second reading of the Lancashire Electric Power Bill and other similar measures. (*d*) That a copy of these resolutions be sent to the Board of Trade and to every member of Parliament."

Electric Lighting Charges.—The editor of the *Croydon Advertiser* has condemned what he calls "the new electric dodge for cooking the accounts sent out from the electricity works." We referred to this matter last week, when we pointed out that, on the statement of those who have objected against the Wright maximum demand system of charging at Croydon, their bills came out lower than they would have done had the old system of charging

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at 6d. per unit been maintained. The editor of the *Croydon Advertiser* recapitulates the question, and adds statements of his own which require a lot of explanation. He evidently thinks that electric meters should ascertain the average supply each night, and all consumed after the first hour's supply should be charged for at the low rate. We should much like to see the apparatus which would do this without entailing far more uncertainty than with the present system. Of course, the fact remains that this would not give so equitable system of charging, as the cost of supplying the consumer is dependent on his maximum demand for the winter quarter, and not on his maximum demand for one day. It is amusing to read that the editor considers that there should be no trouble whatever "in suiting the amount of electricity made to the electricity consumed. Just as they can at the gasworks suit the supply to the demand, so it could be in the electrical department, and if the present staff are unable to accomplish this with the present machinery, they must at once duplicate their engine power or make a change." It is a great pity that such utter nonsense should appear in the general Press.

Electrical Fans and Fan Motors.—It is difficult to realise the tremendous extent to which small electric fans are used in America. Thus the *Electrical Review* of New York published on Valentine's Day a description of the new types of fans for 1900. It seems very early in the year to think of providing against the dog days, but naturally the information given is of great value to agents who have to get their orders dispatched early. Ten pages of our contemporary's issue for the above-mentioned date is devoted to different types and makes of electric fans, and a note at the end states that the description is to be continued in the next issue. We notice that our contemporary places the Lundell electric fans, as manufactured by the Sprague Electrical Company, first in the list, and that it states that the design of the fan blades has been considerably improved in the new types to enable larger quantities of air to be moved without increasing the consumption of power. Thus a 12in. fan running at its normal speed now only requires some 52 watts at 115 volts. Other fans are described, the design of which seems to us to have been influenced by a desire to have novel shapes rather than anything else. Although the great majority of the illustrations have to do with small motors driving small fans, the type manufactured by the Sturtevant Engineering Company, designed for heavier work, are described and illustrated. These are made from 18in. in diameter to 10ft., and are capable of dealing with from 2,000 to 175,000 cubic feet of air per minute. With electric motors on the shaft of the fan very good cooling effects are obtained, so that the motors can be kept smaller than otherwise would be the case. We also notice in the new types certain small fans designed to work with primary batteries.

Rural Telephones.—Mr. H. Jones sends an amusing article to the *Telephone Magazine* of Chicago on the "Personal Equation in the Country Exchange." He deals in a thoroughly business way with the small troubles likely to upset and disorganise a telephone exchange in a small town, and amongst some of his remarks we are pleased to quote the following, which is relative to the exchange at the town of Buncombe, Illinois. There "the operator goes to the window if she hears a man yell, a dog bark, or a cow moo; she goes to the window anyway. She reads Bertha M. Clay, E. P. Roe, and some Dickens, and it is too much to ask her to break off in the middle of a sentence. If she don't happen to like you, she will read a page. She is at home six days in the week to a long list of gentlemen callers and a short but more pestiferous list of lady friends. The operator knows everybody in town. She knows which of the telephone conversations are going to be interesting, and when she is listening to an interesting one you cannot expect her—at least you ought not to expect her—to answer Simpson's lumber yard." Referring to a model country exchange he says, "See what you can find in the Bell Company worth imitating. Be a 'soulless corporation' so far as discipline is concerned. Let one man run the exchange and hold him accountable, but put every stockholder on the inspection committee, if not on the kicking committee. Get a girl from out of town and discharge her as soon as she gets well acquainted with your subscribers. The service ought to be impartial and impersonal. Hire Bell employés when they happen to be efficient and pay a premium, if necessary. Don't try to run an exchange without a monitor connection on the operator's set. The knowledge that the 'boss' may be listening will cut down the consumption of chewing gum more or less."

Municipal Traction.—We learn from our contemporary, *Electricity*, of New York, that the Hon. T. L. Johnson has some ideas as to the best way of municipalising street railway undertakings in the United States. Our contemporary remarks in its introduction to a review of a lecture delivered by the above gentleman before the Manhattan Single Tax League of New York that Mr. Johnson is a millionaire, and acquired his wealth by promoting railway schemes. Mr. Johnson states that street railways should be looked upon much in the same way as elevators are in office buildings, in that they should be provided by the head authority, and that they should be free. In this case the cost of working would be paid from the rates, but he contends that the increased value of the property would make it quite capable of paying the slight addition which would be required in rates. The next question arises as to how the existing franchises, which are sometimes granted for 999 years in the States, are to be acquired. Mr. Johnson suggests that with the present laws it is quite possible to impose such taxes on these franchises that the value of the tramway undertaking will be reduced to the actual property owned. This could be done by making a reduction of the fares on the routes compulsory until the undertakings were practically ruined. Then, we presume, the benevolent municipal authority would step in and relieve the tramway shareholders of the onus of keeping the tramways running. We think a more straightforward and manly way would be to confiscate the whole of the undertakings and shoot the directors and imprison those shareholders who did not readily part with their scrip. At any rate, Mr. Johnson's course is a direct violation of all fundamental laws of justice, and we hope that he will be compelled by law to invest all his millions in street railway franchises before they are taxed down in value in the way he suggests.

Incandescent Lamp Tests.—Mr. E. D. Sheppardson's paper on "The Life of Incandescent Lamps," read before the Electrical Association last month at Milwaukee, contains a few points of interest over and above those which have been brought out in previous experiments with incandescent lamps. To commence with, the average figures of watts per candle-power with a large number of American lamps are of interest on this side. Out of a large number of lamps experimented with and run at their marked voltage for 50 hours, the average candle-power was 17·55 with 55 watts per lamp. After 100 hours' burning the average candle-power had not varied, while the watts had gone up to 55·3, corresponding to 3·3 watts per candle-power. After 300 hours the average candle-power had

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dropped to 16 and the consumption increased to 56·5 watts, corresponding to 3·4 watts per candle-power. After 600 hours the average candle-power per lamp was 14·7 and the watts 55·6, corresponding to 3·28 watts per candle-power. The few surviving lamps, which burnt at from 800 to 900 hours, had a consumption on the average of four watts per candle-power. It must be remembered, however, that in taking these averages a large number of lamps had given way, so that the lower-class types had been weeded out in the earlier part of the experiments. The author also tried to see what the effect on the lamps of an unsteady voltage was. He placed them on a circuit in which the voltage varied from 104 to 118, and although a large number of lamps were not experimented with, he found that all the high-efficiency lamps had given out within 300 hours. The lamps taking more watts per candle-power stood the test fairly well, but the candle-power and efficiency fell as much in 300 hours as did that of the corresponding lamps on the constant-potential circuit in 800 hours. The author concludes that the ageing was increased about three times. As a matter of interest experiments were made with several lamps from various sources without cleaning the globes, the candle-power being then taken. The globes were then washed, and the increase of light was found to vary from 1 up to 30 per cent.

Royal Institution.—The exhibits in the library at last Friday's soirée comprised a number of Lord Kelvin's patent instruments made by Mr. J. White, of Westminster, and various scientific apparatus by Messrs. Everett and Co., Charterhouse-square; Mr. A. Hilger, Hampstead-road; and Messrs. C. E. Müller, High Holborn. Mr. C. E. S. Phillips showed some experiments with cathode rays, and Dr. Hastings Stewart exhibited skiagrams of an infant mummy, which was present *in corpore vile*, and which was subjected to examination, the skeleton and some of the interior organs which had not been removed showing very clearly when brought near the fluorescent screen. The evening's discourse was by Prof. John H. Poynting, D.Sc., F.R.S., on "Recent Studies in Gravitation." The lecturer described the investigations made into the laws of gravitation from the time of Newton to the present day. After referring to the experiments made by Mitchell and Cavendish, he said that really no advance was made until quite recent times. Prof. Boys's well-known balance, where the suspension wire was replaced by a delicate quartz fibre, he described as being beautiful in design, structure, and execution. However, the measurement of such infinitely small forces was rendered extremely difficult through the disturbances created by air currents in the shaft of the apparatus. Braun, of Marienstein, Bohemia, had subsequently constructed an apparatus in which the atmosphere was exhausted to $\frac{1}{200}$. He had only proved the accuracy of Prof. Boys's experiments, as the figures obtained by him agreed with the latter's by 1 in 5,000. Experiments made by Bonjolly and the lecturer had given a similar result, and they had been very minute, an increase of weight of 1 in 100 millions being detectable. In the same way the experiments of Richard and Dr. Menzel agreed, and thus we had five or six times confirmed the accuracy of Newton's guess. Diagrams showing how the lines of force are affected by the mass of intercepting bodies were shown, and it was proved that the laws of gravitation are not affected by magnetic or by electrical influence, as there was no change in the pull of the various parts of the balance. Prof. Poynting then described Mackenzie's experiments, which also proved that unequal distribution of the lines of gravitated forces made no difference. Mr. Grey and himself had made experiments with revolving quartz spheres, the axes of which were alternatley placed in parallel or crosswise, the disturbances were small—1 in 16,000—and they neutralised each other—in fact, all these experiments gave the result that the laws of gravitation were entirely independent and different to the physical laws relating to masses generally. If we had not succeeded in proving all the qualities of the laws of gravitation, we had at least established what qualities they did not possess.

Storage Batteries.—The *Electrical World*, of New York, in a leading article reviews the history of electric accumulators, and also their possibilities in the future. It points out that in spite of the great weight of the storage battery they have found favour in certain instances in electric traction work, and to a much greater extent for automobiles and electric launches. As an example of this excessive weight our contemporary gives the following comparison: Any quantity, say 1lb. avoirdupois, of petroleum contains chemical energy sufficient—if all expended on raising its mass—to lift it through a vertical distance of about 3,000 miles against sea-level gravitation (considering the diminution of the earth's gravitation at increasing distances, this 3,000 miles would be increased to about 4,000, so that for comparative purposes it is simplest to assume constant sea-level gravitation). A pound of good coal has chemical energy within it sufficient to lift it about 2,000 miles; 1lb. of gunpowder about 200 miles, and 1lb. of storage batteries (allowing a discharge of six watt-hours per pound of cell) has enough electric energy in it to raise its weight about three miles. Consequently a storage battery is potentially 1,000 times weaker than petroleum, although of course the petroleum is consumed by use, whereas the storage battery is only discharged; and it should also be remembered that the energy of petroleum can only be obtained by means of thermodynamic engines whose efficiency is much less than the efficiency of a storage battery and electric motor. Considering this wonderful theoretical disparity, amounting to, roughly, 1,000 to 1, it is remarkable that the storage battery should be in the field at all. The fact that it is in the field is due to the great simplicity and convenience of the electric motor equipment, as compared with the complexity of the engine used with petroleum, not to speak of its odour, which is often too distressing for words. In looking for a substitute for peroxide of lead in the storage cell our contemporary points out that the cheapness of the new material will have to be considered as well as its electro-chemical storage capacity. Otherwise the first cost of the substance may be such as to render it useless commercially, in spite of it giving a greater storage capacity for a given weight. In the meantime inventors trying to reduce the weight of accumulators using lead as the active material have not much chance of succeeding. We see in *L'Electricien* a description of an accumulator invented by Mr. L. Tobianski, of Altoff, with this end. In this case weight is saved by using an alloy for supporting the active material which has a much smaller specific weight than that of lead, and which is not attacked by acids. With this construction it is claimed that the ampere-hour capacity for a given weight is increased in the ratio of 1 to 2½. In an ordinary lead cell the ratio of weight of support to weight of active material is stated to be 6·5 to 2·5, while this ratio is reversed with the Tobianski construction. The writer of the description says that he has tested cells which at normal rates gave from 1 to 1½ ampere-hours per pound of plate, while larger cells gave from 1·8 to 2·3 ampere-hours per pound of plate. The question arises as to whether local action will not cause trouble between the active material and the support.

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THE ELECTRICITY WORKS OF THE COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY.

Wandsworth Station.

Last week we were enabled by the courtesy of the above company's late engineer, Mr. A. J. Lawson, to give our readers a full description of the City-road station, together with an outlined history of the company's various undertakings, including the Wandsworth electricity supply station, which we are now about to describe. It will be unnecessary to recapitulate that history here, suffice it to give the reference.

Owing to the peculiar configuration of the district of the Wandsworth District Board of Works, which extends from Richmond Park on the one side to the boundary of Camberwell at Streatham on the other (and also includes within it an outlying portion, or "island," lying within the parish of Camberwell), which contains some densely-populated parts, alternating with sparsely-built areas, difficulties arose as to the selection of a site out of the many available. It was, however, deemed of the utmost importance to select one to which fuel could be cheaply transported, and where a sufficiency of water for condensing purposes and boiler supply could be obtained. Various sites could be had where one or other of these conditions was obtained, but only one where there were both, and this was at the mouth of the River Wandle, where the present station is built. On this site the troubles arising from the rise and fall of the tide have no influence upon the supply of water to the station, since in the River Wandle an almost constant level can be maintained by means of the sluices and weirs which have been made part of the general scheme of construction. On part of this freehold site of $3\frac{1}{2}$ acres there formerly stood a flourmill, of which all vestiges are removed, its site being now occupied by the coal wharf of the company, as shown in the block plan (Fig. 1).

With regard to the station buildings, both the boiler-room and engine-room at this station are of oblong shape with square ends, thus avoiding any waste space. The main buildings are built up of best stock bricks and cement, and

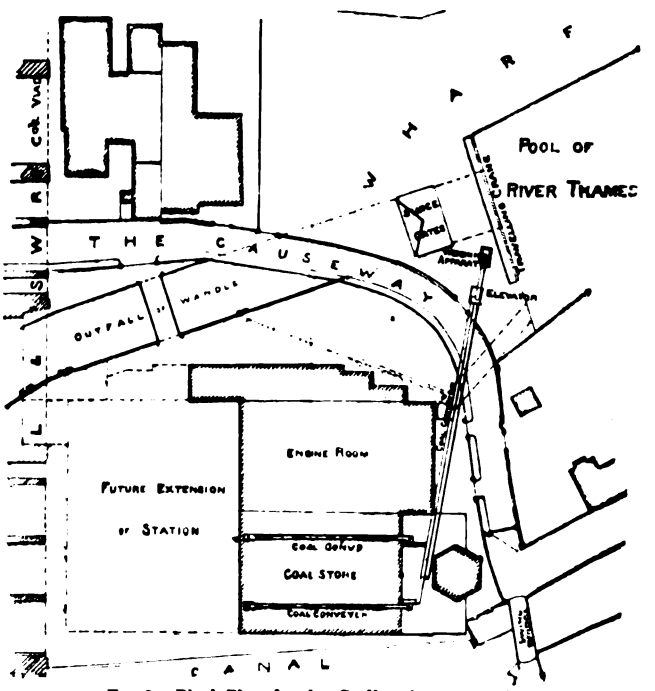

FIG. 1.—Block Plan showing Coaling Arrangements.

the engine-room and switchroom are internally lined with glazed bricks and paved with adamant tiles. To prevent the hum of high-periodicity alternating machinery being too easily conveyed outside, there is an absence of windows in the outside walls of the engine-room, which is lighted from the roof. The chimney is 200ft. in height, and has an internal diameter of 12ft. at the top, being hexagonal in shape. The accompanying photographic view (Fig. 2) shows

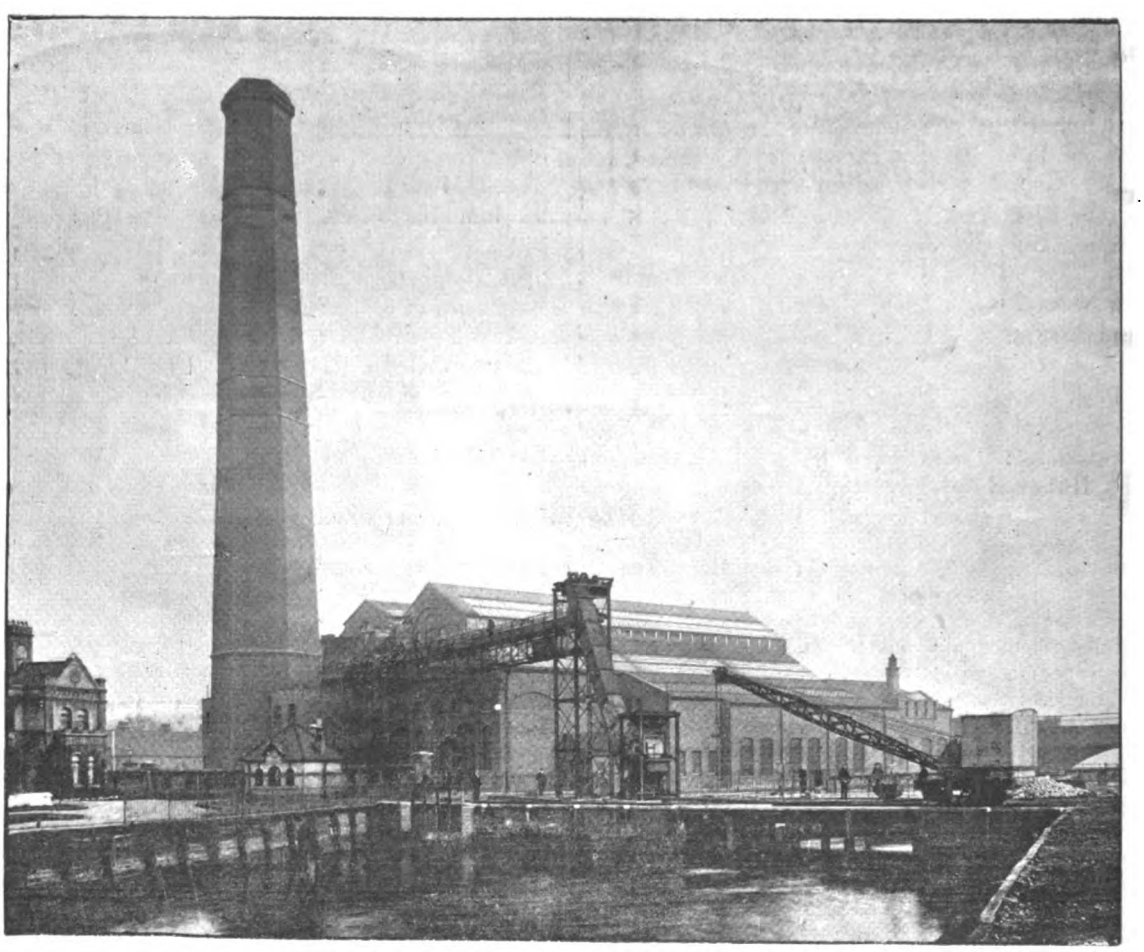

FIG. 2.—Outside View of the Wandsworth Station of the County of London and Brush Provincial Electric Lighting Company, showing Coal-Handling Apparatus.

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the buildings as they now appear, together with the coal-conveying gear. The boiler and engine rooms together occupy just one-half the available building space of the largest plot of land owned by the company, and the foundations for the future extensions have been partly laid in to the ground level. The present offices and switchroom occupy two-thirds of the available site for such accommodation adjoining the main building, but the company possess ample space for additional offices or repair shops on the other side of the River Wandle, between that river and Wandsworth Creek, as shown on the accompanying ground plan. The architect for the buildings was Mr. C. Stanley Peach, F.R.I.B.A., and the contractors were Messrs. Holliday and Greenwood. Fig. 3 shows the general plan of the buildings and of the way the next extensions are planned, while Figs. 4 and 5 give elevations and sections of the works.

The boiler-room is 68ft. in width by 110ft. in length, the latter figure representing half its ultimate length when extended to the full limit of the site. The plans provide for a double row of boilers to be placed with their furnace ends projecting inwards, and separated by a sufficient distance to allow of the withdrawal of the tubes from any boiler. On each side of the room there is space for eight boilers with economisers and by-pass flues. One side is now fully occupied, and on the other side the foundations are already prepared for a similar equipment. Along the centre space, between the boilers and under the floor level, provision is made for ash-conveying gear. The boilers are of the Babcock-Wilcox type, fitted with superheaters by the same firm, and Vicars automatic stokers, while the economisers are of Messrs. E. Green and Co.'s make. The scrapers in connection with the latter are driven by two small alternating-current motors. A large combined feed tank and filter is erected in the boiler-room. Two steam driven feed pumps by Weir, of 4,000 gallons capacity per hour each against a pressure of 150lb. per square inch, supply water to the boilers. Injectors are provided as auxiliaries instead of motor-driven feed pumps. Fig. 6 is a view of the boiler fronts.

A coal store is built over the boiler-room, with which it corresponds in size, and provides accommodation for some 600 tons. Coal is to be conveyed from barges to the coal store by the conveyor previously mentioned, which will be driven by bi-phase motors supplied at 200 volts and 50 frequency. For each line of longitudinal conveyor a separate motor is provided as well as a separate motor for the diagonal conveyor from the elevator by the weighing hopper to the end of the coal store, and separate motors for the three elevators, the lifting crane being also motor-driven. This crane is fitted with a Hone grab, which takes its charge from the barge and discharges its load into the conveyor buckets. The weighing machine is of Messrs. Avery's self-recording make, and the conveyors themselves are of the push-plate type. The motors are of the Westinghouse Company's manufacture. The crane was made by Messrs. Jessop and Appleby, of Leicester and London, the contract for the whole work, including the constructional ironwork, being let to Messrs. Graham, Morton, and Co., of Leeds, whose system was chosen by the company's engineer after examination of coal-conveying apparatus at various gasworks throughout the Midlands and North of England, the work being carried out by Messrs. Graham, Morton, and Co. to his designs and specifications. The apparatus is capable of dealing with 40 tons of coal per hour. Water storage is provided on the floor above the boiler-room to supply the make-up water, which is at present taken from the Southwark and Vauxhall Company's mains, although provision has been made for this supply to be taken later from the River Wandle. The water passes through a purifier of Doulton's make before being fed into the boiler.

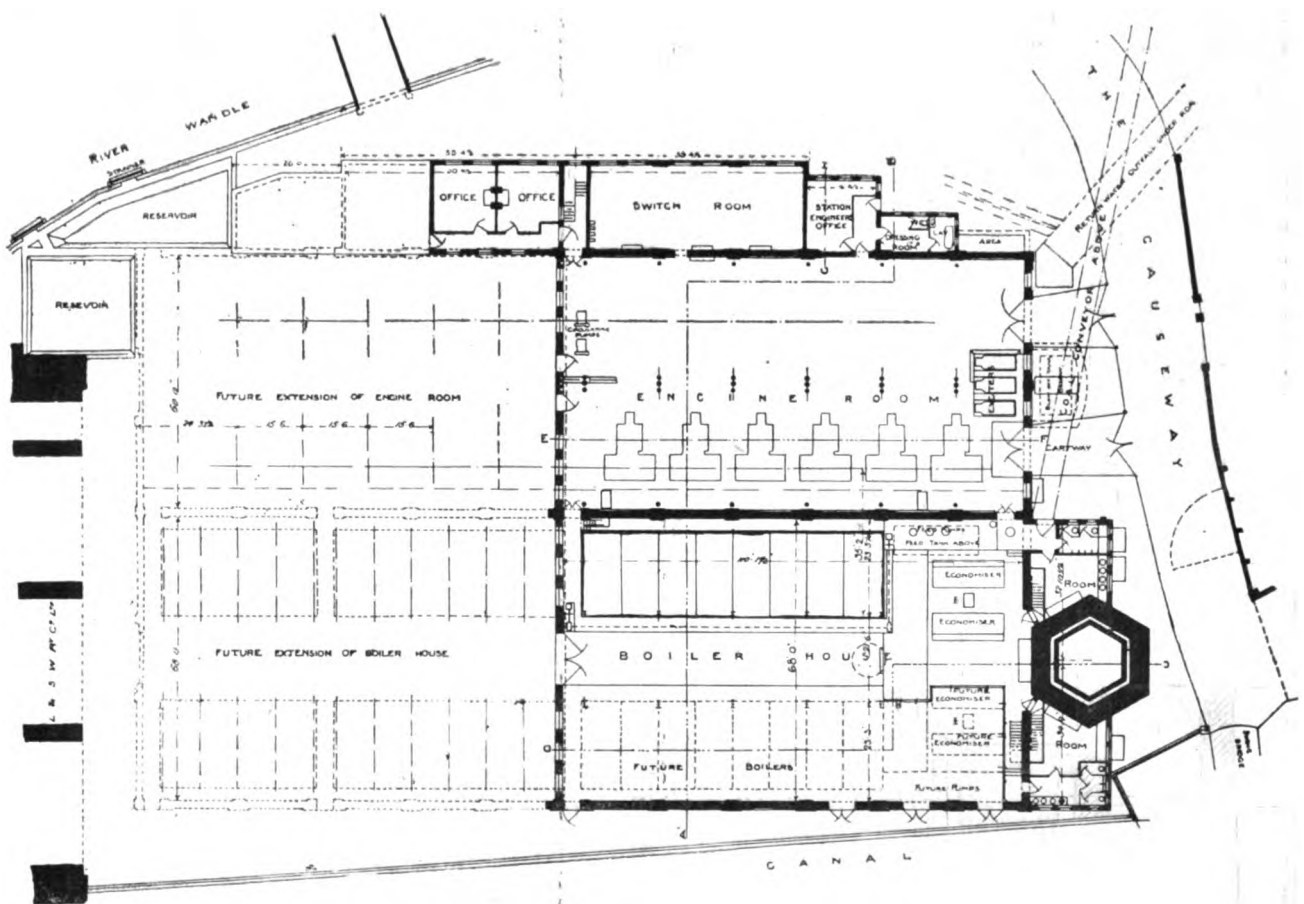

FIG. 3.—Plan of the Wandsworth Station with Proposed Extensions dotted.

The engine-room, which is 60ft in width by 110ft. in length, contains six Mordey single-phase alternating sets, 100 ⌒~, 2,000-2,200 volts, and of 180 kw capacity, each driven by Raworth-Universal engines, and installed on the side of the engine-room (Fig. 7) next to the boiler-room. On the other side provision has been made for five 400-kw. bi-phase 50 ⌒~ 2,000-to-2,200 volt alternators, now on order, to be driven by improved Universal engines, one on each side of a Mordey inductor alternator. To provide for the practical parallel working of these machines of different periodicities, and for economical working at times of light load by the use of one engine and alternator only, a motor-generator has been provided. The exciting current is provided by three Brush continuous-current compound-wound dynamos, driven by Brush cross compound engines (Fig. 8) fitted with electric control governors when the alternators are running

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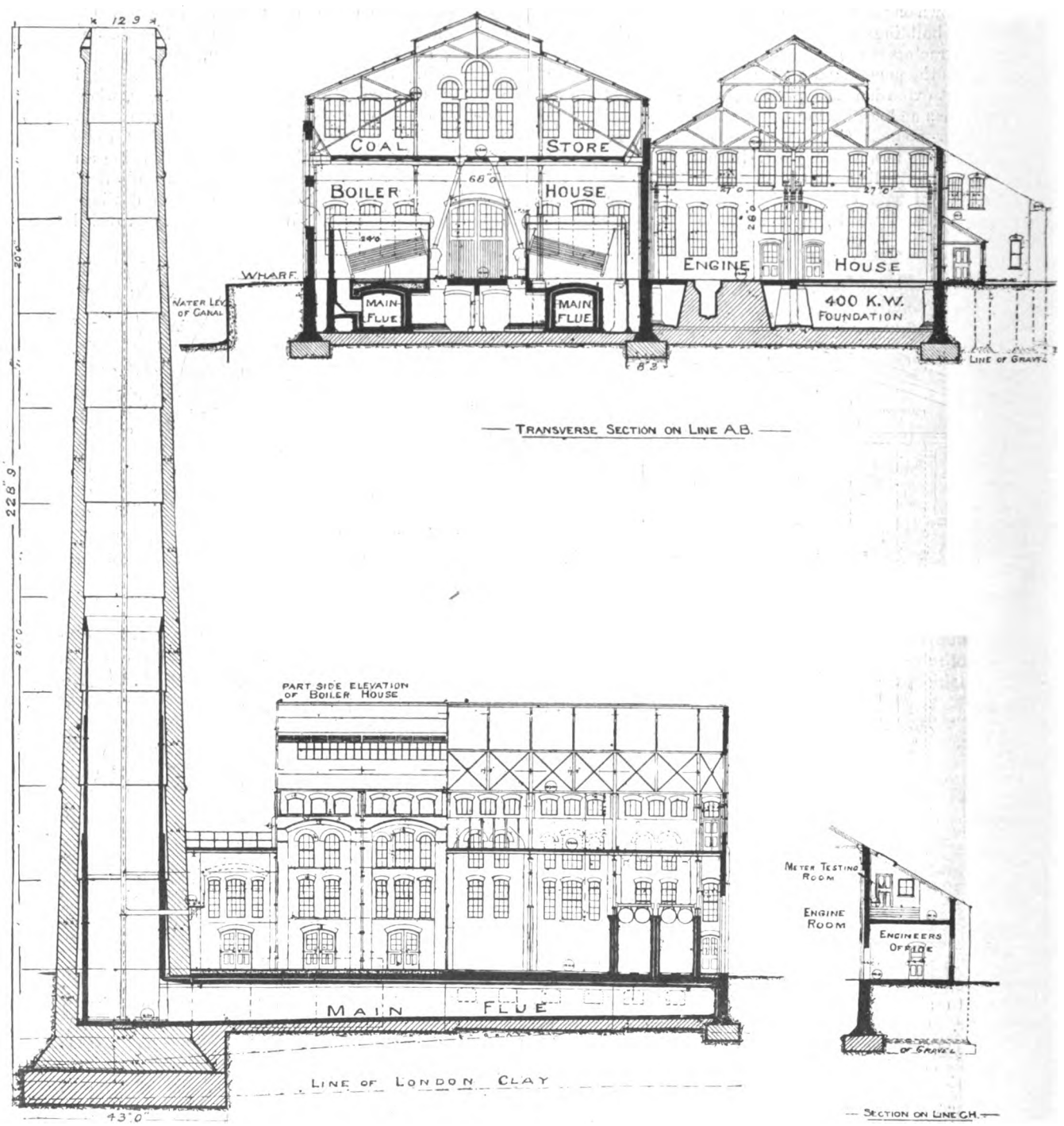
in parallel. Two of the alternators are fitted with separate exciters on the shafts for use when these are running singly during times of light load. The steam-piping is arranged on the ring system, that portion situated in the engine-room being supported from the central pillars. The ends of the main steam-pipe are fixed, expansion being provided for by a central expansion joint. The overhead cranes are of 20 tons capacity each, and have been supplied by Messrs. Vaughan and Son. Circulating water from the Wandle comes into two separate tanks beyond the foundations for future extensions, and is circulated through the engine condensers, which are placed in this case under the floor-level, by means of steam-driven centrifugal pumps, one of which is spare. The air-pumps are also under the floor-level, and are driven by a disc crank off the engine shaft. The condensed water is led off from these pumps by gravity to a tank connected with a Weir feed pump with an automatic valve, admitting or shutting off steam according to the quantity of water in the tank which lifts the water to the feed-water tank previously mentioned.

With regard to the switching gear, the main switches for the alternators, exciting circuit switches, and rheostats are placed on a switchboard (Fig. 9) within the dynamo-room, the current being carried by 'bus bars through the dividing wall into a main measuring board placed immediately behind the alternator board in the switchroom (Fig. 10.) To the left of this main measuring board are the circuit panels for the mains for Putney, Wandsworth, Wandsworth Common, etc., while to the right there are 12 panels for transformer switches, which are connected up to mains leading into extra high-tension transformers placed in the basement of the switch-room, which transformers raise the voltage from 2,000-2,200 to 6,000-6,600 volts, the extra high-pressure side of which connects with the panels shown in the southern end of the switchroom, whence the extra high-tension mains lead to the main distributing transformer stations at Clapham, Streatham, and Camberwell, where this extra high tension is again transformed down to 2,000-2,200 volts and delivered to transformer sub-stations. It should be mentioned that the switchboards are of Ferranti's make.



FIGS. 4 AND 5.—Elevation and Section of the Wandsworth Station.

As showing the extent of the area supplied from this station, it may be mentioned that while Roehampton, by Richmond Park gates on one side, is distant along the route of mains from the Wandsworth station $3\frac{3}{8}$ miles, the furthest

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point in Streatham (still within the district of the Wandsworth Board of Works) is 5¼ miles, and Clapham, by way of however, which extends 5¼ miles from north to south and 2¼ miles from east to west, has its extra high-tension dis-

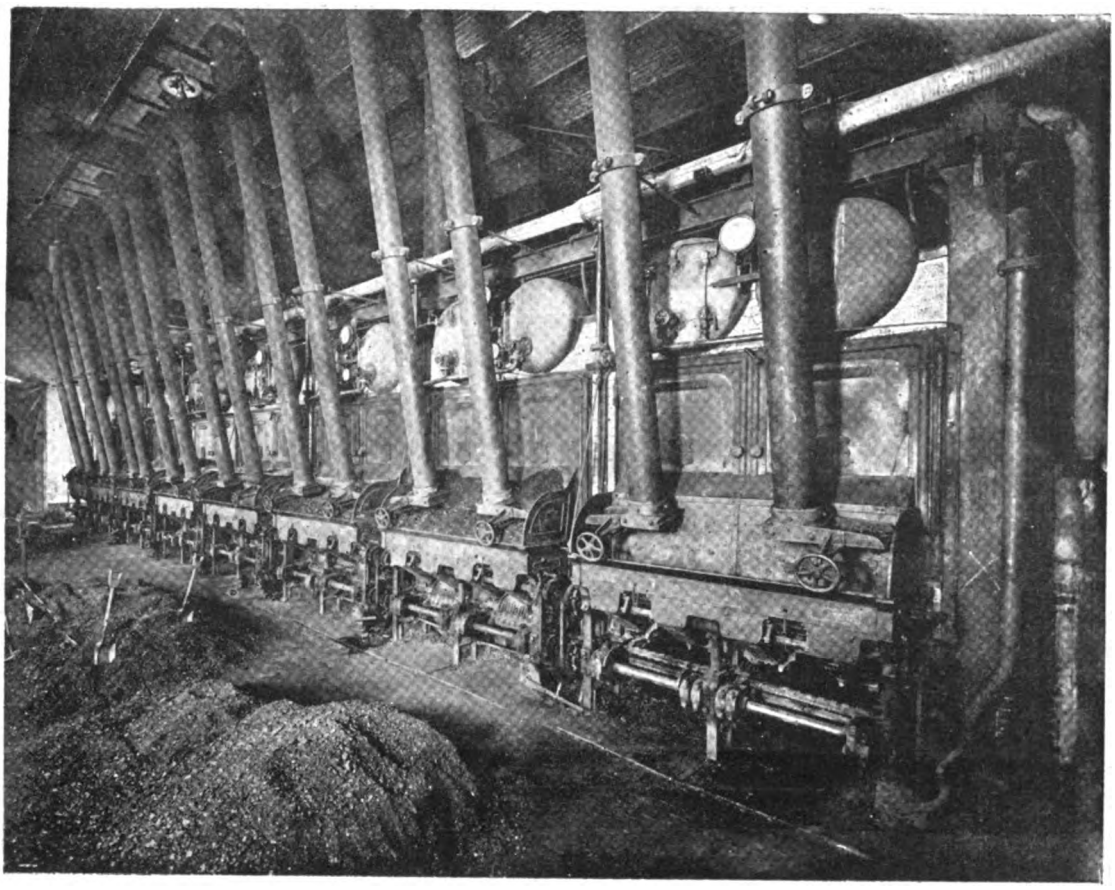

FIG. 6.—The Boiler Fronts at Wandsworth, showing Coal Shoots and Vicars Stokers.

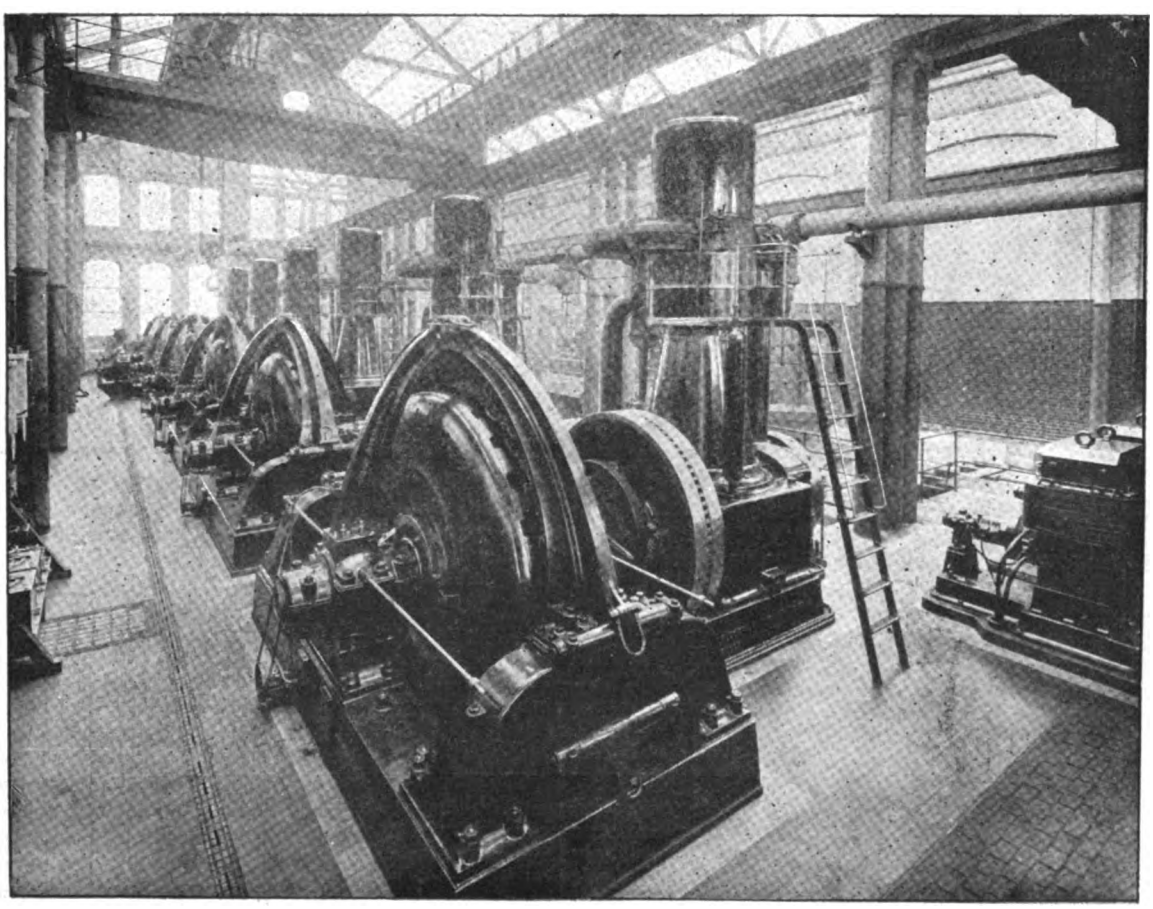

FIG. 7.—The Mordey Alternators and Universal Engines at Wandsworth.

Battersea (a long detour having to be made to avoid passing through more than was necessary of the Battersea area), is distant from the station 5⅝ miles. Camberwell parish, tributing station at a distance of no less than 10¼ miles from the Wandsworth station, and the extreme point of distribution in St. George-the-Martyr, Southwark, is 13¾ miles from

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Wandsworth, while the extreme point in St. Olave's parish is 13½ miles, and is within the comparatively short distance of 2¼ miles of the City-road station, from which, however, several geographical and especially local conditions at present prevent its obtaining a supply.

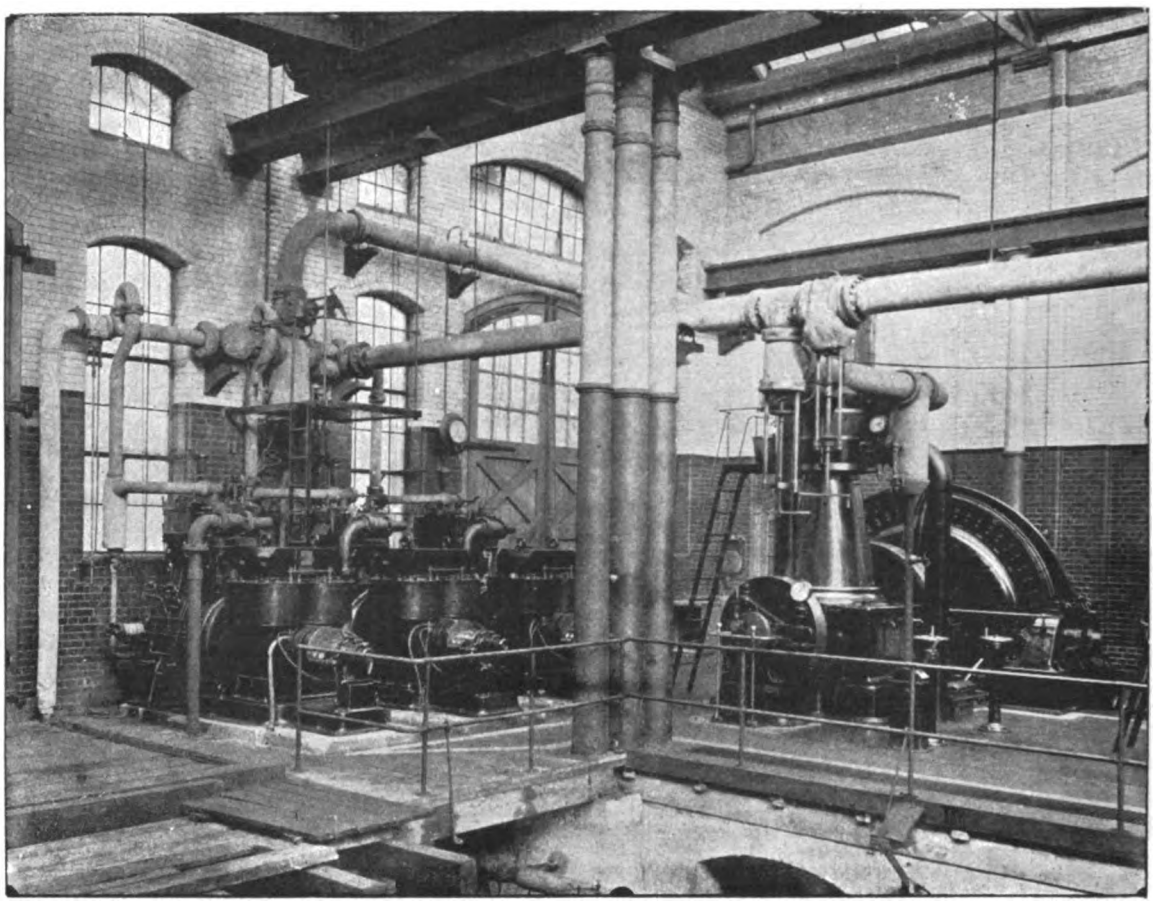

FIG. 8.—View showing the Exciters and Steam-Pipe Details.

The mains throughout the whole of the Wandsworth and Camberwell districts are drawn into cast-iron pipes, and the extra high-tension and high-tension mains consist of rubber-insulated two-conductor cables, lightly sheathed with steel and taped over, all made and supplied by the India Rubber and Gutta Percha Company, Silvertown, while the low-tension cables are Callender's jute and bitumen insulated, lead-covered, two-conductor, concentric cables. For St. George-the-Martyr, the high-tension cables are of Messrs. W. T.

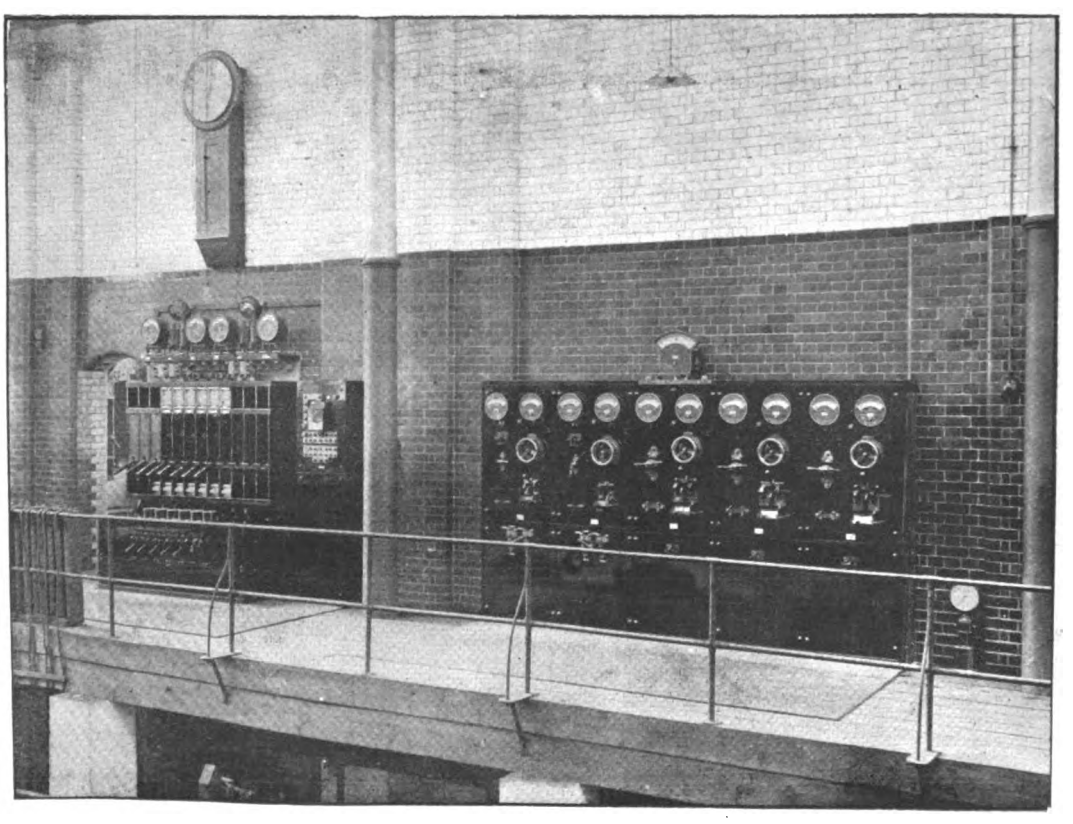

FIG. 9.—The Switchboard in the Engine-Room.

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Glover and Co.'s make, with paper and diatrine insulation, and are likewise of the concentric two-conductor type. All the low-tension cables, which are also concentric, have

any demand for power is likely to arise, balancing the lighting load as evenly as possible between the bi-phase primary conductors, while in Northern Camberwell and in St. George-

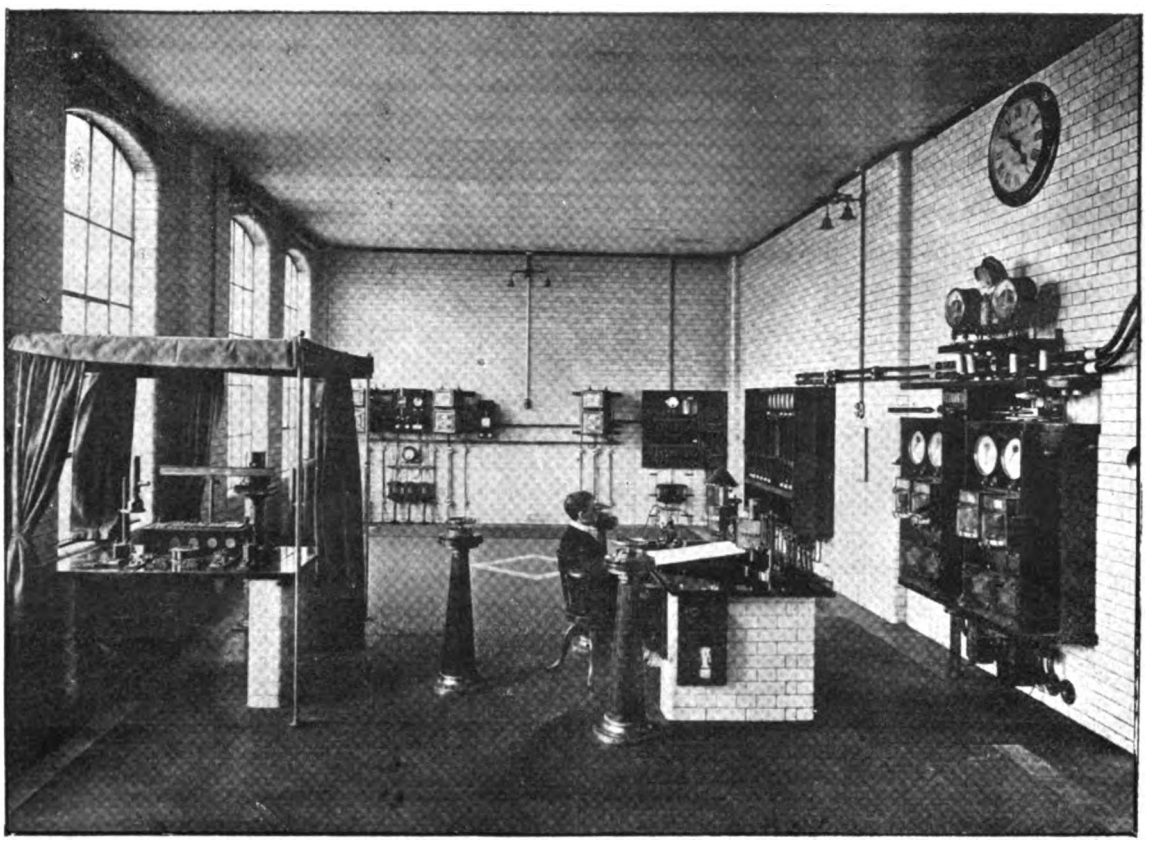
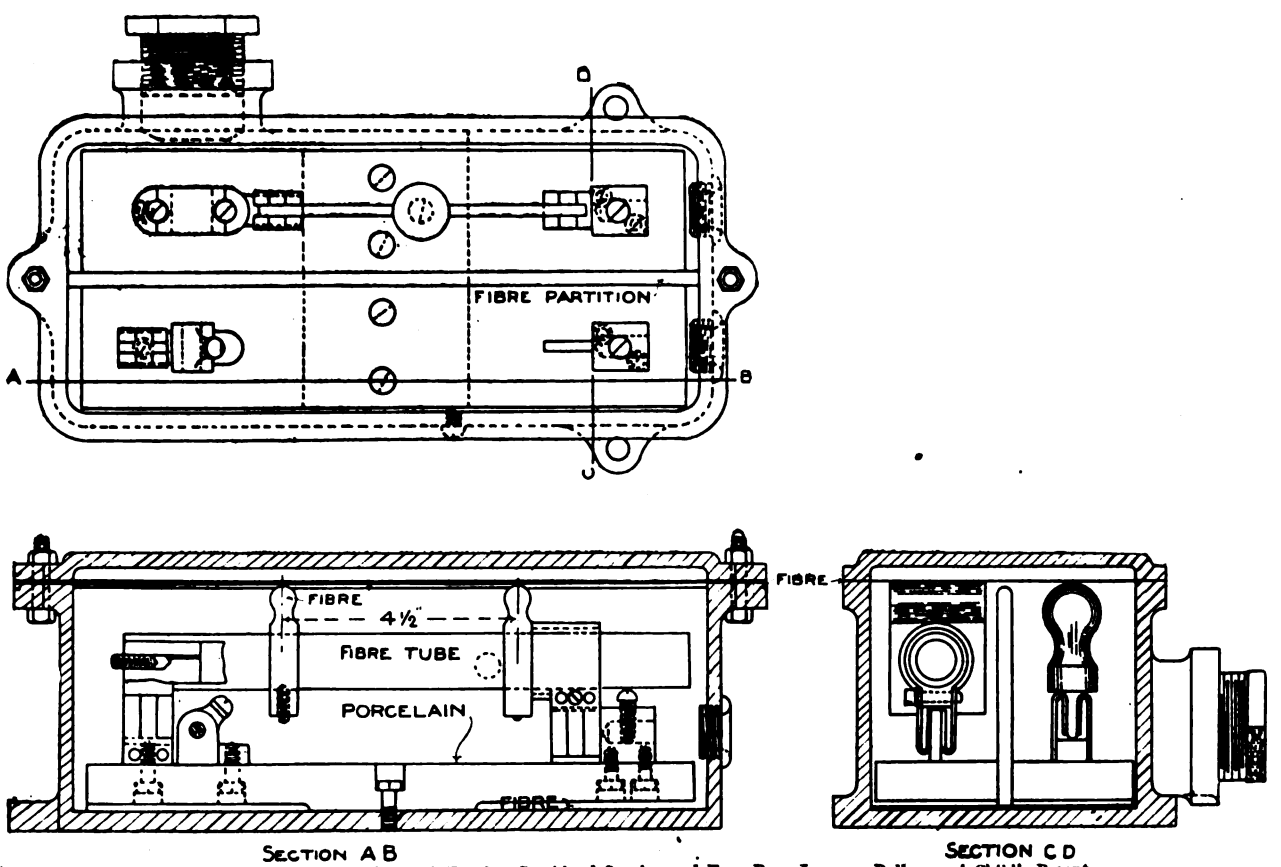


FIG. 10.—The Main Switchroom. View showing Regulating Gear and Measuring Instrument. Some of the Feeder Boards are to the right and cannot be seen.

been supplied by Callender's Cable Company. The low-tension current throughout the whole of these districts is supplied at 200 volts, instead of at 100 volts, as on the

the-Martyr, Southwark, where considerable power may be required, the mains have been laid for a bi-phase supply for both lighting and power. In the Wandsworth,



FIGS. 11, 12, AND 13.—The High-Tension Combined Service and Fuse Box—Lawson, Dallas, and Child's Patent.

north side of the Thames, and the change from 100 ⁓ to 50 ⁓ is already commenced. It was decided to distribute single-phase current in the Wandsworth district, where hardly

Camberwell, and Southwark districts, the length of trenching and reinstatement to date amount to about 75 miles, the length of pipes laid in to over 150 miles, high and extra

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high-tension cable to nearly 50 miles, and the low-tension cable to over 52 miles. With the higher voltage on the type of high-tension service and fuse boxes used for power consumers is shown in Figs. 11, 12, and 13.

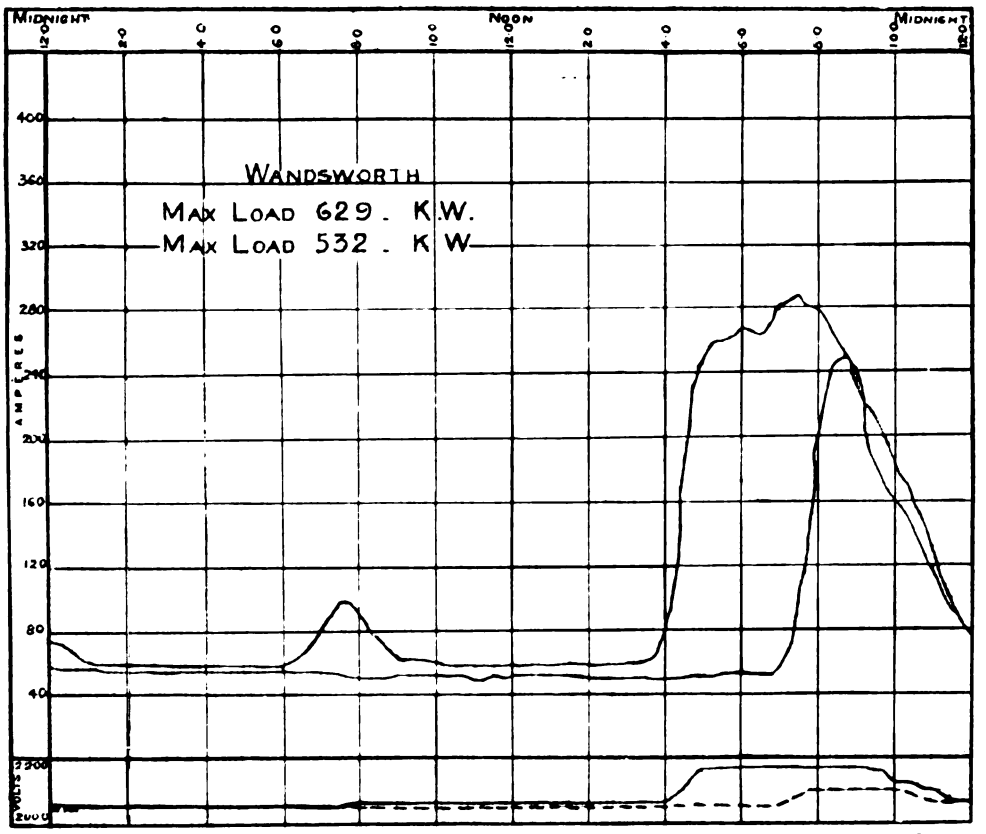

FIG. 14.—Typical Load Curves from the Wandsworth Station, showing Typical Summer and Winter Loads.

secondary mains—viz., 200 volts as against 100 volts on the north side—the number of transformer boxes for the much larger area is about the same as served from the City-road station—namely, 50—with three extra high-tension converting and distributing stations above ground. As these southern districts contain a large number of residences and a few in which late shopping takes place on Saturday nights, the Saturday night loads are generally the highest of the week, and so many private residences being connected to the mains, a fairly large load is obtainable on Sundays. The special

GENERAL REMARKS.

There are several features in connection with the above-described installation calling for particular comment. In the first place, the reader will have been struck with the excellent natural facilities which the site offers for coaling and watering the station. Indeed, the situation is an ideal one in this respect. Nor has Mr. Lawson neglected to take advantage of these facilities to their fullest extent. For although a stone might be thrown from the spot where the river barges are in future to discharge their black cargoes into the station

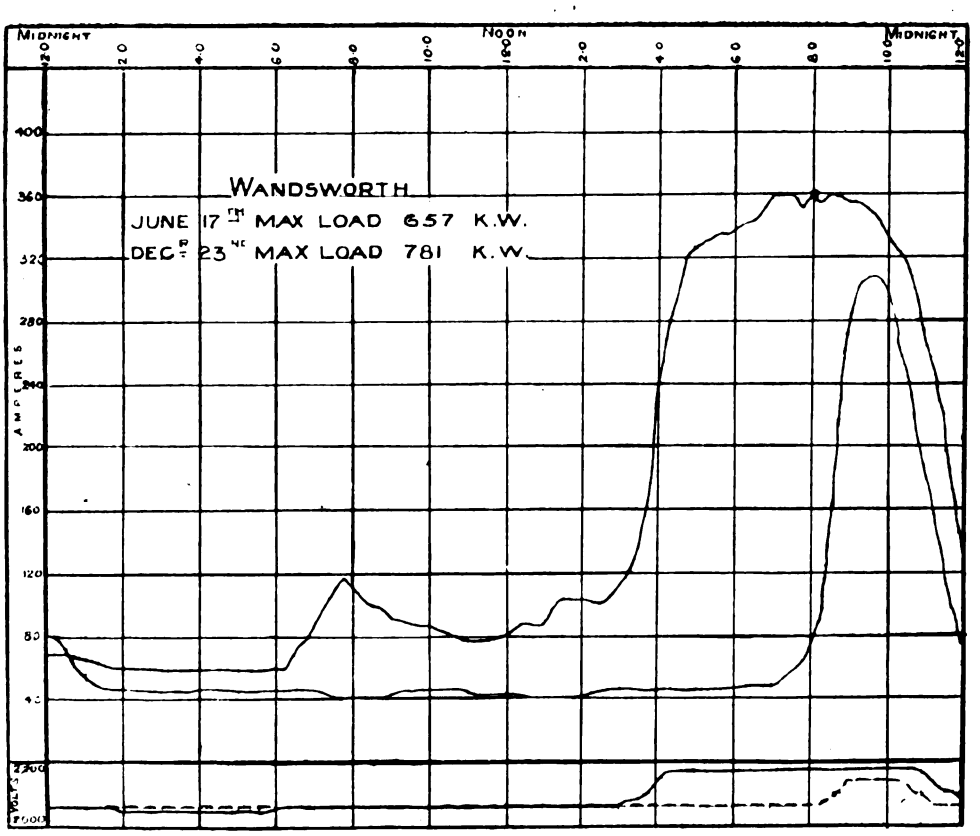

FIG. 15.—Saturday Loads, Summer and Winter, at the Wandsworth Station.

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yard, he has recognised that the cost of handling the coal by manual labour even over this short distance would be no small item in the working costs, having regard to the quantity required, and by providing the mechanical conveyor, described elsewhere, has reduced this cost to a minimum. We believe we are right in stating that the cost of handling the coal by the conveyor is estimated to work out at about a twelfth of that which would be entailed by manual labour per ton. It was not quite ready for operation at the time of our visit, but may be trusted to considerably reduce the coal bill when completion of the conveyor and electrically-actuated travelling grab, which is to work in conjunction with the same.

Another feature—this time pertaining to the general design of the station—is the admirable lack of crowding which is everywhere apparent. Special care has also been taken to secure maximum immunity from fire; there is practically a total absence of woodwork throughout the whole structure.

Exception might perhaps be taken, as at St. Luke's, to the comparatively small unit of plant installed, but, on the other hand, uniformity is obtained, which in a station such as the one in question, where no considerable day load is anticipated, offers no mean advantage, since either of the units installed may be run on the day load without entailing undue waste of energy, as would be the case with a much

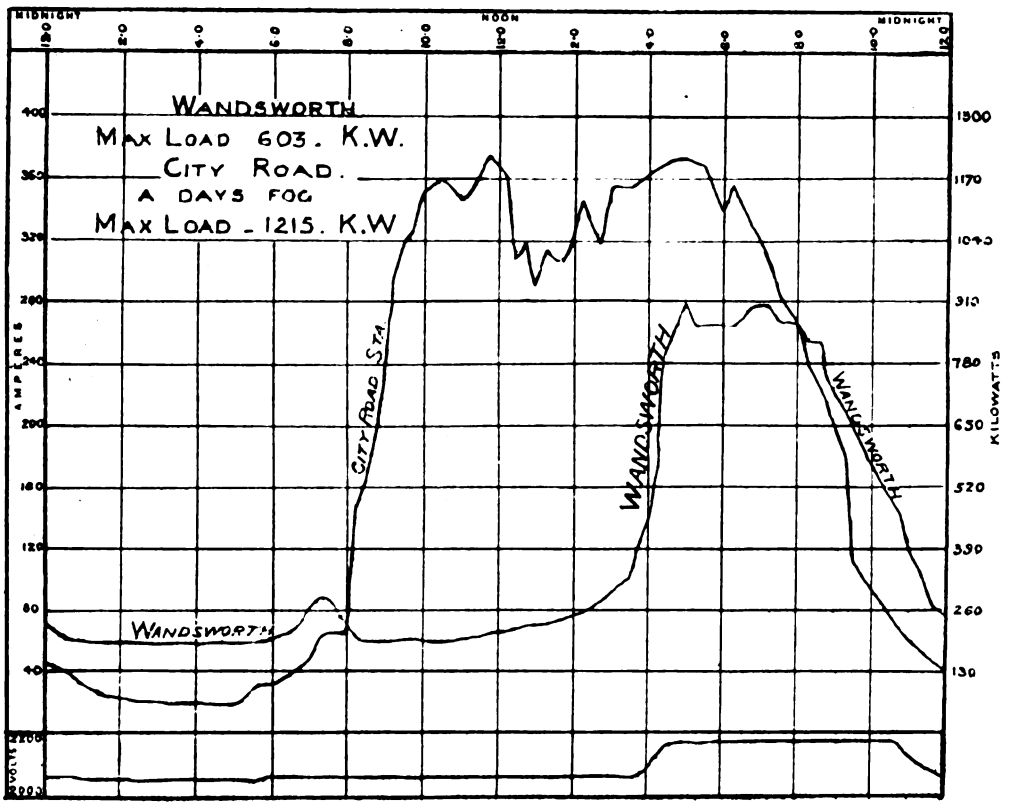

FIG. 16.—Curves showing the Effects of a Fog on the Loads on the City Road and Wandsworth Stations.

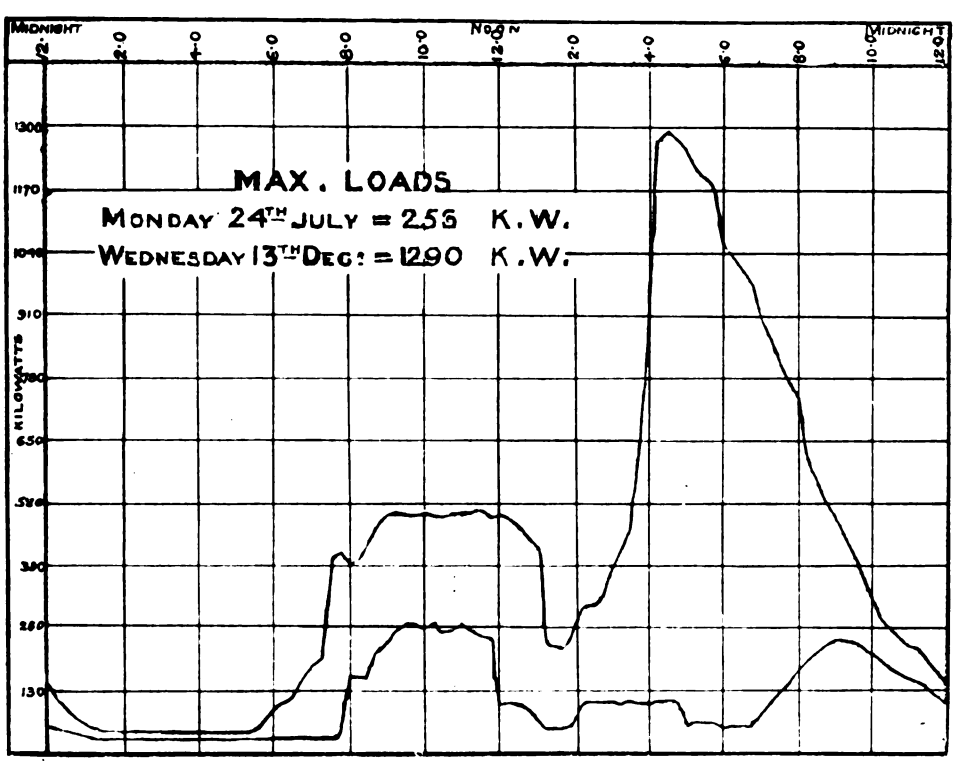

FIG. 17.—Typical Load Curves from the City Road Station. The hump through the day is due to the motor generators being used to charge accumulators.

completed. An alternative means of coaling the station is available—namely, the canal, which skirts the boiler-house. Barges may be brought along the same, from which the coal can be shovelled practically direct on to the stoking floor. As a matter of fact, this means is being employed pending

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larger unit, and at all times a good load factor is obtainable. At the same time the doubtful policy of installing special plant for the day load is avoided.

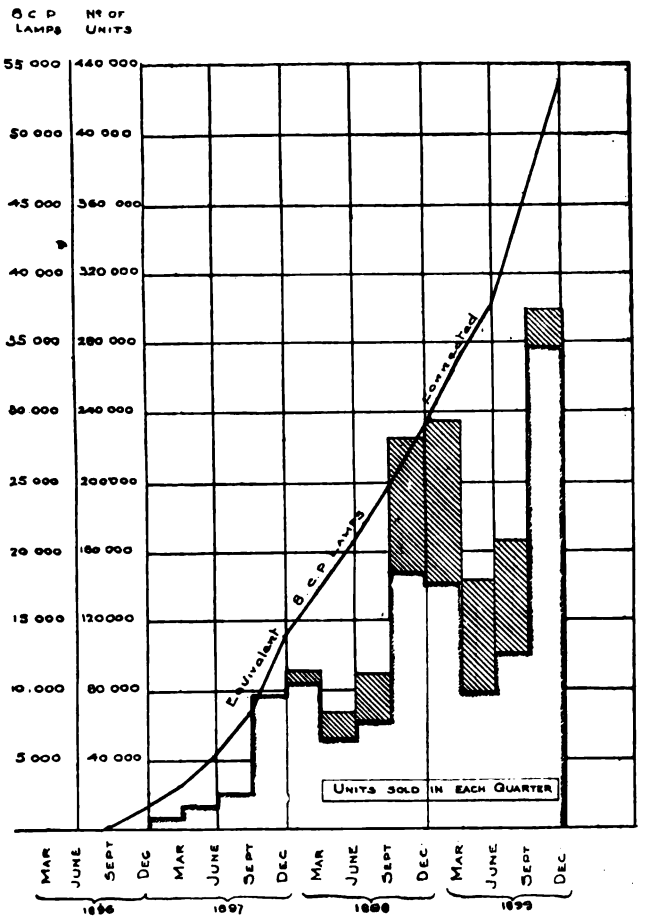

FIG. 18.—Curves of Quarterly Output and Lamp Connections for the Wandsworth Station.

As will have been gathered, the switching arrangements are excellent. In the ample switchroom provided there

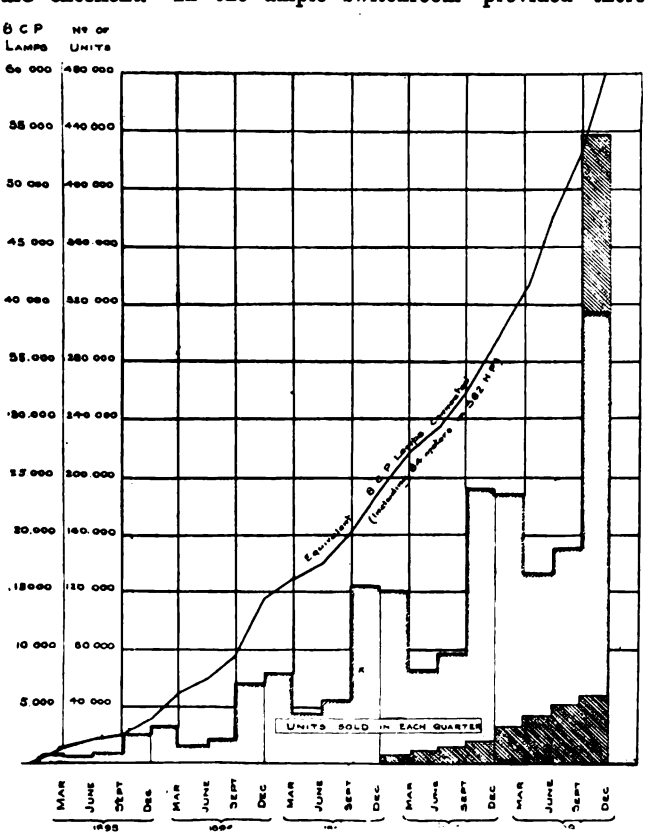

FIG. 19.—Curves of Output and Lamp Connections for the City Road Station.

should be no excuse for crowded connections. The switchboard attendant sits comfortably at a desk with the regulating wheels of the exciter shunt resistances within arm's reach. The more remote transformer sub-stations are in telephonic communication with the switchroom. Judging from a bundle of voltage curves which it was our privilege to examine, we should say justified complaints in respect of pressure at the consumers' lamps must be unknown in the Wandsworth district. This happy state of things is only what might be expected considering the great care which has been bestowed upon the switchboard and distributing arrangements. A Kelvin testing set situated in the switchroom enables the various circuits to be systematically tested for insulation resistance.

Under the able management of Mr. Whitlock, whose photograph we give below, very satisfactory results should be obtained by the company in respect to the above-described section of their undertaking when the same is fully developed.

Load Curves.—Having now described the equipment of the City-road and Wandsworth stations, we are able to give some curves showing the outputs from these stations, which also exemplifies the peculiarities of each district. Thus Fig. 14 gives the summer and winter load curves for the Wandsworth station, taken on Monday, July 24, and on Wednesday, Dec. 13, 1899. It will be seen that the output in amperes required by the mains has now risen to practically 60 amperes at 2,000 volts. This is not power, as at light loads the power factor is naturally low, owing to the capacity

Mr. A. A. Whitlock, resident engineer, Wandsworth, after serving his time in engineering shops, attending technical schools meanwhile, spent three years with the Brush Electrical Engineering Company, Limited, as an assistant engineer. Mr. Whitlock left this company to take up the position of resident engineer to the Dover Electricity Supply Company, Limited, in which capacity he acted for five years, resigning the post in January, 1899, to occupy his present position.

of the mains and the number of transformers on circuit. The early morning load in the winter is not great up to the present, but this will naturally increase with the number of private houses connected. As mentioned above, a very heavy load is obtained on Saturday evenings at the Wandsworth station. Fig. 15 shows this clearly, and also the increase in the morning load due to the drawing in of the days in December.

Fig. 16 is a curve taken on Thursday, Nov. 30, on which day a heavy fog was experienced in London. It will be seen that the station at City-road had to run at full load from 9.30 in the morning till after 6.30 at night. On the other hand, in the Wandsworth district the fog was not so bad and merely broadened out the evening load curve. The ordinary summer and winter loads at the City-road station are shown in Fig. 17. It will be seen that the maximum load, occurring at 4 o'clock, rapidly falls off after 5 p.m., much in the same way as does the load of the City of London Company. The square blocks of load occurring in the middle of the day are due to the use of accumulators, which are charged during the daytime in order to provide for the motor

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load at night. The next two curves (Figs. 18 and 19) show the outputs and number of lamps connected for both the Wandsworth and City-road stations, from the time they each commenced to supply consumers. The City-road supply was commenced from the company's own station in September, 1897, which point is marked on Fig. 19 by a cross. We are not informed what the shaded portion of these curves mean, but presume from our personal knowledge of the Wandsworth station that they are in some way connected with the assistance given to a neighbouring undertaking.

In conclusion, we have to express our indebtedness to Mr. Lawson for his courtesy in showing us over the Wandsworth station, and placing at our disposal the information, drawings, and photographs given herewith.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution last Thursday week the discussion on Mr. R. P. Sellon's paper on the "Standardisation of Electrical Engineering Plant" was resumed.

In reopening the discussion, **Major-General Webber** said he should like to draw attention to the way standardisation had gone in America, where it had been brought about by the circumstances of demand. For small plant the smaller manufacturers could supply various motors and dynamos, but for large plant the trade had settled down into one groove. The condition was that, similarly with traction work, the manufacturers able to meet the demand had had it all their own way, and their standards had been adopted. Thus all the orders for large plant had fallen into the hands of some two or three manufacturers, because these had secured various patents during the beginning of the industry, and then being the only manufacturers had held the trade ever since. Notable amongst these firms were the Westinghouse and General Electric Companies. These large manufacturers were in a much different position to the smaller manufacturers in making similar articles. Then by careful attention and economies the smaller manufacturers were just able to keep down the heavy establishment charges, but in the very large manufacturing works these were covered by the output. It was not easy to see how standardisation could be carried out except, perhaps, in the case of incandescent lamps or telephone apparatus. Thus the standardising of large units was not much good to the user, who had to pay as high a price as public opinion would allow two or three large firms to charge. An engineer also had to be employed for works, and his choice of plant was affected by price, and for his own specification's sake he specified an article which he knew would work well and be durable. The ability of the engineer showed itself, not in the way he could work out an ideal specification, but in his knowledge of the various standards and types of machines on the market. In addition to this, electric light machinery required great care in construction owing to its being constantly running, and the engineer had to know the best machines. The men in America who spoke of having eliminated the consulting engineer in that country were men who probably, if they had had the proper education for it, would have been consulting engineers, but as it was they had acquired a certain amount of knowledge, and had become manufacturers. The only object of large manufacturers was to standardise their own plant, and in the early days there were many examples of this. Taking descriptive catalogues and price-lists issued in 1890, it was curious to find that in standard makes there was but small resemblance in speeds and outputs to those of to-day. One was bound to believe that each type was what the manufacturer believed would satisfy the demand, and would be able to compete successfully with those of other makers. With incandescent lamps the purchaser was bewildered on finding the variety offered him. The wants of the user of small-type dynamos might have also been answered by the number of machines he could choose from. At one time the Brush Company had supplied nearly the whole demand for arc lighting. Thus, if gas had not been in the field, the Brush Company would have practically obtained the monopoly for street-lighting. He could not help thinking that, mistakenly, they had looked to Government departments as a means by which standardisation could be obtained. It was, however, but seldom that Government departments went in for standardisation, the navy being practically the only one. Even then, as Mr. Crompton could tell them, they could not standardise in all things. Mr. Crompton saw at Chatham some projectors which were being tested, but a stock of these could not be laid in, as they would soon become obsolete, and the money spent would be wasted. Mr. Sellon had not laid before them any standard specification which he thought would secure the ends he wished. He should like them to examine the Admiralty specifications in the early eighties for tenders for electrical supplies. These were very clear, and stated exactly what was wanted. He quite agreed with the author that anything which would lead to a determination of standards by organised effort was wholesome, and the Institution should be grateful to Mr. Sellon for bringing the subject into discussion, and he hoped that the members of it would not let the matter drop, and would urge the Council from time to time to appoint committees on the subject.

Mr. W. B. Esson said that if they were to have cheapness of production and give the customer the best value for his money, they must have more standardisation than at present. The more the subject of standardisation was considered, the greater became the difficulties in the way. Although all might know exactly what they wanted, there was considerable diversity of opinion as to how it should be obtained. Mr. Sellon had not drawn a very clear line between the two branches of his paper. It might be divided into standardisation outside the works and inside the works. As to the first, in America and on the Continent there did not seem to be greater agreement as regarded common standards than in this country, as different manufacturers had each their own frequencies and outputs, etc. As to standardisation inside the works, this was carried on to a much greater extent in America than here. He was not, however, sure there was much standardisation of patterns of machines. The American manufacturers had, however, such a great demand that they were able to construct a large number of machines of any pattern before this was altered. He agreed with Mr. Slater Lewis, that if manufacturers, instead of trying to run the whole gamut of electrical industries confined themselves to one machine, great economies would be effected. A manufacturer in England doing this, however, could not keep going. If Mr. Lewis meant to strike the keynote for a combine of a number of large number of firms, he was with him; but it meant, nevertheless, the different machinery going to different individual firms. This, he thought, was what it would finally come to in this country. He had never known a consulting engineer who would not rather take a good thing out of stock than invent a specification for it. Occasionally absurd things were asked for by consulting engineers, but it was generally the result of their having been bitten by a contractor, and they wanted to be on the safe side. Consulting engineers were usually very reasonable, and they were very useful at times in pointing out to manufacturers the weak points in their machines. There were great difficulties in specifying ends to be obtained without bearing to some extent on the means for obtaining them. Take as an example the insulation resistance of a machine running at 440 volts. Some engineer would state that the insulation of the machine must be such as to stand an alternating pressure of 1,000 volts for an hour, but he had recently been asked to guarantee machines for the above working voltage against a test pressure of 5,000 volts. This was an excessive guarantee that it would run for a long time without breaking down. He took it that the author desired to call attention, not so much to the standardisation of small lighting plants, as to medium-sized plants for lighting stations. There would be great difficulty in this latter, owing to the varying types of engines supplied by different makers. It was, therefore, of very little use to try and standardise plant until there was some uniformity of design in the engines. The alteration of the patterns of these would be very expensive, and it would cost less to suit the dynamo to the engine than *vice versâ*. The standardisation of the frequency was a much easier matter in Switzerland than in this country, and within wide limits it would be an extremely difficult thing to standardise here. Within wide limits, also, the frequency was a thing of not much importance. It was significant that the Continental firms had no hard-and-fast frequency. A rigid standardisation of frequency would entail costly alterations in patterns. The consulting engineers specified for a frequency of 50 as a rule, but a little under or over, if the efficiency was not interfered with, was always accepted. As to the taking of railway gauges as an analogy to the electrical machinery, the two things were entirely different. It was absolutely necessary to have the railway gauges the same, owing to the trains passing over the various companies' lines. The making of a hard-and-fast rule as to frequency would, he thought, defeat the object in view, and it would be better to let the manufacturer make machines with the frequencies he thought best, and then let the consulting engineer choose the one which suited his purpose best.

Mr. S. Evershed said he agreed with the author in his statement as to the standardisation of the buyer's engineer. That standardisation was a pressing necessity in England, he thought that all agreed, but how it was to be arrived at was the question. The standardisation of the consulting engineer was a much more formidable task than Mr. Sellon imagined. In these days no new industry could start without suggestions, rules, and Acts of Parliament being passed with reference to it and regulating it in every possible and impossible way. It was not only in this industry that the irresponsible government was felt, but all over the country. There was at Hastings, for instance, a rule made by the local authorities that you must not "play on any musical instrument or performing animal in the streets." This was a sample of municipal government. Also the moment they took the average Englishman and put him in a position of authority he became a changed man, and until Mr. Sellon could show them some way of altering the temperament of the average Englishman, they would have to leave unstandardised the consulting engineer. But still something might be done, and, as Mr. Blackburn had said at the last meeting, if each manufacturer would start and standardise his own machines then the consulting engineer would probably help as well. The start should, he thought, be made in standardising the size and outputs. Mr. Robinson had rather capped Mr. Blackburn's remarks, but that was because the Willans engine was such a fine machine that the demand for it rendered its standardisation rather easy. He, himself, had tried to do something in the way of standardisation of instruments, but with disappointing results. The consulting engineer would think that with instruments anything was possible. One engineer, for instance, wanted an addition of a meter to show which way the current was passing, but this addition must not

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contain a permanent magnet. When he was informed that it was impossible to do this, he said he would not insist on the condition. One consulting engineer wanted a meter which read correctly to 2 per cent. at any part of a 10in. scale. When it was explained to him that this amounted to $\frac{1}{10}$in., and that at the end of the scale such accuracy was very difficult to obtain, he then said that he only wanted it correct to that amount in the centre of the scale. They also specified how an instrument should be made, and they specified that a meter should stand on its terminals—the worst way imaginable for a meter to be placed. This difference in the requirements of the engineers applied to instruments much more than to dynamos, and the patterns were proportionately much more costly to alter. Something might be done by the manufacturers meeting together and forming a committee which might settle such things as the heating of armatures, accuracy of instrument reading, etc., but it was, he thought, a far larger problem than Mr. Sellon imagined.

Mr. L. Andrews said he was one of the buyers' engineers. He thought that the lack of uniformity was a great nuisance to them all round. His was one of the stations which had 100 periodicity, and he had taken the opportunity since the last meeting of discussing with his chairman the question of reducing it to 50. His reply was that it would shake the confidence of the ratepayers in the undertaking to ask for a large sum of money to renew the plant. If certain constructional details were not to be insisted upon, then he thought the manufacturer should take the responsibility as to the turning out of the plant. He did not think it fair to blame the user's or buyer's engineer for the lack of uniformity. The Hastings station, for instance, had been guided more or less by the manufacturers. Up to 1890 the Hastings Company had been supplying on the Brush series system. At that time they were told that they should go in for the parallel system. In spite of this change, they did not seem to get much standardisation in the plant. The plant supplied in 1892 was not standardised with that supplied in 1894. Many persons had again suggested that they should scrap this plant, although it was not very old.

Mr. Stuart Russell said that in attempting to standardise the size of units, they were beginning at the wrong end. They could not very well standardise engines, as if one engine-maker's engines were 10 per cent. faster than those of another, they could not very well ask him to take off this 10 per cent. and so reduce the output from his engines. Each manufacturer of small plant would fix his own speeds. There should, however, be no difficulty in getting manufacturers to all make the same size of machines. The standardising of pressure would certainly be advantageous. As the author had said, they had adopted very readily the standard system of traction from America. In so doing, they had handicapped the makers, because in stations where it was desirable to use the electric lighting machinery for traction as well the traction voltages were higher than the lighting, but the engines did not permit of an extra output corresponding to the normal current and this higher voltage. He thought that there could be some similarity between lighting and traction voltages, and in many cases economies could be effected thereby. There were some other points where standardisation could be carried out, such as the heating of machinery. The rating of machines, also, was a vague matter at the present time. When a maker described a machine as of 50 kw., they did not know under what conditions that had been obtained. If, however, a certain standard test under which 50 kw. are obtained were used, the buyer would then know what was meant. Reference had been made to the Admiralty specifications, and he could say that this body did specify what they required as regarded rise of temperature; while with other users, one wished for 50 rise, and another would say that 75 would do. He should like to see something definitely settled as to the insulation resistance. Some people wanted as high a resistance in armatures as 10 megohms, while others were content with quite a small insulation resistance. By beginning in such minor matters as these a useful start might be made. The larger questions might be left until afterwards. As to the standardisation of the width and number of brushes, no good purpose would be served. If consulting engineers only realised the trouble they caused the manufacturer, they would take out of their specifications many little things which caused needless expense to make, and which were of small importance from the engineer's point of view.

Mr. L. Birks said that he would draw their attention to the tables he had prepared. The second was rather the more interesting, containing the number of machines at various periodicities since 1888.

TABLE I.

~	Stations.	Machines.	Frequencies, kw.
100	24	170	38,746
50	25	124	25,396
83	9	77	16,280
60	10	43	11,791
93	2	25	3,953
80	3	23	2,920
40	3	28	2 838
75	4	13	1 595
90	2	20	1,943
70	1	14	4 210
87	2	11	1,300
77	1	9	425
68	1	6	680
67	1	3	375
66	1	3	235
125	1	5	140
Total	90	574	112,827

TABLE II.

Year.	Alternating					Direct		Total
~	100	83	Various	60	50	H.T.	L.T.	
1888	2	2	—	1	—	—	4	9
1889	3	1	1	—	—	1	5	11
1890	3	1	2	—	—	—	2	8
1891	4	—	2	—	1	1	4	12
1892	1	1	1	1	1	1	4	10
1893	3	2	4	—	—	2	9	20
1894	3	2	4	1	3	1	5	19
1895	2	—	7	—	2	2	6	19
1896	—	—	—	3	2	—	9	14
1897	3	—	—	1	3	1	4	12
1898	—	—	—	1	3	1	11	16
1899	—	—	1	1	6	2	20	30
1900	—	—	—	1	4	—	41	46

They would see that it was an indisputable fact that the periodicity was standardising itself very quickly at 50. For four years past only one station had been started with a periodicity different to 50 or 60. The question was practically settling itself, and would be noticed in other classes of manufactures. Another point was the large number of 440-volt stations started at the present time.

Mr. A. E. Levin said it was interesting to note what was happening on the Continent. It was, he thought, regarded as a sort of celestial paradise, "where consultors cease from troubling and designers are at rest." He did not think there was much progress in standardisation there when they had no standard screw thread, and all sorts of threads were used. Although also the periodicity was lower than was formerly the case, there was no actual uniformity, it ranging from 35 to about 60. He did not agree with Mr. Esson that standardisation was not very important except for small motors. Standardisation should begin with the larger plant instead of the smaller. The tendency which was now shown by people to bring down the standard to 50 was a very healthy sign, and he believed it would make itself felt in future.

Mr. G. L. Addenbrooke thought it a mistake to define frequency with the strictness which had been done. They had not enough knowledge at present to enable them to select the best value. As more progress was made, conclusions might be arrived at which might make it necessary to depart from the frequencies now in use. The reason of the lack of standardisation was that the electrical industry in this country was being forced out of its natural course by legislative action. For instance, they knew that most of the work was practically thrown into the hands of municipalities, and led to a large number of young men being appointed engineers to the stations. The usual run of things was that if there was a consulting engineer to start with, they did without him after a time. A great many of these young men had been very successful as engineers, and they began to draw up specifications. The drawing of a specification was an extremely difficult thing to do well, and they did not prove such a success in this. In other branches of engineering, centuries of experience had proved that there was yet room for consulting engineers. There was no doubt that some of the engineers employed by local authorities would not have been employed by a board of directors in a commercial undertaking. It would be a pity to go too far on the part of the Institution and attempt to absolutely standardise things. They should specify sizes of shafts and sizes of bearings, and other similar things. It should not be left to the man at the lathe to make a shaft, say, right to about $\frac{1}{16}$in. A good deal might be done by the manufacturers and consulting engineers. As to the tramway-work standards, they would, perhaps, prefer 600 volts instead of 500, and the saving of copper and saving of drop would be considerable, and they might have to restandardise this work.

Mr. C. E. Grove said there were several kinds of standardisation. There was standardisation in the sense of trying to do the same thing in different places in the same way, and the kind which was only specialisation. There was a good deal of human nature in this problem. One electrical engineer went to one place and laid down plant and brought his experience to bear on it. Another engineer did the same in another place, and consequently different conclusions were arrived at. The industry would have to be many years older before standards could be made, and until these were settled the broad question of standardisation must stand over. The small manufacturer standardised his machines to a much larger extent than was known. There was a great deal to be done in the country in the way of specialisation. It must be done by agreement. There were a number of big works all over the country, and if one or more of these firms took a definite line and achieved the success which standardisation was supposed to bring, the others would at once start on similar lines. The question must, however, be more one of agreement, and standardisation would only be brought about by one firm making one thing and another firm making another thing.

Prof. W. E. Ayrton said he did not agree with Mr. Esson that America was like England in having no standardisation. The idea arose owing to people not properly understanding the American system. He had travelled in America and knew standardisation there did not mean no progress, as although the makers had standard machines they were always experimenting privately to see if these could be improved, but until an improvement was perfected it was not put on the market. The same system was in vogue at Rotherham's watch factory at Coventry. Mr. Russell had pointed out that consulting engineers worked for all sorts of requirements, and this prevented standardisation. The manufacturers were to blame in this respect, as if they made certain

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sizes, and no others, the thing would be done. It would be a good thing, also, if the manufacturer stated exactly what were the capabilities of his machines, as if an engineer had no means of knowing, without writing to every manufacturer in the country, what was made he would be likely to specify something which they did not manufacture. Let the manufacturers tell them the qualities of every detail of the machines, and the consulting engineers would ask for exactly what was manufactured.

Mr. S. Sellon said that by some peculiarity of reasoning the author seemed to think that consulting engineers were banded together in some unholy league to prevent the standardisation of engineering practice. The tone of the paper seemed to be like a voice crying in the wilderness, "Mr. Consulting Engineer, please will you let me standardise, that is, if you have come to stop!" He thought the consulting engineers had a little more regard for the men who had aided and abetted the commerce and trade of the country. Standardisation was entirely in the manufacturers' hands. If they had a good article, they might be sure the consulting engineers would take it. There were manufacturers and manufacturers. Some standardised in the way Mr. Robinson had shown them, and there were others who would not standardise, and, if they would, had nothing worth standardising. The experiments towards standardisation by trial and error should not take place at the users' expense. When electric traction came into the country none of the manufacturers were ready for it, and none of the machines could be called reliable for the purposes for which they were wanted, and the consulting engineer had to specify what he wanted for his own particular case or specify plant which could be better secured on the Continent. Most of the first tramway plant laid down had been scrapped. As to the large orders for municipal plant which was of Continental design, this was because the manufacturers neglected to take the advice of the Continental experts, and standardise. If the buyer wanted a complete equipment for a tramway, if a firm would tell him that they only manufactured a certain article, well and good, but there were already firms who supplied plant for the whole purpose whether they were able to or not. This was where the consulting engineer came in, and he must know where the best things for the purpose required are to be obtained, and this was the object of his existence. No manufacturer could possibly guarantee to supply all the tramway plant. He was championing the cause of those who had spent their lives in working out the tramway industry, and in making it possible for the manufacturers to fill their workshops. He thought the time would come when the continuous-current motor would depart from tramway work and the three-phase type be adopted. Mr. Mark Robinson the previous week completely answered the author in that he had been able to standardise in spite of the electrical engineer.

Mr. J. E. Kingsbury said he thought that Mr. S. Sellon had taken a rather wrong view of the author's remarks on the relations between the engineer and manufacturer. Standardisation had been divided into standardising of mechanical parts and standardisation of supply. He himself had been trying to obtain standardisation of demand, but he had not got it yet.

Mr. R. P. Sellon, in reply, said the discussion might be divided into four heads—namely, the question as to whether standardisation was backward in the country as compared with rival countries; whether standardisation was desirable; whether it was practicable; and, finally, whether the Institution ought to take any action in the matter. He ought first to define what he meant by standardisation. It meant such an understanding or agreement amongst buyers as should allow manufacturers to go in for quantitative production. From this point of view the discussion had brought out the confirmation of the view that standardisation was further advanced in America and on the Continent than here. Mr. Levin, however, was well qualified to speak on that subject, and he had thrown some doubt as to whether it was more advanced on the Continent than in this country. As to the question of the desirability of standardisation, Major-General Webber had stated that, judging from the action of the big American companies, it was not. He himself would venture to say that it was not undesirable owing to the lower price which the consumer had to pay. He thought the larger number of speakers had thought it desirable. As to the practicability of standardisation, several speakers thought it too late, and, on the other hand, others thought it even too early. It would seem, then, that it was just the time to deal with the question. There had been much discussion as to the responsibility of standardisation, whether it lay with the manufacturer or consulting engineer. He himself thought it should in a large measure be placed at the door of the manufacturer. The manufacturer had not the courage to standardise goods and manufacture them in quantity, and tell the buyer that he can take or leave an article. The difficulty of the manufacturer in this country was much greater than in America, because they were there in more of a position to dictate to the buyer. It had not been his intention to unfairly criticise consulting engineers. His desire had been to make a fair and impartial criticism, and not to bring forward the interests of any party. As to whether the Institution should concern itself with standardisation, if both sides were willing to receive regulations to that effect it would be good. It seemed desirable that steps should be taken, and he hoped they would be taken up in a willing manner. In common with most electrical engineers, he was desirous of seeing the improvement of the electrical industry in England, and he thought it was a matter for the Institution, which would do good for the country at large.

A vote of thanks was then passed to Mr. Sellon for his paper.

The following is an abstract of the communication which **Mr. C. Bright** is sending for incorporation in the *Proceedings* on the discussion of Mr. Sellon's paper: After Mr. Raworth and Mr. Hammond had been gnawing at the two ends of a bone, there was naturally not much left for anyone else. He, however, would take a humble nibble at the middle. As the field for debate was so wide, he would not challenge the title of Mr. Percy Sellon's important paper, but would at once say that whilst very fully appreciating the excellence of Mr. Sellon's suggestion, he could not quite agree with some of his arguments. For instance, he ventured to think that the fact of electrical engineering having been practised on so much large a scale in the United States hitherto than in this country could be sufficiently accounted for by other and much larger considerations than the want of standardisation in electrical engineering plant in this country—*i.e.*, the comparative conservatism of English officials rendering the demand, and therefore the supply, materially less, the difference in the cost of gas, the much greater distances to be covered, etc. In the case of Germany, too, surely the non-reciprocation of free trade went a long way to explain English manufactures not meeting with as much demand as they should like in comparison with German material. In fact, the whole explanation was somewhat wrapped up with political economic considerations. To add force to his point, Mr. Sellon seemed rather to have gone out of his way to condemn the consulting engineer wholesale to an untimely end; but surely his type was an unfortunate one, and not in accordance with the law of averages. He ventured to think that those who had previously served their time in engineering works or under a recognised engineer were well able to appreciate the importance of allowing a manufacturer of high standing to approach and carry out details of construction in his own way. He also ventured to think that a consulting engineer with an all-round engineering training was unlikely to show himself to be a wanton faddist in his specification generally. He doubted whether "faddism" was any more characteristic of the consulting engineer than that of any other member of the community, but was purely a question of character, training, and experience. Many consulting engineers would have been only too glad if the producers of electrical engineering materials had a little earlier in the day gone in for standardisation. He certainly agreed with Mr. Sellon that the producers were the best judges from a commercial standpoint, only they must give a wide scope to choose from to suit all sorts of requirements. No doubt Mr. Sellon's suggestion was mainly with a view to traction and the distribution of power rather than for lighting work. In this connection it might be noted that, though they might be behind other branches of civil engineering in a proper understanding of professional etiquette, they would be ahead of their brother engineers in the matter of standardisation; for he believed it to be a fact that the reason the Americans were outstripping them in the sale of locomotives was largely due to the fact that, whereas the engineers of this country were constantly changing the types, in the States the manufacturer felt justified in turning them out *en bloc* and having them practically in stock. With further reference to Mr. Sellon's strictures on the consulting engineer, he observed that he proposed to standardise him. Perhaps he would go a little further and standardise humanity, so as to leave no scope for "individuality" anywhere. Perhaps there could even be room for a little "standardisation" in the "producer" whilst engaged in this extraordinary and somewhat exhaustive occupation! He felt sure a large number of consulting engineers would, like himself, greet Mr. Sellon's paper and his practical suggestions with the greatest possible pleasure.

The following is a list of the candidates balloted for at the meeting:

Members.—L. B. Atkinson, 9, Victoria-square, Penarth, Cardiff; Prof. A. Gray, F.R.S., LL.D., etc., 11, The University, Glasgow; W. W. Lackie, 75, Waterloo-street, Glasgow; T. Young, 4, West Regent-street, Glasgow.

Associate Members.—J. C. Beattie, D.Sc., F.R.S.E., South African College, Cape Town; S. Beeton, Green Bank, Bowdon, Cheshire; C. E. Bright, Post and Telegraph Department, Brisbane, Queensland; J. M. Carr, 14, Waverley-gardens, Glasgow; H. J. Cash, 5, The Market, South Croydon; G. H. Woods, 77, Northgate, Blackburn.

Associates.—M. J. Allward, 9, Mount View-road, Crouch-hill, N.; W. H. Barker, 12, Robin Hood-street, Nottingham; F. Biliotte, 12, Elliscombe-road, Charlton, Kent; W. Densham, Cliffe Hotel, Dovercourt, Essex; J. Lister, 18, Lowfield-road, Stockport; W. H. W. Napier, 24, Nelson-street, Dublin; P. P. Wheelwright, 136, Montague-street, Blackburn.

Students.—A. Blok, 47, Pyrland-road, Canonbury, N.; J. Butcher, The Rowans, Beaconsfield-road, St. Albans; A. W. Goodwin, Old Hall Cottage, Hanley, Staffordshire; J. S. Heath, Heathcote, 68, Geraldine-road, Wandsworth Common, S.W.; P. S. Hudswell, Clareville, Monton-road, Eccles, Lancs.; F. H. Morley, Sydney Mount, Counter-street, Stockport; G. Walsh, 182, Haverstock-hill, Hampstead, N.W.; E. R. Wynne, 56, South Park-road, Wimbledon, S.W.

Bequest.—We learn that the late Prof. D. E. Hughes, F.R.S., besides remembering the Institution of Electrical Engineers by bequeathing funds to found a scholarship, has left £4,000 to the Royal Society for the furtherance of physical science.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street London, E C. Anonymous communications will not be noticed.*

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STANDARDISATION.

The recent paper read at the Institution, with the discussion thereon, constitutes very interesting reading, but we are utilitarian enough to ask where does it profit? The question was presented in an abstract form, leading to a very wide field of discussion, but to no goal. Standardise what? Plant in the general, hardly in the particular. Is it possible, would it be profitable, to standardise all electrical plant? If not, what items could be standardised to advantage? Neither paper nor speakers tell us anything definite. Man after man says it would be a good thing to do something in the abstract, but swims around anything concrete without deigning to touch it. From beginning to end the dream of standardisation in the bulk is the dream of the millennium or of wholesale combination. It is a wonder no company promoter suggested a gigantic combine, then standardisation could be partially effected, but we do not say for the benefit of the buyer. From the manufacturer's point of view it is almost a crime to be a consulting engineer and to have views of one's own. The contractor's views are very limited—limited, in fact, to four walls and a balance-sheet. Anything that tends to upset the ordinary work within the former, or to decrease the balance on the right side of the latter, is anathema. Well, so be it; that is human nature, and must come into the calculations of this sublunary sphere. Many would argue that such a limitation limits progress, but that is not necessarily true. The larger the concern, the greater the quantity of apparatus turned out, the easier to standardise or the easier to restrict output to one class of apparatus. Before, however, referring more to what has been said, let us refer to one point that has not been said. We say deliberately and emphatically that several of our manufacturing companies do not conduct their business in the manner best calculated to increase output. Their idea of the value of brains is about three pounds a week, and instead of employing men who know their business, and may be calculated to produce *the best* designs, and therefore the best apparatus for the work it is to do, they employ at a comparatively low price men who profess to be as good as any other, and offer apparatus that will not stand the test of real examination. They try to work off second or thirty-second rate goods on their customers, and then expect consulting engineers to take what is offered. Is it any wonder that buyers fight shy of such goods? The matter for wonder is that representatives are able to sell anything. Surely the consulting engineer is not to take such apparatus because it is made to stock and can be supplied at once. His duty is to see that the customer gets, not what is offered, but what is required. Firms that follow a different plan and produce what is the best have little or no difficulty in standardising or selling their make of goods as specialities. The speciality may be a nut, corkscrew, ordinary screw, or piece of electrical apparatus, but it is the very best that brains can devise in accordance with the most recent scientific knowledge and latest

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practice, and hence commands a steady sale. What does standardisation mean if not the making of large quantities of apparatus to the same pattern? If the pattern is the best, it standardises itself, and there is an end of it. The seekers after official or authoritative standardisation are generally those who will not employ competent men in their own works, but who desire to benefit themselves at the expense of others. A good deal has been made of the standardisation of Willans's engine; but why could it be standardised? Was it not simply because it was about as good a design as genius could discover and workmen construct? When those who desire "standards" employ good men and special tools to perfectly construct what is thus designed, they need have no fear but that consulting engineers will not accept them. They will, and gladly. All the American examples are wide of the mark. There is no standardisation in America in the strict sense of the term. A glance at the literature of "bicycles" ought to teach even electrical engineers what is meant by standards. Each firm produces its "model" for 1900 and makes to that model for 1900, but with 1901 a new and improved model is produced, becoming the standard for that year, and so improvements are continuous, but in a way standardisation exists. Electrical engineers, go then and do likewise!

ELECTRICAL POWER DISTRIBUTION.

Writing on March 1 we are unable to say what will be the fate of the Power Bills this evening in Parliament. The *Times* of to-day opportunely calls attention to the subject, not only in a lengthy communication from a correspondent, but in a leading article, while its columns also contain a letter from a Mr. Thos. Farrow which shows the futility of attempting to teach those who do not desire to be taught. Mr. Farrow entitles his letter "A Menace to Local Authorities." It ought to have been entitled "Rip van Winkle's Ideas about Bumbledom." We have little patience with such men as Farrow, who show so clearly they do not understand the question, nor do they appreciate the condition of affairs. The world has not stood still during the nineteenth century, and in this particular case there surely is a way of adjusting conflicting interests. Our opinions have so often been expressed that we hesitate to say anything further on the subject, but it may be well to reiterate that progress points to the necessity of larger central stations in some districts for more economical supply. The parrot cry of the Farrow's and such like men about "fundamental rights and privileges" has no meaning. Neither he nor they define or can define these "fundamental rights." Municipal areas are artificial. Modern progress has shown that in various directions, such as water supply, gas supply, electric light and power supply, traction, etc., the artificial boundaries must give place to natural conditions, and thus, instead of whining like whipped children, the true course of the opponents to these Bills would be to attempt the adjustment of rival interests by compromise. We say most emphatically that in our opinion the terms of agreement should be found fairly simple, easy, and practicable.

THE SEND-OFF DINNER

Our friends, the active-service contingent of the Electrical Engineers (R.E.) Volunteers, will doubtlessly have the heartiest send-off their patriotic hosts can give. Although the history of the past week has shown that

> **Fortune has smiled approving favours,**
> **And crowned the toil of long endeavours,**

it may be that our guests of to-morrow will find plenty of scope for their genius and labour when they reach the other side of the Great Karroo. Reader, what a depth of meaning that word "volunteers" conveys! They go to the front, not only for themselves, but for us, and ought we not to show that we appreciate their action?

> **Joy to Old England! she has stuff for storm sail and for stay,**
> **While she can breed such heroes in her quiet, homely way.**

There has been, and is, a noble response to the country's call, and though many are prevented from leaving our island shores they are not backward in showing the close band of brotherhood that links the hearts of those who have to stay with the hearts of those who select to go. Before the day of the dinner we have to write our heartiest wishes for victory to crown their efforts, and a safe return to those who watch their career in the arduous labours undertaken. And now

> **Come, harper, strike up; but first by your favour,**
> **Boy, give us a cup. Ah! this has some savour.**

God-speed and a safe return.

POWER BILLS.

At the moment of going to press we hear that these Bills have been read a second time, and referred to a Hybrid Committee.

CORRESPONDENCE.

> **"One man's word is no man's word,**
> **Justice needs that both be heard."**

FOREIGN COMPETITION.

SIR,—It may interest your readers to learn that the action for libel that the National Conduit and Cable Company of New York commenced against us last year in the matter of a letter we wrote to your paper as to the way in which the cable contract for the Dublin tramways was let, has now been finally dismissed for want of prosecution.

We inform you of this in justice to ourselves, as the taking of this action against us was published at the time. Further comment on our part is needless.—Yours, etc.,

THE BRITISH INSULATED WIRE COMPANY, LIMITED.
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Prescot, Lancs., Feb. 27, 1900.

ELECTRICAL ENGINEER VOLUNTEERS' SEND-OFF DINNER—VISIT TO CHELMSFORD.

SIR,—Major Crompton desires me to say that the active-service contingent of the corps will be paraded on Saturday afternoon (March 3) at the temporary camp at Chelmsford, and will be glad to exhibit to any of their friends who can

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be present the plant which they are to take to South Africa. The train leaving Liverpool-street at 2.25 p.m. for Chelmsford is recommended, but other trains leave at 10 and 10.55 a.m., 12 noon, 1.55, and 3.32 p.m. Return trains leave Chelmsford at 3.13, 5.5, 5.15, and 5.55 p.m., arriving at Liverpool-street at 4.20, 5.50, 6.32, and 6.53 p.m. respectively. Special carriages will be provided on the train leaving Chelmsford at 5.55 p.m. to convey the officers and men who are coming to London to the dinner, and covered brakes will meet the train at Liverpool-street to convey them to the Prince's Restaurant. There will be a few vacant seats in these brakes. Those wishing to avail themselves of this means of conveyance from the train to the restaurant, will please remit the sum of 2s. to Mr. Edmunds in payment for a ticket. No special arrangements can be made for railway tickets, which will be purchasable at the station in the usual way.

Major Crompton asks me to say that he will be happy to give facilities to visit his works at Chelmsford to any of the party who are able to go down by an early morning train.—Yours, etc.,

W. G. McMILLAN,
Hon. Secretary to Dinner Committee.

FORTHCOMING EVENTS.

SATURDAY, MARCH 3.

Electrical Engineers Volunteers.—At 7.15 for 7.30, at Prince's Restaurant, Piccadilly, send-off dinner to Major Crompton and the volunteers proceeding to South Africa.

Royal Institution.—At 3 p.m., Lecture I., on "Polarised Light," by Lord Rayleigh.

MONDAY, MARCH 5.

Society of Arts.—At 8 p.m., Cantor Lecture I. of four, "Photography of Colour," by Mr. E. Sanger Shepherd.

Society of Engineers.—At 7.30 p.m., at Royal United Service Institution, Whitehall, ordinary meeting.

TUESDAY, MARCH 6.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Discussion on paper on "Corrosion of Marine Boilers," by Mr. J. Dewrance, and, time permitting, paper on "A Short History of the Engineering Works of the Suez Canal," by Sir Charles Hartley, K.C.M.G.

THURSDAY, MARCH 8.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper on "The Applications of Electricity in Medical and Surgical Practice," by Dr. H. Lewis Jones, M.B.

Society of Model Engineers.—At 7 p.m., Exhibition of Models entered for Model-making Competition. Tickets (free) of Mr. F. E. Powell, 6, Farringdon-avenue, E.C.

Camera Club.—At 7 p.m., lecture on "Steam-Turbines, Land and Marine," by Mr. A. A. Campbell Swinton.

FRIDAY, MARCH 9.

Royal Institution.—At 9 p.m., discourse on "Bacteria and Sewage," by Prof. Frank Clowes, D.Sc.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "The Distribution of Stress in the Walls of a Thick Cylinder," by Messrs. J. Duncan, B.Sc., W. A. Wales, and G. J. Day.

SATURDAY, MARCH 10.

Royal Institution.—At 3 p.m., Lecture II. of six on "Polarised Light," by Lord Rayleigh, M.A.

Institution of Electrical Engineers.—At 11 a.m., students' visit to the works of the Langdon-Davies Motor Company, Limited.

Institute of Junior Engineers.—At 7 p.m., conversazione at Westminster Palace Hotel. Reception by the President.

Glasgow and West of Scotland Technical College Scientific Society.—Paper on "Notes on the Mechanics of Cycling," by Mr. J. Blacklock Henderson, D.Sc.

North-East Coast Institution of Engineers and Shipbuilders.—At Newcastle-on-Tyne, graduates' meeting.

THE PROPOSED VIENNA-PRESSBURG TRAMWAY.

We notice an article in the *Elektrotechnischer Anzeiger* by Josef Mechtl-Steinamanger which describes a proposed electrically-worked tramway between Vienna and Pressburg. The principal interest attaching to the line centres in the fact that a clear stretch of some 55 miles is to be worked from one generating station, the entire system, including branch lines at either end, amounting to the respectable length of somewhere about 62 miles. The power station, we are told, is situated in Hainburg, which is probably about midway between the two extremities of the line, though there is nothing in the article indicative of its exact position; nor does an ordinary map help us out of the difficulty. We learn, however, that the motive power employed for driving the generating machine is water, the natural fall of the Danube being partially utilised for the purpose. An effective fall of 19ft. is obtained at the turbines, which are of the Victor type and four in number. They are mounted on a common shaft and drive the main transmission shaft by means of rope pulleys. The turbines are regulated by Lombard regulators. To the main transmission shafts are keyed three belt pulleys, which serve to drive the dynamos, and may be set in and out of action by means of friction couplings.

The dynamos are designed to furnish alternating current and continuous current simultaneously from one winding. The output of each machine amounts to 250 kw., and the current generated in the winding is taken partly from a commutator situated on the one side and partly from the collector ring attached to the other side of the machine. As the speed of the machines is 600 revolutions per minute, and each possesses 12 poles, the alternating current generated consequently has a periodicity of 60 per second. The potential of the continuous current varies from 500 to 550 volts, while that of the alternating current is 300-350 volts, since the two currents, as previously mentioned, are furnished by the same winding, their respective potentials bearing, therefore, the known ratio. Owing to the periodicity, the peripheral velocity of the armature is high, and the poles are placed close together, so that the machine resembles a rotary transformer rather than a traction-type generator. As a matter of fact, the machines are almost identical with rotary transformers of similar frequency and terminal potential. The sole difference consists in the employment of a belt pulley and an exterior bearing for supporting the same, which feature is added in order to render mechanical driving possible. The magnet cores are attached to a yoke piece, and provided with a compound winding sufficing to generate the normal potential of 500 watts with the machine running light, and 550 volts on load. The armature winding consists of copper strip, while the machines are so designed as to be capable of taking 50 per cent. overload for a period of four hours without suffering injury. The generators are self-exciting. The author goes on to describe the switchboard, which is correspondingly arranged for the distribution of both alternating and continuous current. The alternating current, it should be mentioned, is three-phase. From the switchboard the alternating current is conveyed by means of lead-covered cables underground to a transformer chamber situated 20 yards distant. This transformer chamber was separated from the machine-house for safety's sake. It contains eight step-up transformers insulated with oil and cooled automatically. Each has an output of 125 kw. and a transforming ratio of 208 : 5,980 volts. Both the primary and secondary windings are connected on the star system, whereby a combined pressure of 10,000 volts is obtained in the secondary windings. With a pressure of 330 volts between the primary terminals of each transformer, 6 or 12 per cent. of the winding may be switched out according to which of the two plugs provided for the purpose is used. By connecting the feeders to the one or other of these plugs, or finally to both of them instead of with the terminals, 6¼, 12½, or 18¾ per cent. of the primary—that is to say, the low-pressure winding—may be switched out, whereby the transforming ratio is correspondingly altered. The secondary, or in this case high-pressure winding, is also provided with a plug to enable a reduction of the line pressure below that which would be given with the whole winding switched in. By means of these plugs the ratio between the pressure of the current generated in the station and that in the sub-station may be varied as required. From the transformers the high-potential leads are conducted to a 10,000-volt switch. This switch is of the "plug" type, and is operated by means of flexible connections provided with spring contact pieces—which fit into the plug sockets—mounted upon marble or composition bases. From this switch the current is conducted to a group of similar plug switches after passing through the fuses. These switches enable

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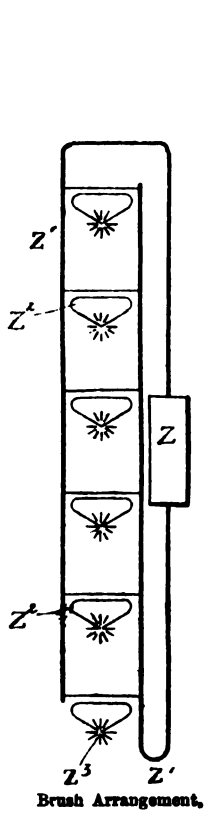
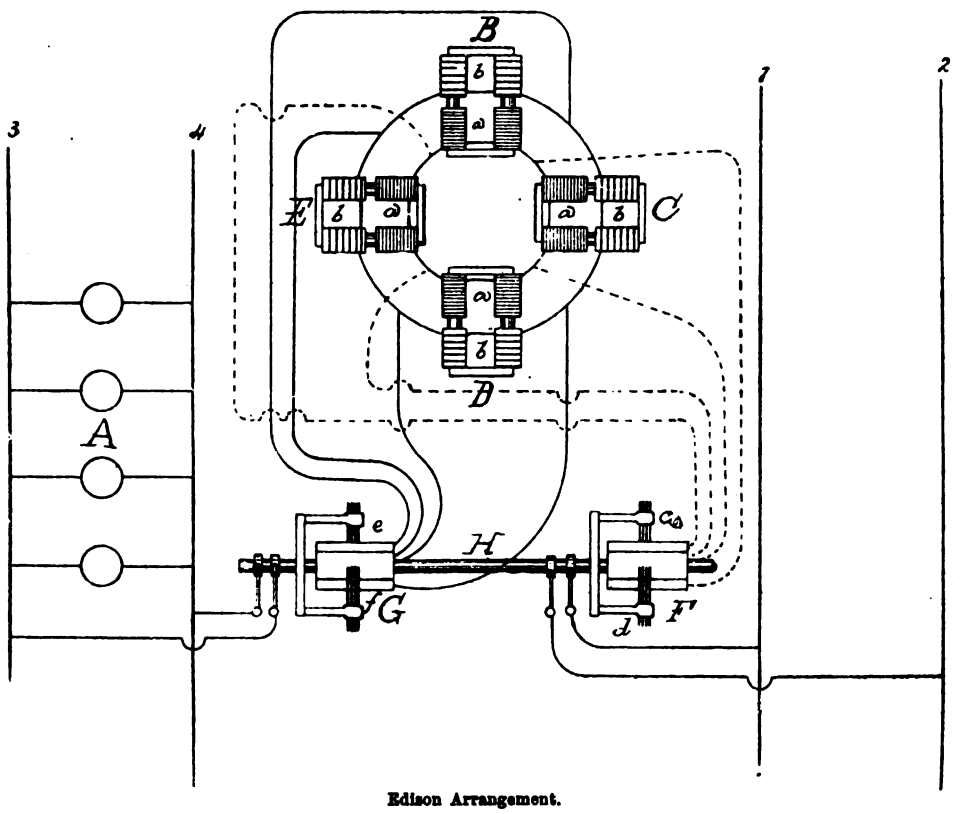
the several transformers to be grouped on to the two external circuits as circumstances may require. The high-pressure fuses consist each of three porcelain insulators provided with brass terminals, between which latter aluminium wire insulated with ebonite tubing is stretched. The fuses are fixed in a horizontal position, and are so arranged that in the event of their melting the ebonite tubing falls away and thereby secures a complete break in the corresponding circuit. Besides supplying current for working the projected tramway, the generating station is also designed to supply current for lighting and power purposes to private consumers, and a good demand in this direction is already assured. The tramway is to have a double track, and to be equipped for the overhead trolley system of working. But it is unnecessary to dwell further upon the electrical equipment of the line now, since more detailed particulars thereon, supplemented by drawings and photographs, are promised at a later date by the writer of the article, who, it may be mentioned, was also responsible for the designs of the scheme.

RUCKER v. LONDON ELECTRIC.

From our report of this case it would be seen that two specifications played an important part in the question of prior publication. One of these concerns a patent by C. F. Brush dated Sept. 2, 1879, and contains the drawing herewith reproduced. It shows the intention to run arc lamps from the secondaries of transformers, the transformers being in parallel. We shall not attempt to discuss whether the arrangement is practical, or exactly how much Mr. Brush knows of his subject. The only moot point so far as the case is concerned is how an electrical engineer would have interpreted this diagram in 1884. The other drawing is from Edison's specification of May 29, 1883 (both are published by the American Patent Office). It shows a complicated arrangement for transforming high-pressure direct currents to low-pressure direct currents, the latter for use by the consumer with lamps in parallel. As Edison was working with direct currents he used a commutator, hence complication and inefficiency. The defendants claimed that both these drawings showed the combination of high-pressure feeding transformation and low-pressure distribution, hence that though there might be improvements in detail, there could be no claim for such combination.



Brush Arrangement.



Edison Arrangement.

CENTRAL STATIONS.*

BY C. STANLEY PEACH, F.R.I.B.A.

The subject on which I am privileged to address you this evening is one which at first sight might not, perhaps, be considered of general interest. The popular idea of a central station is a plain, factory-like building, usually with a large chimney stack—a mere home for machinery—in the design and construction of which cost is a primary consideration. As such it does not appear to be a structure which appeals particularly to the architect. This idea is only correct to a very limited extent, and a closer consideration of the subject will, I am confident, disclose that although the *raison d'être* of these buildings is to protect the machinery and plant and the staff working them, they are very far from being mere shelters or enclosures for machinery. They are already buildings of some size and considerable importance, possessing many points capable of architectural expression, while in regard to special points of construction they are, even in their present stage, full of interest. In the design of these structures the engineer and the architect are very closely connected, and they already afford opportunity for the exercise of both the science and art of construction, and in the future this must be even more the case if they are to be really suitable for the important purposes they are designed to meet, and I hope to-night to show that the architect, accustomed as he is to apply his knowledge of building methods to many and widely different purposes, will find full scope for his art in the design and construction of central stations. These buildings are frequently called electric light stations, and the title originated in the early days when lighting was the principal purpose for which the current was required, but this is no longer the case, and the name "central station for generating electricity," called shortly "central station," is now more frequently used and is a much better term to employ.

Before proceeding to consider the matter in detail it will not, perhaps, be out of place first of all to explain what a central station is, what was its origin, to review shortly its development, to consider its present use and significance, and what purposes it is designed to meet. From this we shall most easily deduce what considerations govern the design of these structures, and what points should be kept in view when deciding on the most suitable construction to adopt in order to meet in the

* Lecture delivered at Carpenters' Hall, March 1, 1900.

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most complete manner all the conditions required in these buildings. A central station, then, is a co-operative establishment in which the mechanical power, required by a large number of persons, is concentrated on one spot and worked under one management, and from it as a centre the power generated is distributed to all who require it. It is the outcome of scientific progress, and is one of those works which involve the adaptation of known things to new requirements, the novelty of the application in many instances amounting almost to invention. The effect is to economise the capital and time of the individual, to do away with the waste of labour, space, and material inseparable from a number of small installations of machinery, and to enlarge the scope of manufacture by placing the exact amount of power required, in the cheapest and most convenient form, within the reach of everyone, and to render the use of power possible in many trades in which in any other way it would be unattainable. The value of such an establishment was first realised by the Asiatic peoples many thousand years B.C., who, by constructing "irrigation centres" (many of which are, I believe, in operation to this day), brought into cultivation large tracts of land which otherwise would have remained desert. A modern instance of the immense benefit which is derived from works conducted on the principle of the central station is the irrigation centre established in 1849 by Brigham Young in the mountains above the great Salt Desert in Utah, by means of which this desert was converted into one of the most beautiful and fertile spots in the world, and a people were not only enabled to exist but to work many industries by the water power and to amass great wealth. Many other forms of central stations will occur to all of you, such as those for distributing hydraulic power, steam, hot air, gas, etc., but those which chiefly engage our attention to-night are central stations connected with the generation and distribution of electricity. It is immaterial for what purpose the current, when generated, is used, nor is it any longer necessary or desirable to differentiate between stations which supply power for traction or lighting purposes, as within a very short time both will be combined in nearly every station.

The process of altering electricity from a passive to an active state, which we call generation, is at present usually accomplished by steam-driven machinery, and no doubt many of my audience will be inclined to say at this point there have been machinery-houses, boiler-rooms, and chimney shafts of all kinds and for innumerable purposes ever since steam came to revolutionise the world, and that there is no necessity for central stations to be different from them; but it must be remembered that the amount of power generated in these buildings hitherto has been relatively small. It was used in the immediate vicinity of the plant, and its application was confined to a particular purpose. In central stations the power developed is already very great, is daily increasing, and will shortly be immense. It is distributed to any point at which it may be required. It can be used simultaneously for innumerable and widely different purposes—to illuminate a house, to cauterise a wound, to turn a lathe, to work a lift, to forge a cannon, to solder a joint, or propel a train. An interruption to the working of the machinery department of, say, a mill or factory, practically affects only the particular business concerned. The interruption of the supply of power from a central station might plunge a city or district in darkness, stop the traffic of the tramcars, and generally disorganise various industries dependent on it. Once started it must work uninterruptedly day and night, year in and year out. It is in such respects primarily that central stations differ from what has been done in the past, and it is these differences which, reacting on the buildings, necessitate new arrangements and special methods of construction. The origin of the central station is then of considerable antiquity, but its modern development—viz., the central station for supplying power—dated from the discovery that power could be used at a distance from its point of generation.

The foregoing sketch of the origin, use, and importance of central stations would not be complete without a reference to the legal and commercial history of the industry of the supply of electricity. As you all know, buildings are subservient to legal regulations, to which an architect must have regard when preparing a design, but, as will be seen later, the laws in force when central stations were first required did not altogether cover the new and in some respects distinctly special conditions. In regard to both the industry and its buildings, the commercial and legal history are one. The whole industry of "commercial electric supply" was almost strangled at its birth by the laws which it called into existence. The subject was approached by Parliament with a nervous dread of granting a monopoly. In its anxiety to avoid this, conditions were imposed which gave the local authorities power to purchase the undertakings on such terms that commercial enterprise was made impossible. This was in 1879, when, although a Select Committee expressed the opinion that "electric light is an evolution of scientific discovery which has been in active progress during the whole of this century," and although the object of this committee was to advance that progress, yet the Act of 1882, which was the outcome of their deliberations, brought the industry practically to a standstill for a period of nearly eight years. This is shown by the fact that of 69 provisional orders granted in 1863 only seven now remain in force, and little or no work was done under them, and that from 1884 to 1887 only five were granted at all, of which none now exist. The whole matter had, therefore, to be raised again, and an amendment Act was passed in 1888, which greatly modified the onerous purchase clauses of the Act of 1882, with the result that in 1889-1890 178 orders were applied for, 86 were granted (of which 69 are still in force), and progress became active once more. Work was carried out, I believe, in every case. As soon, however, as buildings of some importance became necessary, new difficulties cropped up. It was found practically impossible under the existing building laws to construct the kind of buildings necessary. Fortunately, however, about this time a new Building Act was in contemplation. The buildings erected, and in course of erection, proved conclusively that some alteration of the law was necessary, and that concessions must be made in their favour. Representations were made to the London County Council, who were promoting the Bill, and it was pointed out to them that it was impossible at the moment to foretell what the future requirements of these buildings would be. The Council, and the committee who were considering the Bill, took a broad view of the whole question, and a clause (203) was inserted in the London Building Act of 1894, which for all practical purposes exempts these buildings from the provisions of the Act, subject to the approval of the London County Council. This was a great gain, and shows not only the importance which the subject had now assumed, but also how the enterprise was gradually freeing itself from legal trammels, and how as these were removed it made each time greater and still greater strides.

Under the present Building Act, the architect of a central station is now given a fairly free hand. The County Council from time to time as plans have been submitted for approval, have considered them with the same open mind with which they approached the question when it was before Parliament, and there seems no reason to doubt that the central stations which have been built since the Act was passed, and those which are being built now, are not only well adapted to their purpose, but are as strong and fireproof as any other buildings carried out strictly in accordance with the regulations of the Act. Last year saw yet another new phase, which is not only the greatest concession of all, but is one that will, if I mistake not, give rise to further immense developments in the industry, and will bring about great changes in the buildings. It will probably also introduce an additional type of central station. Parliament, recognising that electric supply companies are great public bodies, and that the public interest is best served by facilitating their operations, passed the Electric Lighting (Clauses) Act, 1899, by which sites for buildings can now be acquired by compulsory purchase, and central stations need no longer be erected within the boundaries of the district they supply. Further, the practical effect of the Act is that buildings erected on sites acquired in this way possess certain privileges, among them being immunity from injunction or

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action for causing a nuisance or for annoyance arising from vibration, and other matters inseparable from building operations, and which cause building owners and architects much trouble. Such is very generally the legal position of the industry.

(To be continued.)

PHYSICAL SOCIETY.

At an ordinary meeting of this society, held on Feb. 23, Prof. S. P. Thompson, F.R.S., foreign secretary, in the chair,

Prof. R. W. Wood, of the University of Wisconsin, U.S.A., exhibited and described (1) "Photographs of Sound Waves and the Kinematographical Demonstration of the Evolutions of Reflected Wave Fronts." The sounds were produced by electric sparks, and photographed by means of the light emitted by carefully-timed subsequent sparks, according to the method described in the *Phil. Mag.* for last year. The photographs included: (*a*) The reflection of a spherical wave as a spherical wave from a plane surface; (*b*) the reflection by an ellipse of circular waves from one focus, and the concentration of the waves as circular waves at the other focus; (*c*) the plane-wave front formed by the reflection of a spherical wave at a parabolic surface; (*d*) the wave front formed by a spherical wave incident on a spherical surface; (*e*) the wave front formed by a plane wave incident on a spherical surface. In cases (*d*) and (*e*) the wave fronts are complicated and contain cusps. Prof. Wood pointed out that the paths of the cusps on the wave fronts traced out the caustic curves. In the following cases the wave fronts were drawn for 100 successive positions, and the evolution of the reflected wave was made clear by means of a kinematograph: (*a*) plane wave on a hemispherical mirror; (*b*) spherical wave on a hemispherical mirror; and (*c*) circular wave inside a complete circular mirror.

(2) "A New Scudoscope." In this instrument the real and inverted images formed by two convex lenses are viewed stereoscopically. The inversion of the object viewed causes the relief to be reversed.

(3) "Diffraction Colour Photographs." Prof. Wood showed some coloured photographs taken by his diffraction process. The principle of the method is based upon the tri-colour theory. Different colours are produced by gratings so ruled and arranged as to throw upon the eye the particular constituents of the required colours. The arrangement of gratings necessary to produce a coloured picture is obtained by photographing properly-spaced gratings through red, green, and blue chromograms of the object. The superposition of one grating upon another which occurs in this process gives rise to an in-and-out-of-step arrangement which produces secondary spectra. These, however, seldom affect the picture to any serious extent.

(4) "Artificial Parhelia" When printing fine gratings upon gelatine, if the film is too thick, no print is formed but the gelatine warps. If such a film is placed in a converging beam, the central image is accompanied by four marked concentrations of light situated at the extremities of two diameters at right angles. An examination of one of these plates with a microscope shows that there is a ridge for every third line of the grating, and that the plate is crossed at right angles to these lines by irregularly spaced cross ridges.

Prof. Wood also exhibited some photographs taken by zone plates, a silvered copy of a Rowland grating, a photograph of a dynamite explosion, the motion of a ball in its flight, and the anomalous dispersion produced by a cyanine prism.

Mr. Boys gave some details concerning the photograph of the explosion shown.

Prof. Everett expressed his interest in the demonstration.

Prof. Herschel asked if the photographs of sound waves after reflection had been verified by comparison with waves on mercury.

Mr. Watson pointed out that this could not be done, as it is impossible to get a solitary wave on the surface of mercury. Owing to the dependence of velocity on wave length, any such solitary wave draws out into a train of waves.

The **Chairman** proposed a vote of thanks to Prof. Wood, and announced that by invitation of Prof. Callendar a special meeting will be held at University College on March 2. The meeting then adjourned.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

249. Give a diagram showing necessary connections for reversing direction of rotation of a two-phase motor; also of connections for resistances of same.—H. J. B.

250. Explain the three-voltmeter method of measuring power spent in the primary coil of an alternating-current transformer.—C. MORRIS.

ANSWERS.

Question No. 243.—Assuming a supply company charges 4½d. per Board of Trade unit, what is the smallest quantity required by any one user for which it will be cheaper to establish an isolated plant, gas being 2s. 2d. per 1,000 cubic feet or coal 12s. 6d. per ton delivered?

[The first two answers to this question are considered equal.—ED. *E. E.*]

Answer to No. 243 (*awarded 7s. 6d.*).—If an examination is made of the analysis of cost of the various central supply stations, it will be found that the actual cost of fuel is considerably under 1d. per Board of Trade unit in the majority of cases, and that the large total cost is mainly arrived at owing to the amounts which have to be added for salaries, sinking fund, and interest. Now, in an isolated plant the salaries will not be so excessive per unit, nor will the interest be so high, as there is not such a long length of heavy and expensive cable required per unit as there must be when the mains have to be laid underground along the streets, often for 200 or 300 yards without a tapping off to supply a customer.

Taking, first, the case of a gas-engine plant; with a fair efficiency the gas consumption should not exceed 33·3 cubic feet per Board of Trade unit, which means 30 units for 2s. 2d., or about ·866d. per Board of Trade unit. As the supply company are charging 4·5d. for the same amount, it is evident that if x be the number of units required per year, that as soon as $3{\cdot}6\ x >$ charges for interest, maintenance, and wages, it will be cheaper to put down a private plant. For an installation up to 500 lights it may be assumed that the cost of a gas-engine plant is 25s. per light; and if we further assume that each lamp will require 60 watts per hour and will burn for 1,000 hours per year, we have sufficient data to work on, and the calculation becomes a simple matter. Maintenance and depreciation will be 10 per cent. per annum and interest 5 per cent., while we may say that wages will be £50 per annum, as the attendant will not devote his whole time to the plant. Since we assume that each lamp consumes 60 units per annum, the total number of lights installed is $\frac{x}{60}$, and the total cost for plant in pence is $25 \times 12 \times \frac{x}{60} = 5x$. Depreciation, maintenance, and interest will be equal to $\frac{15}{100} \times 5x = \frac{3}{4}x$, and as the saving is $3{\cdot}6x$, the isolated plant will be as economical as the current from the supply station, when $3{\cdot}6x = {\cdot}75x \times 12{,}000$, or $2{\cdot}85x = 12{,}000$, or $x = 4{,}277$ B.T. units; or when the current supplied is equal to 4,300 B.T. units, or the bill $= 4{,}300 \times 4\frac{1}{2}$d. $=$ £80. 12s. 6d., it is more economical to put down an isolated plant. Of course, if each lamp was burnt for 2,000 hours per annum, interest, depreciation, and wages remaining the same, it would be cheaper to change before this quantity was required; while if the lamps were only burnt for 500 hours, it would not be more economical until this amount was largely exceeded.

With a steam plant the cost of plant for small installations would be £2 per lamp, while, owing to the additional attention required in stoking, etc., and floor space required, our charge for wages, etc., should be £100. The cost of fuel would be rather less than with a gas-engine, as a good engine and boiler should work with 5lb. of coal per kilowatt-hour for these small sizes—that is, the cost per B.T. unit is $\frac{5}{2{,}240} \times 150\text{d.} = {\cdot}34\text{d.}$ The saving per unit is then 4·16d., and our calculation is now: $4{\cdot}16\ x = 1{\cdot}2\ x \times 24{,}000$, or $2{\cdot}96\ x = 24{,}000$, or $x = 8{,}000$ B.T. units approximately; or it is just as economical when the bill reaches £150 per annum.

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TABLE A.

	40 lamps. Steam.	40 lamps. Gas.	50 lamps. Steam.	50 lamps. Gas.	60 lamps. Steam.	60 lamps. Gas.
First cost of plant	£186	£112	£204	£120	£226	£135
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Annual cost of fuel	9 7 6	15 5 0	11 5 0	19 0 0	12 10 0	20 13 0
Annual cost of attendance	65 0 0	47 0 0	65 0 0	47 0 0	65 0 0	47 0 0
Annual cost of oil, waste, and stores, at ½d. per B.T.U.	6 0 0	5 0 0	7 10 0	6 0 0	9 0 0	7 0 0
Annual interest on capital outlay at 4 per cent., and depreciation at 10 per cent.	24 8 0	14 13 0	26 15 0	15 12 0	29 17 0	17 8 0
Total annual cost	105 15 6	81 18 0	110 10 0	87 12 0	116 7 0	92 1 0
Total annual cost per 16-c.p. 60-watt lamp	2 12 10	2 1 0	2 4 2	1 15 0½	1 18 9	1 10 8

From the above it would appear as though a gas-engine plant is preferable to a steam plant; this is only the case for small plants. It will be noticed that with a gas-engine the fuel cost is ·866d. per B.T. unit, and with a steam plant it is only ·34d. per B.T. unit. Both these values may be reduced somewhat with large plants, but it is evident that a size will soon be reached where the steam plant gives the better economy.—F. J. A. M.

Answer to No. 243 (*awarded* 7*s.* 6*d.*).—As the price of gas and coal is mentioned in the question, it is presumed that a comparison is required between a public supply and a private installation driven by a gas or steam engine. The best comparison will be to take the annual cost of each 16-c.p. lamp under the different systems, and supposing the lamps to consume 60 watts each, and to be alight for 1,800 hours per annum, the annual cost of each lamp, when current is taken from a public supply company at 4½d. per B.T.U., will come to £2. 0s. 6d., to which must be added a proportion of the meter rent, say 6d. per lamp per annum, bringing the total cost per lamp to £2. 1s. per year. The accompanying table (A) shows the annual cost of private installations of different size driven by gas-engines or steam-engines and boilers, the figures being carefully calculated from practical data.

In this table the steam-engines are supposed to consume 5lb. of coal per brake horse-power per hour, and the gas-engines 22 cubic feet of gas per brake horse-power hour, this being as good a performance as can be expected from engines of such small size. The sum put down for first cost of plant includes, in the case of steam plant, steam-engine and boiler, dynamo, main switchboard, feed pump, foundations, pipes, and erection complete; and in the case of gas plant, gas-engine, dynamo, water-vessel and pipes, main switchboard, foundations, and erection. The cost of the engines and dynamos, etc., is estimated at the present average prices for good-quality work. Some makers charge less, and others more. As no accumulators are provided for, the engines must run all the time the lamps are alight—viz., 1,800 hours per annum. In the table, attendance is reckoned at full time, a man being required for the steam plant and a lad for the gas plant, but if a man is already employed about the premises he could probably look after the plant in addition to his other duties, in which case the cost of attendance would be lessened very considerably. It will be seen from the table that a steam plant is more expensive than a gas-driven plant, both in capital outlay and annual cost, not to speak of the greater space required, danger of boiler explosions, dust and dirt from the coal and ashes, etc., so that where gas is available a gas-engine should always be employed for small private installations. The table shows clearly that under the conditions given in the question the point at which it will become cheaper to put down a private installation than to take current from the supply company's mains is reached when an equivalent of 40 60-watt lamps are required for 1,800 hours per annum, or in other words, when the demand exceeds 4,320 Board of Trade units per annum. In this case a gas-driven plant will produce current more cheaply than it can be supplied by the public company, but a steam-driven plant will not be cheaper until the demand exceeds 5,500 Board of Trade units per annum.

On account of the extra trouble, etc., involved with a private installation, it would not be advantageous to put one down unless the demand exceeded the figures given by 15 or 20 per cent.—R. D. S.

Answer to No. 243 (*awarded* 5*s.*).—The size of the installation at which it becomes advantageous to adopt an isolated plant depends on many particulars, which vary with every case, such as the question of available space; whether a handyman is already employed who could, with little increase in wages, look after the plant; the risk of annoyance to surrounding householders by noise and vibration, etc. But, neglecting these wholly intermediate points, the necessary comparison of cost can be made as follows: To begin with, there is no doubt that of the various isolated sources of power the gas-engine is, with coal-gas at 2s. 2d., decidedly the most economical for small installations, so that the question of a private Dowson gas plant or of a steam-engine need not be considered.

Let W = total number of B.T.U. required per annum;
L = maximum number of 60-watt lamps ever in use at one time;
K = maximum number of kilowatts which the dynamo must be capable of giving $= \frac{L \times 60}{1{,}000}$;
P = combined cost of gas-engine, dynamo, switchboard, and erection of the isolated plant, in pounds;
·15 P = annual allowance for 5 per cent. interest on capital expended, and 10 per cent. of cost for depreciation and repair of plant;
G = gas consumption in the engine per Board of Trade unit given out by dynamo when working at the average load. This will be at least 35 cubic feet for a small engine using ordinary coal gas;
M = annual salary of attendant, which, for a small gas-engine plant, need not exceed £60.

Then using the values given in the question:

$\frac{W \times 4\frac{1}{2}}{240}$ = annual cost, in pounds, of direct supply from the mains, and $\frac{W \times \frac{G}{1{,}000} \times 26}{240} + \cdot 15\ P + M$ = annual cost of supply with the isolated gas-engine plant.

Equating the two, we get the power for which the two cases are equally expensive as

$$W = \frac{9{,}200\ (\cdot 15\ P + M)}{173 - G}.$$

For a yearly demand greater than this amount it will be cheaper to introduce the gas-engine than to have the direct supply.

The actual value of this demand can only be found by a trial and error process somewhat as follows: Assume an installation of 150 60-watt lamps, all of which are occasionally in use together, the average demand, however, being only 100 lamps for two hours every night in the year. Then $W = \frac{100 \times 60 \times 2 \times 365}{1{,}000} = 4{,}400$, and the cost of obtaining this direct from the mains at 4½d. per B.T.U. is £82. 10s. On the other hand, if a gas-engine and belt-driven dynamo are installed the maximum output of the dynamo must be $\frac{150 \times 60}{1{,}000} = 9$ kw., and the price of such an engine and dynamo would be about £180, and

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allowing £20 for switchboards and erection we get P = £200. Taking the gas consumption as 35 cubic feet per B.T.U., and the salary of the attendant as £60, we get as the cost of supply by isolated plant

$$\left\{\frac{4{,}400 \times \frac{35}{1{,}000} \times 26}{240} + \cdot 15 \times 200 + 60\right\} = £106.\ 10s.,$$

showing that so small a demand as that assumed could be obtained more cheaply from a public supply at 4½d. per B.T.U. than by means of an isolated plant. At the same time it will be noticed that the actual cost of the power in the gas-engine case is very small (£16. 10s.) compared with the maintenance and attendance expenses, so that if, owing to any special circumstances, the latter charges can be considerably reduced, the isolated plant may come out cheapest after all.—Q.

Question No. 244.—How can a 5-h.p. shunt motor be designed and arranged to run at speeds varying between 300 and 1,200 revolutions per minute with good efficiency?

Best Answer to No. 244 (*awarded* 10*s.*).—It is practically an impossibility to design a shunt motor to run at such speeds as 300 revolutions per minute and 1,200 revolutions per minute if the speed regulation is to be effected only by means of shunt resistance, for at the higher speeds the field ampere-turns will be so few that the induction due to them will be overpowered by the induction due to the armature, and disastrous sparking will occur. One way of solving the difficulty would be to wind the armature with two commutators. If, then, with the two windings in series the speed is 300 revolutions per minute if the windings are thrown into parallel the speed will rise to 600 revolutions per minute, and the various speeds between 300 revolutions per minute and 600 revolutions per minute, and between 600 revolutions per minute and 1,200 revolutions per minute, can be obtained by means of external shunt resistance. For this purpose a great amount of resistance will be necessary, hence it might be advisable to effect large alterations by arranging the shunt coils so that they also can be thrown at will into parallel or series, and so keep the external resistance for finer adjustments. Another method which has been adopted, notably at Peterborough, is to supply current at two different voltages for the various speeds, in this instance 460 for high speeds and 230 for the low speeds. There is an external resistance, equal to the total shunt resistance, which is thrown into the shunt circuit at the higher voltage, so as to keep the shunt ampere-hours the same, the smaller adjustments of speed being obtained by means of a variable shunt resistance. The method of securing the alteration in speed by means of a variable resistance in the main circuit, so as to reduce the voltage of the full current supplied, is too uneconomical to receive more than a passing notice.

Another method, due originally, I believe, to Mr. Oliver Firth, of Bradford, is to arrange the magnet limbs upon a V-shaped slide on the bed, and to attach a screw arrangement, in such a manner that the magnets and pole-pieces may be drawn further apart, and in this way reduce the field flux. This method will not lead to such a great amount of sparking, as, the air-gap being increased, the reluctance in the magnetic path of the flux due to the armature is vastly augmented.—F. J. A. M.

Answer to No. 244 (*awarded* 5*s.*).—The speed of a motor is given by the equation

$$n = \frac{e}{k\,\mathrm{N}},$$

where n = revolutions per second, e = induced E.M.F. of the motor, N = total magnetic flux in the armature, and k is a constant depending on the number of armature conductors, number of poles, etc. This follows from the ordinary E.M.F. equation.

In every case if E = tension of supply, R = armature resistance, and c = current in the armature then

$$e = \mathrm{E} - c\,\mathrm{R}, \text{ and, therefore, } n = \frac{\mathrm{E} - c\,\mathrm{R}}{k\,\mathrm{N}}.$$

To vary n, either the numerator or denominator may be varied. That is to say, N may be varied by varying the shunt current. Suppose n has to be diminished, then N must be increased. Consider the effect on the efficiency. The hysteresis losses increase proportional to N, and are also proportional to $\mathrm{N}^{1\cdot6}$ approximately. Hence, assuming that the armature current does not alter enormously, the diminution in hysteresis, owing to a smaller n, is more than balanced by the increase due to the increased saturation, hence hysteresis losses increase when n is diminished.

The eddy-current losses are proportional to the square of n and also to the square of N. Hence, assuming that n and N vary approximately inversely proportional, the loss will not alter. The friction will diminish with diminution of n.

The increase in N will necessitate an increased magnet current, and as n has to be about four times as great, the magnet current must be much more than four times as great, the amount depending on the part of the magnetism curve between which the limits lie. If sparking conditions allow the weakest field to be extraordinarily weak, say about 3,000 lines per square centimetre, then the ratio may be, say, 6 : 1; but less it can hardly be, and may be much more. Hence with diminishing revolutions the efficiency at the same load will diminish probably, and if the highest saturation is very great the diminution may be 10 to 15 per cent. Joule loss in armature remains about constant, but will also rise, if anything, owing to increase of current in armature with diminished N.

Another method is to make E smaller—*i.e.*, to put resistance in series with the armature. This, however, for such wide limits would be very costly, and, further, would reduce the efficiency approximately proportional to the speed, which the foregoing method certainly does not do.

Yet another method is to wind the armature with two windings which have separate commutators, these having a special controller which puts them in series or parallel as desired, and thus alters the induced E.M.F., and therefore the speed at a constant value of N. The current here remains about the same, because the only losses that vary are friction and armature reaction losses. This method necessitates a somewhat heavier motor, and for a 5-h.p. size might make the cost too great, but it is probably the most efficient. Next comes the method by weakening the field, and last of all comes the series resistance method, which should certainly not be employed throughout the whole range. A suitable combination for a small motor like this would probably be a little series resistance at first, and the rest of the regulation by shunt. This would avoid the cost of a double armature, while it would keep the variations in N within smaller limits, and might help thus to increase the efficiency by diminishing hysteresis losses and joule losses in the magnets at high saturations.—T. C.

LEGAL INTELLIGENCE.

LONDON ELECTRIC OMNIBUS COMPANY v. NEILL.

This case came before Mr. Justice Ridley and a special jury on Monday, and was an action to recover £120 calls on shares. The defendant alleged material misrepresentation in the prospectus, and counter-claimed against the company for rescission of contract and against the directors for damages. The defence was a denial of the alleged misrepresentation.

Mr. Witt, Q.C., for the plaintiff, quoted from the company's prospectus as follows: "A contract has been entered into with the Crystal Palace Company to run in the grounds, carrying passengers, a new type of omnibus similar to those about to be run in the streets. Omnibuses are now to be seen at the Crystal Palace which will be carrying passengers shortly. The electric omnibus designed by Mr. Ward has run upwards of 5,000 miles on the London streets, through the most crowded traffic, with complete success, and has proved as noiseless as a horseless carriage fitted with pneumatic tyres." These were not facts, as no completed motor 'bus had been running at the Crystal Palace, and the company had never put an omnibus on the Loddon streets, had never carried a passenger for hire, had never done any business at all, but had spent the whole of its money, some £37,000, on the purchase from Ward of some patents which counsel believed had lapsed, in experiments, demonstrations, and directors' fees, so that at last they only had £1. 19s. 1d. in the bank.

Mr. William Marshall, a mining engineer, and a promoter of the company in conjunction with Mr. Radcliffe Ward, and one of its directors, gave evidence as to the arrangement made by Mr. Ward for running a motor omnibus at the Crystal Palace. At the Palace there was the body of an omnibus on Mr. Ward's

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design, but without wheels or motive power, and a second omnibus on an older design by Mr. Ward, but that had been brought down by horses; it had not been run by electricity. The first 'bus had been finished five months later and had a most successful run, but had broken down on a second trial. He considered that the directors who believed Mr. Ward's statements, and who had received favourable independent reports on the invention, had been misled altogether by Mr. Ward as to the capabilities of his electric omnibus.

Mr. Justice Ridley considered that the letter from Mr. Gillman, of the Crystal Palace Company, which said that his company would be glad for Ward's omnibus to be sent on to the Horseless Carriage Exhibition, at that time being held there, the company to receive 50 per cent. of the takings, did not constitute a contract.

The defendant, **Mr. W. M Neill**, said that when applying for shares he was greatly influenced by the statement in the prospectus that the omnibus had run 5,000 miles in the thick of the London traffic.

Mr. Dickens, Q C, said that the defendant did not take these shares as an ordinary investor, but on an underwriting contract, under which he was to obtain 15 per cent. commission. At the time of the underwriting the paragraph relating to the Crystal Palace was not in the prospectus. It was the fact that a car on Mr. Ward's earlier design had been run for upwards of 5 000 miles in the London streets, and this design was being improved upon in the company's omnibus. The company had paid £20,000 to Ward and Marshall for the patents and promotion, and spent money on experiments and demonstrations.

After further evidence the hearing of the case was adjourned.

CLAIM FOR ELECTRIC WIRING.

In the Westminster County Court on Friday, the case of the National Electric Wiring Company *v.* Lambert was tried before his Honour Judge Lumley Smith Q.C., and a jury. It was a remitted action from the High Court, in which the plaintiffs, of Faraday House, Charing Cross-road, sued the defendant, who carries on business at 33, Lower-road, Rotherhithe, to recover payment in respect of certain electrical wiring and fittings supplied to his order.

Mr. John F. Knapp was called and said that early last year his firm received an order to wire the defendant's premises under a joint contract with the company, who were to supply the electric power. Under that contract the plaintiffs undertook to do a certain amount of wiring and fitting free of charge, and took their payment by way of a rental charge, which was included in the lighting. The present claim was in respect of a sum of £19 for extra work done to the order of the defendant, which work was quite outside the contract. A large proportion of the claim was in respect of the conversion of gas fittings so as to make them suitable for electric light.

The **Defendant** resisted the claim on the ground that he was induced to give the order and sign the contract owing to the misrepresentation of the plaintiffs' traveller, by whom he was led to believe that he would find electric light much cheaper than gas.

After a lengthy hearing the jury found a verdict for the plaintiff for £10, and judgment was entered for that amount with costs.

COMPANIES' MEETINGS AND REPORTS.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY.

The annual ordinary general meeting of this Company was held on Tuesday at 15, Maiden-lane, W.C., Mr. William Francis Fladgate presiding.

The **Chairman** said that last year they considered the position of the Company was a good one, and that the progress was equally satisfactory. However, this year the directors came before them with an increased income, a more fully-developed business, and with largely increased reserves. The sales for the year 1898 amounted to 3,241,000 units, and the sales for 1899 were 3,862,000 or an increase of over 19 per cent. on the whole sales. They had hung no less than 48,000 additional lamps during the past year, as against 26,000 the year before, which he thought was very satisfactory. Their largest increase had been where he had expected—namely, in the Strand district. In Holborn and St. Giles during the past year they had done a considerable amount of work. The districts gave promise of bearing good fruit, and rewarding the Company for trouble they had in obtaining the provisional order. The result of the sales was again satisfactory, amounting to £69,700, an increase of over £1,700. Referring to the expenditure on coal, the Chairman said that for some time past they had not been in by any means a happy position as to the amount of coal consumed, owing to the boilers not working satisfactorily. They had now practically put an end to that difficulty. As a proof of this, he stated that they had done more work in 1899 than in 1898, and yet they had consumed 104 tons less. The result of the year's working was that the net profit for 1899 amounted to £27,677 as compared with £21,377 for 1898, which was satisfactory. During the year no less than £5,000 had been spent in keeping the plant, machinery, and mains in a proper state of repair, and, in addition to that, they had set aside £8,000 for depreciation, as against £7,000 in 1898, the increase of £1,000 being consequent upon the additional machinery. The directors were able to recommend the payment of a dividend at the rate of 9 per cent. per annum, which he considered was a very fair return. There were three stations in working order—namely, at Maiden-lane, Lambeth, and Short's-gardens, though Lambeth and Short's-gardens were hardly completed. The capacity of the three stations was sufficient to supply 250,000 lamps, and as the present supply was 190,000 they had a surplus of 60,000 to deal with the increase of business which was expected in future years. The engineer, after going very carefully into the matter, had reported to the directors that in order to compete with the demand of the Strand, St. Giles, Holborn, and St. Martin's districts, irrespective of the City, they would have to spend large sums on further stations, machinery, and mains. The capital for those purposes would be the subject of a special meeting, which would shortly be called in order to secure the shareholders' opinion on the policy the directors would then submit. Last year he told them that they were applying for, and hoped to obtain, a provisional order for supplying the City. The Local Government Board deemed it necessary to have an enquiry into the matter, and, as a result, Sir Courtenay Boyle reported that the best company to whom such an order should be given was the Charing Cross and Strand Electricity Supply Corporation, Limited. The decision had to be confirmed by Parliament, and finally the Company succeeded in getting an order. The directors had carefully considered a policy for dealing with the City, and it would be placed before the shareholders at the special meeting he had referred to. The order had enabled them to secure a very large area to supply, and had made it worth while to build a large station in order to be able to compete with not only the City, but any West-end district which they supplied. He was glad to say that the directors had succeeded in acquiring a large plot of land at Bow for the erection of such a station, and they were promoting a Bill in Parliament to obtain powers to run their mains to the City in order to link together the whole of the stations and make one supply supplement another. Under the order they had to give the City a separate station, and sufficient space had been reserved to erect a separate installation, if expedient, for the purposes of the Company. All the capital of the Company was issued, and the directors' powers to issue debentures were limited to £150 000. In all probability the Board would ask the shareholders to increase the whole of the share capital, both ordinary and preference, and increase their powers to borrow upon that capital. Funds were required to complete the works in St. Giles, Strand, Holborn, and St. Martin's district. In conclusion, he moved: "That the dividend paid on the cumulative preference shares on Feb. 15, 1900, at the rate of 4½ per cent. per annum, be confirmed, and that a dividend at the rate of 10 per cent. for the year ending Dec. 31, 1900 on the ordinary shares, making, with the interim dividend paid in August, 1899, 9 per cent. for the whole year, be declared."

Mr. G. H. Brougham Glasier seconded the motion, which was adopted.

W. T. HENLEY'S TELEGRAPH WORKS.

The annual report of the directors of this Company states that of the £120,000 additional preference capital authorised by the shareholders in 1899, £90,000 was taken up by the shareholders or their nominees at par, and £30,000 by the holders of the old 7 per cent. preference shares with the sum of £30,000 paid to them out of reserve account as compensation for the reduction of the dividend on those shares to 4½ per cent., in accordance with the resolutions passed at the general meetings held in 1899. During the past year a net profit has been made of £46,037. 9s. After payment of debenture interest and income tax, and making ample allowance for depreciation of buildings, plant, machinery, etc., there remains £40,311. 12s. 4d., making, with £14.528 14s. 3d. brought forward from last year, a total of £54,840. 6s. 7d. available for distribution. The directors have transferred £10,000 to the reserve account, and they recommend the payment of the following dividends—viz., on the preference shares at the rate of 4½ per cent. per annum (less income tax), on the ordinary shares at the rate of 15 per cent. per annum (less income tax), including the interim of 4 per cent., paid on Sept. 1 last. These payments will, together, amount to £35,986. 19s. 3d., leaving £18 853. 7s. 4d. to be carried forward. The directors record with deep regret the death of their esteemed colleague, Major-General George Hutchinson, C.B., C.S.I. They have elected Sir Henry M. Stanley, G.C.B., M.P., in his place. Mr. Sydney Gedge, M.P., and Mr. Frederick Newton retire by rotation in accordance with the provisions of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Ball, Baker, Deed, Cornish, and Co., retire, and, being eligible, offer themselves for re-election.

The twenty-first ordinary general meeting was held on Wednesday at the Cannon-street Hotel, E.C., Mr. Gedge, M.P., presiding.

The **Chairman** moved the adoption of the report, and congratulated the shareholders on the fact that the directors were enabled to recommend the payment of a dividend of 15 per cent. for the year on the ordinary shares. The directors proposed to add £10,000 to the reserve fund. The Bahamas cable—like the Halifax and Bermuda cable and the cable between the West India Islands and South America—had maintained its position during the year without requiring any expense for repairs. Under their contract with the Government of the Bahamas, the latter paid the Company £350 twice a year to be accumulated as a repairing fund, but when this fund amounted to £6 000, and so long as it continued at that sum or more, only £350 was to be invested, the other £350 being paid to the Company. Accordingly, on the 1st inst., they received this amount, which would go to the credit of the current year's income. He thought it very satisfactory that not a penny had had to be paid for the repair for the Bahamas cable beyond a few pounds on land lines connected with

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it. A number of the company's employés, being reservists, had had to go to the front, and the directors had arranged that these men on their return would resume their posts or other similar positions in the Company's service, and meantime they were taking care of the wives and children who had been left behind. With reference to the capital, the directors found it necessary last year, owing to the expansion of the business, to make a further issue, and they, therefore, raised £90,000 by 4½ per cent. preference shares. This issue, however, could only be made by getting rid of the £30 000 in 7 per cent. preference shares, which were worth in the market at the time almost 200 per cent. The directors induced the holders of these shares to accept £60,000 of the new preference shares for them, and to give up certain rights which they formerly possessed. This looked rather like a "watering" of the capital, because for their £150,000 of preference capital only £120,000 had been received; but it was only an apparent "watering," for this reason—that in 1897 and 1898 they received on an issue of £50,000 of ordinary shares a premium of £35,000, out of which, under counsel's advice, they had been able to pay to the holders of the old 7 per cent. preference shares £30,000, which was then reinvested in the new preference shares. The capital was, therefore, in no sense "watered." On the contrary, they had £5,000 beyond the £300,000 of ordinary and preference shares. Between 1896 and the present time their capital in ordinary and preference shares and in debenture stock had been increased from £180,000 to £350,000, and the results had been better than had been anticipated. In 1896 the item of land, plant, buildings, and stock stood at £196,000, whereas it now stood at £381,000. Therefore, against the £171,000 of additional capital there was £185,000 of capital value not forming part of their income or divisible profits. If they wished an additional issue of capital, they could do so without having to make any bargain with the preference shareholders.

Mr. Drysdale seconded the motion, which was carried unanimously.

WIRELESS TELEGRAPH AND SIGNAL.

The adjourned third ordinary general meeting of the Wireless Telegraph and Signal Company, Limited, was held at the Cannon-street Hotel on Friday last, Major S. Flood Page presiding.

The **Chairman**, in moving the adoption of the report, said the past year had been another year of experiment and development. He wished to refer to the paragraph in the report about the Trinity Board. It stated: "Since the last meeting communication has been established for the Trinity Board between the East Goodwin lightship and the South Foreland lighthouse, a distance of 12 miles, and between the South Foreland and Wimereux in France, a distance of 32 miles. Her Majesty's ships 'Alexandra,' 'Europa,' and 'Juno,' were fitted with apparatus, and under the personal charge of Mr. Marconi the system was made great use of during the subsequent naval manœuvres, signals being transmitted a distance of 70 miles. The results were most satisfactory, and it is expected that the Company's system of wireless telegraphy will henceforth take its place as part of the equipment of her Majesty's ships." At the request of one of the Elder Brethren of Trinity House they allowed the apparatus to remain on the lightship a good deal beyond the time originally intended, but he regretted to have to refer to the fact—though the circumstances of the rescue was at the time well corroborated—that the Trinity Board traversed the statement made in the article on "Science in 1899" in the *Times*, that owing to the use of this Company's system of wireless telegraphy on the East Goodwins lightship a French vessel had been saved, and losses amounting to £52,000 avoided. There was no doubt the rescue was owing to the Marconi system. Having alluded to the steps being taken in Germany in regard to the adoption of the system in lightships, lighthouses, and on the largest of the North-German Lloyd steamers, the Chairman referred to the success of the system at the naval manœuvres over distances of 70 miles in the dark between war vessels steaming 20 knots an hour. He regretted to say that they had been unable to come to an arrangement with the Crown as to what was to be paid for the use of the patent on her Majesty's warships, and under the Patents Act of 1883 they would have to settle with the Treasury. He did not believe that the Treasury could or would do a crying act of injustice to the Company. Continuing, the Chairman said that he told the Comptroller of the Navy that if they could prove that large commercial shipping companies were willing to pay a certain specified price for the Marconi apparatus to be fitted on their ships, it would be impossible for the Government to maintain that the system was not worth as much on every-one of her Majesty's line of battleships as it was on the vessels of these companies and on much smaller ships. If, however, they did not obtain what they thought a fair price, they would take what steps were necessary to obtain a better price. He could not believe that anything like confiscation could be meant. As to the statements that the Company had sold the American patents, it was quite true that an agreement was entered into for the sale of those patents, and it seemed very much as if it was coming to pass, but negotiations were broken off. With respect to the relations with the American navy, he had seen it stated that this navy were going to introduce another system, and were adverse to the Marconi system. He did not believe that there was any foundation for that, and would read a letter from the United States Navy Department which was received shortly after Mr. Marconi returned from the United States. The letter read as follows: "Navy Department, Washington, Nov. 11, 1899. Sir,—The department desires to express its acknowledgement and thanks for the demonstration of the Marconi system of wireless telegraphy recently given by you before a Naval Board. The department further desires to congratulate you on the success attained, and on the probable further perfection of the system. The certainty of transmitting a signal under conditions impracticable with any other known method renders the Marconi system of great value. The department begs to express the hope that you will further perfect the system, and will be glad to learn in the future of any progress made in this direction.—Respectfully, CHARLES H. ALLEN, Secretary." There was a very simple reason for Mr. Marconi not continuing the negotiations with the American Navy Department—namely, they asked certain questions, and the patents were not complete, and in America there was no provisional patent. The patents being completed, however, he had no doubt that they would be glad to accept the invitation conveyed in that letter by the Navy Department at Washington and give them information, so that they might go on. He then gave considerable information as to the war in South Africa, and lamented that they were not asked to send out apparatus sooner.

Mr. J. Mooney seconded the adoption of the report, which was carried.

An extraordinary general meeting was afterwards held, when resolutions were carried to the effect: "(1) That the name of the Company be changed to that of Marconi's Wireless Telegraph Company, Limited; and (2) that the following article shall be substituted for Article No. 68 of the articles of association of the Company—viz: 'The remuneration of the directors shall be the sum of £1,000 per annum, and, in addition thereto, in any year in which the dividend or dividends declared and paid on the ordinary shares of the Company shall be in excess of the rate of £7 per cent. per annum, the remuneration of the directors shall for every such year be increased at the rate of £500 for every additional £1 per cent. paid in dividend on the ordinary shares in excess of £7 per cent. per annum; but so that in no case shall the entire remuneration of the directors for any one year exceed £3,000, and the remuneration shall be divided between the directors in such proportions as they may from time to time determine."

TELEGRAPH CONSTRUCTION AND MAINTENANCE.

The thirty-sixth ordinary meeting of this Company was held on Tuesday last at 38, Old Broad-street, E.C., Sir R. G. W. Herbert, G.C.B., presiding.

In moving the adoption of the report and accounts, the **Chairman** said that these showed an improvement upon the two preceding years. The Company had practically returned to the condition in which it was in 1896, when the net profits were £92,854, while for the year under review they were £92,348. The total figures in the balance-sheet were larger than in any previous year, owing to the extended operations of the Company. While larger sums had been received, the expenses for the purchase of materials, wages, ships, and laying of cables had been much greater. The cost of materials had largely increased during the last few years, and the chairman did not see any likelihood of any reduction. Looking at this increased cost of materials, and the possibility, owing to the uncertainty of the business, of being without large orders in any one year, the directors thought it necessary to carry forward the large sum of £53 803. He stated, in reply to questions, that about 40 men from the works and staff had joined the forces in South Africa, and they would be liberally dealt with and their places kept open for them.

The report and accounts were adopted, and a dividend at the rate of 10 per cent. declared, making, with the amount already paid, a total dividend for the year of 15 per cent.

ALLIANCE ELECTRICAL.

The directors report that the accounts, after making due provision for depreciation, etc., show a net profit of £9,648 available for dividends. Warrants for the interest on the preference shares have been posted, and the directors propose, after applying the sum of £666 towards the expenses of the Company's formation and £100 to the profit sharing scheme, to declare a dividend of 10 per cent. on the ordinary shares, carrying forward the sum of £864.

NORTHAMPTON ELECTRIC LIGHT.

The annual general meeting of the Northampton Electric Light and Power Company, Limited, was held in the committee-room of the Northampton Town Hall on Thursday last week. Mr. Francis H. Thornton, J.P., of Daventry, presided. The report and balance-sheet (a summary of which has already appeared in our columns) was adopted.

The **Chairman** said he regarded it as no small achievement that, in spite of a reduction of about 20 per cent. in the price of current and an increase of about 15 per cent. in the price of coal, the company had achieved the same results as they did the year before, and were able to keep up the dividend to the same level as in 1898. The increase (6,702) in the number of lamps was partly due to the reduction in the price of the current and partly to the reduced cost of installation, which amounted to over 50 per cent. The free wiring system had been found a great convenience by a great many customers. It was from the private houses that they had the best returns.

Mr. Seckham, one of the directors, not seeking re-election, Mr. Cleaver was re-elected a director. The Board of Trade auditor, Mr. W. D. W. Lyons, was also re-elected. The dividend was formally agreed to as follows: 6 per cent. and 5 per cent. on the

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6 per cent. preference shares and 5 per cent. preference shares respectively, and 2 per cent. on the ordinary shares. A resolution was also carried that the Board of directors receive £100 for their services.

OXFORD ELECTRIC.

The report of the directors to be submitted to the shareholders at the ninth ordinary general meeting, to be held at the Randolph Hotel to-day, states that the revenue account shows a profit, including £85. 3s. 5d. brought forward from last year, of £5,553. 1s. 2d. After providing £1,741. 11s. 2d. for debenture and other interest, writing off £184. 19s. 11d. on account of hire-purchase installations, and £53. 0s. 1d. from office furniture account, the available balance is £3,573. 10s., which your directors propose to appropriate as follows: £2,500 in payment of a dividend at the rate of 5 per cent. per annum on the share capital, and £1,000 to be added to the reserve and renewal of plant account (which will then amount to £1,750), leaving £73. 10s. to be carried forward to next year's accounts. Since the last report 3,638 8-c.p. lamps (or their equivalent) have been connected to the mains. This increase compares favourably with the average progress in previous years. The hire-purchase system of installing the light continues to give satisfactory results. To meet the increased demands for current a sub station has been established at New College, and an additional transformer installed in Ship-street. The distributing mains of the company have been extended in the South Parks, Bradmore, Norham, Woodstock, Chalfont, and Frenchay roads. The whole plant has been maintained in efficient order. Mr. J. W. Barclay and Mr. J. Irving Courtenay retire from the Board by rotation, and are eligible for re-election. The auditor, Mr. W. S. Carver, offers himself for re-election.

HOVE ELECTRIC LIGHTING.

Directors: Colonel A. J. Filgate, R.E. (chairman); Colonel H. Wood, C.B., (vice chairman); Harold A. Hoare, Esq.; Carleton F. Tufnell, Esq. Engineers: Messrs. Crompton and Co., Limited, London and Chelmsford. Secretary: Francis R. Reeves, Esq., M.I.E.E.

Eighth report of the directors (with abstract of accounts) to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon-street, E.C., on Wednesday, March 7, 1900, at 1 p.m.:

The electricity sold to consumers during the year amounted to 444,499 units, compared with 350,354 units in 1898, while the gross revenue amounted to £12,070. 5s. 8d., as against £9,480. 7s. 1d. in the previous year, an increase of £2,589. 18s. 7d. The gross expenditure reached £4,973. 2s. 1d., against £4,390. 8s. 11d. in 1898, an increase of £582. 13s. 2d., the net result being a profit of £7,097. 3s. 7d., compared with £5,089. 18s. 2d. in the previous year, or an increase of £2,007. 5s 5d. The directors have again much pleasure in congratulating the shareholders on the successful working of their undertaking, a result due in a great measure to the reduction made in price in favour of the consumers in 1898. A further reduction in the prices charged has been made under certain conditions from Jan. 1 in this year, which it is hoped will still further add to the profits of the Company, and the directors propose to again make further reductions as the Board see their way to meeting the increasing demand. The lamps and motors connected to the Company's system on Dec. 31 last were equivalent to 44.824 8-c.p. lamps, and the number of house connected 671, as compared with 36,967 lamps and 513 houses at the end of 1898. To the net revenue of £7,097. 3s. 7d. there has to be added the sum of £376. 0s. 7d. brought forward from the previous year, making a total of £7,473. 4s. 2d. After deducting debenture interest paid and accrued, the interim dividend at the rate of 6 per cent. per annum paid in October last, and providing for income tax, there remains a net balance of £5,030. 14s. 3d. to the credit of net revenue account. The directors propose to write the sum of £262. 5s. off preliminary expenses account, to place £2,000 to the credit of the reserve fund, to declare a dividend, payable on April 14 next, at the rate of 9 per cent. per annum for the half-year on the share capital, making, with the interim dividend, 7½ per cent. for the year, and to carry the balance, £614. 17s. 10d., forward. With the addition now proposed to be made, the sum at credit of reserve fund will amount to £12,287. 17s., and, with the sum of £155. 14s. 3d. added to depreciation and maintenance reserve account, the balance under this head is increased to £1,261. 7s. 4d. During the past year the directors have issued 2,000 additional shares at the price of £7. 10s. each, the premium on the issues being added to the reserve fund. The expenditure on capital account during the year amounted to £16,210. 2s. 7d. The generating station has been enlarged to the fullest extent which the Corporation of Hove will allow on the present site. Two additional steam dynamos of 350 h.p. and 250 h.p. respectively, and another Babcock and Wilcox boiler, have been placed in the generating station. A sum of £4,686 has been expended on new mains and in strengthening the existing feeders and mains and £1,255 on additional meters and demand indicators. The total expenditure to the close of the year amounted to £93,660. 14s. 9d. The directors have ordered another 250-h.p. steam dynamo for delivery in the early autumn. This will completely fill up the space for machinery at the present station, and, it is hoped, will meet the requirements for next winter. It is clear that the Company must add largely to its generating power before the directors can reduce the charges to a point which it is anticipated will yield the very best results, and that the steady growth of the Company's business fully justifies the erection of a second generating station the following figures will prove:

Year.	Houses.	8-c.p. lamps.	Units sold.	Gross revenue.	Net revenue.
1896	314	21,756	200 562	£6,518	£3,114
1897	397	27,777	268,243	7,269	3,602
1898	513	36,967	350,254	9,480	5,089
1899	671	44,824	444.499	12,070	7,097

The directors have consequently been seeking for a fresh site for a second generating station, and they have found one in an exceptionally good position, on which they propose building as soon as the agreements, etc., are completed and the necessary plans and estimates have been prepared. The erection of this new station and its equipment with the generating plant, together with the connection of the station with the existing mains, will, of course, involve considerable capital expenditure, but the directors have every confidence that the outlay will prove as remunerative as that already incurred. In accordance with the articles of association, Mr. Carleton F. Tufnell retires from the Board of directors by rotation, but offers himself for re-election. The auditors also offer themselves for re-election.

Revenue Account.

Dr. Generation of Electricity.	£	s.	d.
Coal or other fuel	£1,641	2	1
Oil, etc., and engine-room stores	103	2	3
Proportion of salaries	329	12	0
Wages and gratuities	606	17	2
	2,680	13	6
Repairs and Maintenance.			
Amount expended	444	5	9
Balance set aside	155	14	3
	600	0	0
Rents, Rates, and Taxes.			
Rents payable	247	8	4
Rates and taxes	54	9	8
	301	18	0
Management Expenses.			
Directors' remuneration	450	0	0
Salaries	492	2	0
Stationery and printing	67	6	5
General establishment charges	220	6	0
Auditor of Company	10	10	0
	1,240	4	5
Special charges—insurances	150	6	2
Total expenditure	4 973	2	1
Balance carried to net revenue	7,097	3	7
	£12,070	5	8

Cr.	£	s.	d.
Sale of current to private consumers	11,245	15	2
Public lighting	88	2	6
	11,333	17	8
Rental of meters and other apparatus	684	5	6
Transfer fees	2	2	6
Miscellaneous receipts	50	0	0
	£12,070	5	8

General Balance Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	51,174	0	0
4½ per cent. debentures	7,300	0	0
4 per cent. debenture stock	17,700	0	0
Sundry creditors	6,937	7	6
Consumers' deposits	78	0	0
Creditors for interest	170	5	1
Unclaimed dividends	13	14	7
Reserve fund	10,287	17	0
Depreciation and maintenance account reserve fund	1 261	7	4
Net revenue account, balance at credit	5,030	14	3
	£99,953	5	9

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	93,660	14	9
Stores on hand—coal, £23. 5s. 6d.; oils, waste, and general stores, £32. 7s. 3d.	55	12	9
Sundry debtors	5,065	16	3
Cash at bankers and in hand	1,171	2	0
	£99,953	5	9

CHELSEA ELECTRICITY SUPPLY.

Directors: J. Irving Courtenay (chairman); Nugent Daniell; G. N. Marten; Major-General Webber, C.B. (retired R.E.). Chief engineer: Percy Still. Secretary: S. J. Cluer.

Report of the directors (with abstract of accounts) to be submitted to the shareholders at the ordinary general meeting of the Company to be held at the Town Hall, Chelsea, S.W., on March 7 at 12 noon:

In October, 1899, an issue of £50,000 debenture stock was made at the price of 107 per cent. This issue was fully paid up in January, and a Stock Exchange quotation has been granted. The balance of premium received in 1899, after deducting expenses of issue and certain special law and incidental expenses, has been carried, as on previous occasions, to the reserve fund. In consequence of the exceptionally high price of coal, the directors

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think it prudent to place a special amount of £1,096. 8s. 5d. to reserve, as provision for the largely increased outlay under this head of expenditure, for the current year. The total of the reserve fund now stands at £48,604. 13s. 8d. The sum of £3,000 has been added to the renewals and depreciation fund, out of the net revenue. After deducting this amount and the above-mentioned amount of £1,096. 8s. 5d., and after payment of interest on debenture stock (£4.668. 15s.), there remains a balance of £12,000. The directors recommend that this balance shall be applied as under: interim dividend of 6 per cent. per annum on preference shares for half-year to June 30, 1899, £900; interim dividend of 5 per cent. per annum on ordinary shares for half-year to June 30, 1899, £4,250; dividend of 6 per cent. per annum on preference shares for half-year to Dec. 31, 1899, £900; dividend of 7 per cent. per annum on the ordinary shares for the half-year to Dec. 31, 1899, making a total dividend of 6 per cent. for the year, £5,950. The number of lamps connected on Dec. 31, 1899, was 128,867, an addition of 16,280 during the year. The directors have adopted what is known as the maximum demand system of charge for customers on the 200-volt supply. They believe that this change is appreciated, and that it will benefit the Company. The hire-purchase system for wiring and fittings has also been introduced. The retiring directors, Mr. J. Irving Courtenay and Major-General C. E. Webber, C.B., are eligible for re-election. Mr. Emile Garcke, owing to the pressure of other engagements, has retired from the Board. The auditors, Messrs. Cooper Bros. and Co., offer themselves for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£4,151	13	8			
Oil, water, and engine-room stores	593	18	7			
Wages and engineers' salaries	1,709	3	7			
Repairs, maintenance, and renewals of buildings, £281. 15s. 4d.; engines and boilers, £843. 7s.; dynamos, £88. 8s. 1d.; instruments, etc., £82. 14s. 8d.	1,296	5	1			
Sundry costs not included in above	585	5	1			
				8,336	6	0
Distribution of Electricity.						
Wages at out-stations, meter reading, etc.	860	2	7			
Stores used at out-stations	137	11	1			
Repairs, maintenance, and renewals of mains, £272. 0s. 8d.; accumulators and apparatus at distributing station, and motor-transformers, £389. 0s. 3d.; meters on consumers' premises, £109. 5s. 9d.	770	6	8			
				1,768	0	4
Rent, Rates, and Taxes.						
Rents payable	610	5	0			
Rates and taxes	1,325	18	7			
				1,936	3	7
Management Expenses.						
Directors' remuneration	1,000	0	0			
Salaries of staff	1,017	6	6			
Salary or commission of collector	120	0	0			
Stationery and printing	140	5	0			
General establishment charges	259	16	8			
Auditors of Company	52	10	0			
				2,589	18	2
Law and parliamentary expenses				5	16	8
Special Charges.						
Insurance	238	10	8			
Wayleaves	7	0	0			
				245	10	8
Balance carried to net revenue account				20,121	11	9
				£35,003	7	2

Cr.	£	s.	d.
Sale of current (less allowances made)	33,463	19	9
Rental of meters	1,440	5	2
Transfer fees	26	10	0
Discounts and sundry small accounts	72	12	3
	£35,003	7	2

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount received	338,430	0	0
Sundry creditors for plant and buildings	12,094	10	6
Sundry creditors on open accounts	2,658	1	8
Bills payable	1,525	16	0
Debenture stockholders for interest accrued	2,338	2	6
Reserve fund, including provision for extra cost of coal in 1900	48,604	13	8
Balance at credit of net revenue account, £12,000; less interim dividend paid, £5,150	6,850	0	0
	£412,501	4	4

Cr.	£	s.	d.
Capital account—amount expended, £389,835. 1s.; less renewals and depreciation, £10,270	379,565	1	0
Stores on hand—coal, £264. 0s. 9d.; general stores, £6,062. 19s. 5d.	6,327	0	2
Sundry debtors for current supplied, etc.	15,309	19	0
Cash at bankers and in hand	11,299	4	2
	£412,501	4	4

EDISON AND SWAN UNITED ELECTRIC LIGHT.

An extraordinary general meeting of this Company was held on Tuesday at the Westminster Palace Hotel, S.W., for the purpose of considering a resolution authorising the directors to create and issue debenture stock.

Mr. James Staats Forbes, who presided, stated that when the Company was formed they were protected by patents. The whole of these, however, had disappeared by the end of 1898, and they emerged into the open markets. The character of their business also had greatly changed. From being mere makers of lamps they had become makers of everything connected with the installation of the electric light. He had now to direct their attention to the fact of a large proportion of their money being locked up. In the balance-sheet of June 30 they would observe there were two things which had operated upon their business. Installers, hundreds of them, were people who very often were short of capital. Some of them were very well-to-do; but they were governed by what they called the custom of the trade. That custom was that the unfortunate creditor, who had to supply their wants, had to wait a long time for his money. Traditionally the period was three months' credit, and when that period had expired, even then great difficulty was experienced in obtaining payment. Were pressure brought to bear, the chance was that they might lose a customer. That was the character of the business, and the question before them was how to meet the difficulty. After much consideration, the directors had come to the conclusion that the proper way was to raise money by issuing debentures. They had considered how much money they were likely to want in some reasonable time, and they had made up their minds it would be wise to take powers for £300,000, but with the provision that only £100,000 would be wanted in the coming year to put them on their legs, to pay their debts, and make them independent of their bankers' advance. They would not issue the remainder, say the third £100,000, for two or three years. Those were the principles on which they came to the shareholders to ask their concurrence in the proposal. They had a large number of proxies in response to the circular which had been issued. He then moved that the directors be authorised to create and issue debenture stock providing for the payment of principal sums not exceeding £300,000, and carrying interest at the rate of not exceeding 5 per cent. per annum, such debenture stock to be secured in such manner (subject to the existing debenture stock already issued by the Company to the amount of £350,000) and to be issued to such persons and on such terms as the directors shall think fit.

The motion was seconded by the **Earl of Lichfield** and agreed to.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Brighton.—The Corporation require tenders for switchboard. Tenders by March 9

South Shields.—The Corporation invite tenders for cables. Tenders by March 11.

St. Annes.—Tenders are to be in by March 5 for the building of the new electricity works.

Barrow-in-Furness. — The Corporation invite tenders for boilers, condensers, etc. Tenders by 19th inst.

Waasmes (Belgium).—The Municipality are open to receive tenders for the electric lighting of the district. Tenders by May 31.

Islington.—The Vestry invite tenders for the supply of electrical stores for one year from March 25, 1900. Details in our advertisement columns.

Leeds.—The Tramways Committee invite tenders for one, two, or three steam dynamos. Tenders by March 21. Details in our advertisement columns.

Swansea.—The Corporation invite tenders for the supply and laying of insulated electric mains, conduits, junction boxes, etc. Tenders by 12th inst. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the extension of the electric lighting at Shrubhill tramway power station, Edinburgh. Tenders by March 5. Details in our advertisement columns.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for (A) one 50-ton electric crane; (B) one 25-ton hand-crane; (C) one 6-ton electric crane; and (D) one 2-ton hand-crane. Tenders by noon on March 5.

Paris.—The Under Secretary of State for Post and Telegraphs invites tenders for about 230,000 yards of electric cable (india-rubber insulated). Tenders are to be addressed to that department, Rue de Grenelle, No. 103, by March 8.

Leeds.—The Corporation invite tenders for wiring for the electric lighting of the crypt of the town hall. Specification and form of tender may be obtained on application at the Electric Lighting Department, 1, Whitehall-road, Leeds. Tenders, marked "Crypt, Electric Lighting," to be at the Town Clerk's Office by March 8.

Farnworth.—The Urban District Council invite tenders for the supply, delivery, and erection of the following: Lancashire boilers, economisers, condensing plant, feed pumps, steam and exhaust pipes, etc., three 100-kw. steam dynamos, lighting switchboard, traction switchboard, accumulators, underground cables, travelling crane, and recooler tower. Tenders by March 7. Details in our advertisement columns.

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Blackpool.—The Tramway Committee invite tenders for the construction of a double line of tramways in Central Drive from Revol to Waterloo-road. The contract will include the laying of rails, points, etc., excavating, concreting, paving, flagging, etc. The Corporation will provide all the materials. Tenders by 12th inst.

Durban (Natal).—The Corporation are prepared to receive tenders for the supply and delivery at Durban of 1,900 tons steel girder rails, 64 tons fishplates, the necessary quantity of fishbolts, nuts, tie-bars, and electric bonds, 407 loads Australian hardwood stringers, the necessary quantity of dog-spikes, etc. Tenders by March 8. Specification, etc., may be obtained from Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation.

Lancaster.—The Committee of Visitors of the County Asylum, Rainhill, invite tenders for the supply and erection of three Lancashire boilers and superheaters and one Green's economiser; three 175-b.h.p. steam dynamos, with booster, switchboard, feed pumps, piping, tanks, cranes, and other accessories; secondary battery (1,200 ampere-hours capacity) and accessories; feeder mains (solid system); and wiring of buildings. Tenders by March 22. Details in our advertisement columns.

Dartford.—The Urban District Council invite tenders for the supply and erection of the following plant: Lancashire boilers, with fittings, economiser, feed pumps, etc., pipework, etc., in engine and boiler house, surface-condensing plant, two steam dynamos (vertical enclosed high-speed engines) and motor boosters, storage batteries, main switchboard and connections, six-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed type) and posts, station lighting. Tenders by 27th inst. Details in our advertisement columns.

RESULTS OF TENDERS.

Morecambe.—The tender of Messrs. Hughes and Stirling Bootle, for a refuse destructor has been accepted.

Tynemouth.—The tender of Messrs. Chamberlain and Hookham, Limited, at £470, has been accepted for the supply of electric meters.

St. Pancras.—The tender of Messrs. J. Fraser and Son, at £6,309. 18s., for condensing plant at the electric light station, has been accepted.

Hull.—The City Council have accepted the tender of the Horsefall Destructor Company, at £9 060, for construction of a 12-cell refuse destructor for the western district.

Glasgow.—The Tramways Committee have accepted contracts for equipping 200 electric cars, the total amount involved being between £60 000 and £65,000. The Westinghouse Company and Messrs. Dick, Kerr, and Co. each secured a contract to provide 100 motors and controllers.

Bedford.—The Council have decided to order a condenser for the electric light works, at £910, from the Wheeler Condenser and Engineering Company; they have also accepted the tender of J. Corby and Sons, at £3,076, for alterations and new buildings at the electric light works.

Barnes.—The Urban District Council have accepted the following tenders: Callender's Cable Company, mains, £9,648; Siemens Bros. and Co, steam dynamos, etc., £6,880; Babcock and Wilcox, Limited, boilers, £1,803; Electrical Power Storage Company, Limited, accumulators, £882.

Bermondsey.—The tender of Messrs. Hughes and Stirling, amounting to £10,342, has been accepted for the construction of a dust destructor. The specification included the supply of six destructor cells of sufficient capacity to burn 50 tons of ashbin refuse in a working day of 22 hours. Seven tenders were sent in.

Hull.—The Tramways Sub-Committee have received the following tenders for the complete order of 10 cars and 25 equipments: British Thomson-Houston Company, Limited, £14,568. 15s. (accepted); Messrs. Macartney, McElroy and Co., Limited, £14,575; and British Westinghouse Electrical Company, £14,813.

Hull.—The Corporation have received the following tenders for supply and erection of the following apparatus for their electric lighting works—viz.: (Contract 23) 30 cast-iron street section pillars, each containing eight switch fuses, etc.:

R. W. Blackwell, London*	£691	17	6
Edwards's Electrical Company, Limited, London	597	13	6
Laing, Wharton, and Down, Limited, London	855	0	0
J. Fowler and Co., Limited, Leeds	862	10	0
Macartney, McElroy and Co., London	898	0	0
Electric Construction Corporation, Limited, Wolverhampton	900	0	0
British Insulated Wire Company, Limited, Prescot	966	0	0
Callender's Cable and Construction Company, Limited, London	1,200	0	0
W. T. Glover and Co., Limited, Salford	1,410	0	0
General Electric Company, Limited, London	1,950	0	0
Siemens Bros and Co., Limited, Woolwich	3,180	0	0

* Recommended for acceptance.

Stockport.—The Corporation have received the following tenders for wiring and electrical fittings at the infirmary: Heap and Worthington, Manchester (accepted). Also tendered: J. Lomax, Kendal, and Co., Manchester; Laidlaw, Scholes, and Co., Manchester; Alliance Electrical Company, Limited, Manchester; Scholes and Co., Manchester; E. J. Eckersley and Co., Manchester; Keighley Electrical Engineering Company, Doncaster; Pulford Bros., Limited, Liverpool; J. Bakewell and Co., London; Donnison, Berlyn, Sillem, and Co., Liverpool; W. A. Shaw and Co., Stockport.

Newcastle.—The following tenders have been accepted: Mr. S. F. Davidson, foundations of the car sheds at Byker, at scheduled prices, approximate cost, £2 500; Mr. Edmund Nuttall, Manchester, for laying the new tramways, contract price, £105,257. 12s. 10d.; British Westinghouse Company, Limited, one 2 000-h.p. generator, with engines made by the Wallsend Slipway and Engineering Company, Limited, contract price £16,230, and two 1,000-h.p. generators, with engines by Victor Coates and Co., Limited, of Belfast, contract price £16,450.

Hastings.—The Corporation have received the following tenders for transformers and sub-station gear:

Supply, delivery, and maintenance of 12 20-kw. transformers.

Electric Construction Company (accepted)	£588	0	0
Siemens Bros. and Co.	612	0	0
British Transformer Manufacturing Company	678	0	0
Burnand and Co.	680	0	0
Fowler and Co.	684	0	0
Gilbert Arc Lamp Company	696	0	0
British Thomson-Houston Company	780	0	0
Brush Electrical Engineering Company, Limited	890	0	0
Ferranti, Limited	921	0	0

Supply and erection of high-tension and low-tension alternate-current switchgear for eight sub-stations.

Cowans, Limited (accepted)	1,548	16	0
Siemens Bros. and Co.	1,759	0	0
Brush Electrical Engineering Company, Limited	1,906	0	0
Fowler and Co. ('bus bars and fuses only)	343	0	0

BUSINESS NOTES.

TRACTION.

Glasgow District Tramways Bill.—This Bill will come before the examiner on the 18th inst.

Bristol.—The work of wood paving the sides of the tramway in Ashley-lane has been commenced.

Dartmouth.—The Light Railway Commissioners will hold an enquiry at Totnes on the 15th inst.

Johnstone.—The Town Council have refused to consent to the Glasgow and district tramways scheme.

Dunstable.—The Town Council appear to be greatly in favour of the suggested light railway to St. Albans.

Clontarf.—The Dublin United Tramways Company have lodged a petition against the Clontarf Urban District Council Bill.

Falkirk.—A committee of the Town Council and the promoter are discussing the proposed Falkirk and district tramways.

Southampton.—The Harbour Board have withdrawn their opposition to the tramway extension proposed by the Corporation.

British Electric Traction Co.—Letters of allotment in respect of the issue of £150,000 5 per cent. perpetual debenture stock have been posted.

Ashton.—The rival tramway schemes were discussed at a meeting of ratepayers recently, and finally the discussion was adjourned until the 19th inst.

Great Grimsby Street Tramways Bill.—The Corporation of Grimsby have lodged a petition against this Bill, consideration of which originates in the House of Lords.

Rishton.—The District Council are discussing with a committee of the Blackburn Corporation the advisability of continuing the tramlines from Furthergate to Rishton canal bridge.

Cork.—At a recent general meeting of the Cork and Muskerry Light Railway Company it was mentioned that a great deal of direct and indirect traffic was lost to them on account of the electric tramways.

Devonport.—It is proposed to use double-decked cars on the Devonport and district tramways, now in course of construction. The car sheds will be situated at Milehouse, and when the service is opened about 30 cars will be in use.

Lincoln.—The Great Northern Railway Company have given notice at the Private Bill Office of the House of Lords of their intention of opposing the Lincoln Corporation Tramways Bill when considered by an Upper House Select Committee.

Liverpool Overhead Railway Co.—The total to be expended on the Bill to be promoted by this Company is estimated at £113,583, of which £92,971 will be spent on extensions and £20,612 upon a widening at the Pierhead Station.

Burnley.—At a recent meeting of the Rural District Council a resolution was passed approving of the Bill to authorise the Corporation of Burnley and the local authorities to reconstruct and electrically equip tramways between Padiham and Burnley, and Burnley and Nelson.

Moss Side.—At the meeting of the Urban District Council on Monday, it was proposed that the scheme of tramways should include a line along Moss-lane East and Moss-lane West. An amendment was carried that the matter should be referred back to the Highways Committee for further consideration.

Stock Exchange.—The Stock Exchange Committee have appointed March 7 as a special settling day for the Barcelona Tramway Company's 7,000 5 per cent. cumulative preference shares of £10 each, fully paid, Nos. 3,001 to 10,000; and a further issue of £48,100 4½ per cent. redeemable debenture stock.

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Wigton.—The Rural District Council appear to have no objection to the proposal of Messrs. Dickinson and Co., of Birmingham, to lay a light railway between Silloth and Maryport and on to Workington.

Airdrie and Coatbridge Tramways Bill.—The Committee of the House of Lords on the 27th ult. agreed to dispense with with standing orders in the case of the Airdrie and Coatbridge Tramways Bill, on condition that the provisions with regard to tramway construction in the burgh of Coatbridge are withdrawn from the Bill.

Carlisle.—The Rural District Council have decided to adhere to the resolution of a previous meeting asking the tramway company if they proposed to extend their line from the foot of Etterby-street to Edentown, to cause a line to be laid down on one side of the roadway in place of the centre. In the alternative a double line is to be asked for.

London United Tramways Bill.—Both the Twickenham and Teddington Councils have now accepted this Bill as proposed by the company for Standing Orders purposes, agreeing to Clause 24, the purchase clause, subject to confirmation by Parliamentary Committee; but the right to petition against preamble and clauses was reserved in order to secure the insertion of agreed terms.

Linthwaite.—The Huddersfield Corporation have agreed to make the disputed three yards of line necessary to connect with Linthwaite and hand it over to the Linthwaite Council. They have also agreed to the principle of the claim by Linthwaite Council that they should be paid an extra rent for wear and tear of their lines caused by traffic over them from Linthwaite and Marsden.

St. Helens.—On the 23rd ult. Sir Francis Marindin, accompanied by the Mayor of St. Helens (Councillor Beecham), Alderman Bishop, Councillor Hy. Martin, Mr. G. W. Bailey (town clerk), Mr. J. Cuttler (tramway company's manager), inspected the new line of tramway from the Toll Bar to Thatto Heath, as well as the routes of several of the proposed new lines. The inspection was on behalf of the Board of Trade.

Grimsby.—After considerable debate the Tramways Committee's report has been adopted. Some of the speakers seem to think the town would lose at the rate of 1d. per unit if the agreement was carried out, and that it would mean about £1 500 per annum. The Town Council on Monday decided to reopen negotiations with the tramway company with a view to re-leasing the lines to the company on terms advantageous to the Corporation.

Swansea.—At the quarterly meeting of the Town Council the extension of tramways was further considered. The extensions are proposed to be spread over a wide area, embracing Sketty, Brynmill, and Port Tennant, and at some points they will cut right across the track of the present system, which is controlled by the British Electric Traction Company. After some debate it was agreed that powers for a piece of line between Mount Pleasant Chapel and the bottom of High-street be added to the existing proposals.

Wimbledon.—The Urban District Council are asking the Croydon Rural District Council whether they would be prepared to favourably consider the construction of the proposed tramway from Tooting to Wimbledon Station as a joint undertaking upon the basis of respective proportionate ratable values, or if in the alternative they would be prepared, in the event of the Wimbledon Urban District Council becoming the sole undertakers of such a scheme, to actively support any application by them for the necessary powers.

Teddington.—The ratepayers are being circularised with the view of obtaining their support to the London United Tramways Company's scheme. A meeting of ratepayers has been held in the matter, and the *South-Western Comet* publishes the following statement: "We are asked to state that there is no one on the Teddington District Council objecting to the tramways. What they require is that Teddington shall be put into the same position as to clauses (including the purchase clause) as Brentford, Heston, Chiswick, and Hanwell; they want nothing more, and will take nothing less."

Stoke-on-Trent.—At a recent meeting of the Town Council a letter was received from the Board of Trade respecting the dispute between the Potteries Electric Traction Company and the Corporation as to the laying of cables under footpaths without the permission of the Corporation, to the effect that the question raised appeared to them to be one of a legal character, as to which the Board had no power to give an authoritative opinion, and that, therefore, they were not in a position to be of any further service. It was decided to obtain counsel's opinion with a view to definite action being taken.

Accrington Corporation Tramways Co.—The ordinary general meeting was held last week. The Chairman of directors (Alderman Kenyon) stated that for the first time in the history of the Company they had placed to reserve a sum of £2,400 in actual cash. If maintained it would place the Company in a very favourably position at the end of their lease—even if nothing came of the proposal to sell the undertaking to the British Electric Traction Company. Dividends of 6 per cent. on the preference and ordinary shares were approved, and Messrs. Riley and Watson were re-elected directors.—*Preston Herald.*

Newcastle.—During the debate on the tramway tenders on Wednesday it was stated that the parliamentary estimate for laying 22 miles of rails was £220,000. Mr. Nuttall's tender was £105,000. The committee would have to add £33,000 for rails, £5,000 for junction points, and contingencies would bring it up to £151,000, as against the estimated £220,000—a saving of about £70,000. Mr. Nuttall was prepared to start the work at once. The work was to be completed in 12 months from March next under a penalty of £100 for every week's delay. The tender was accepted. The list of tenders appears in another column.

Tipton.—At the meeting of the District Council on Monday the Tramways Committee recommended that all the necessary proceedings be taken enabling the Council to acquire the portion of the tramways undertakings within the district of the Council, and that notice in writing be given to the promoters of the South Staffordshire and the Birmingham and Midland Tramway Companies respectively with respect to the purchase. It was stated that the undertakings within the parish could be purchased for £7,000, and that the necessary electric equipment and contingencies could be provided for a further £18,000, making £25,000, on which outlay there would be a handsome profit. The resolution was carried.

Electric Traction.—We have received from the British Thomson-Houston Company, Limited, their pamphlet No. 24, which deals with electric traction. The pamphlet is practically a review of electric traction as it stands at the present time. Views are given illustrating the electric tramways at Dover, Dublin, Colombo, and Bristol, while inside views are shown of the Middlesbrough and Dover power stations. At the end of the pamphlet is a very useful list of the electric tramways and railways in the United Kingdom equipped with the Thomson-Houston apparatus. There are considerably over 30 of these, and the list gives one an idea of the enormous value which this firm has been to the country at large.

South-Eastern Metropolitan Tramways Bill.—This Bill came before the Standing Orders Committee on Monday. The promoters having been unable to obtain the consent of the London County Council and the Lewisham Board of Works, the local authorities interested, those portions of the Bill providing for the construction of further lines were struck out, and the Bill was allowed by the committee to proceed only so far as the provisions for the application of mechanical traction to the company's present system were concerned. As amended, the Bill now proposes to empower the company to adapt their system for electric traction. The estimated cost of the necessary alterations and electrical equipment is put down at £158,029.

London United Tramways Provident Society.—The annual meeting of this society was held at the Chiswick depôt early last Friday morning, when Mr. J. Clifton Robinson presided. The annual report, which was presented by Mr. Clifton Robinson, jun., showed members' subscriptions of £243, and disbursements of £207 for sick and funeral allowances. Thanks to contributions voted by the directors of the company, there remained a balance to the credit of the society amounting to £274. Mr. Cummings, the treasurer, presented the accounts and balance-sheet, and the officers were unanimously reappointed. The usual votes of thanks and cheers for Mr. Clifton Robinson brought the meeting to a close. A supper followed, at which the usual speeches and recitations, etc., were delivered.

Annual Dance.—The annual assembly of the employés of the Aberdeen Corporation tramways last week passed off very successfully. Councillor Wilkie, convener of the Tramways Committee, presided. After a service of tea, the Chairman said they had finished a very large contract on the George-street route, where they had introduced the electric car system, and that had been in operation now for two months. He was glad to say it had proved a success. They had at present in Parliament a Bill to make extensions to Torry, Ferryhill, and the sea beach, and, if he might venture to say it, before the twentieth century was very old they hoped to have these tramways running. The evening's entertainment comprised a variety performance and a cinematograph exhibition, after which dancing was indulged in until the wee hours of the morning.

Manchester.—The tramways in Trafford Park are about to be worked by one company, known as the West Manchester Light Railway Company. They will carry goods and passengers. Electricity is expected to be adopted as the motive power in the near future. The Tramways Committee of the Corporation has had under consideration the question of training as electrical car-drivers a number of the men now employed on the tramcars, and they have adopted a resolution submitted by a sub-committee declaring that it was desirous of finding employment for employés of the carriage company who may be found suitable as drivers of electric cars, and recommending the committee to afford every facility for the training of such men in their respective duties at the expense of the department, without entering into any definite undertaking on the subject.

Middlesex Tramways.—At last week's meeting of the County Council a report was adopted showing the terms of the agreement proposed to be entered into between the Council and the North Metropolitan Tramways Company concerning the making and working of the electric tramways in the county. Under the agreement the County Council will have the option of purchasing the company's interest at the cost price of the order within six months from the granting of the same. In this case the Council are to provide all the land and to construct the lines and works, whilst the company are to erect the generating stations, fixed machinery, engines, carriages, and rolling-stock. The lease is to extend over 25 years, the company to pay 4 per cent. for the first third and 4½ and 5 per cent. for the remaining two-thirds of the lease on all moneys expended by the Council.

Aberdeen.—A conference between members of the Tramways Sub-Committee of Aberdeen Town Council and the Docks and Pilotage Sub-Committee of the Harbour Board was held on Monday to discuss certain arrangements in connection with the

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tramway to Torry, power to construct which the Corporation seek in the Bill they are promoting. It was agreed that the Harbour Commissioners should be recognised as the local road authority with respect to the quays; and some minor questions, such as the cleansing of the quays, were also discussed, and a mutual understanding arrived at regarding them. No understanding was arrived at referring to the proposal to lay a double line along South Market-street; the representatives of the Harbour Board strenuously objected to it, while the Town Council representatives as strongly contended that, in view of the great width of the street, there was ample room for a double line. It is stated that a majority of members of the Harbour Board are in favour of a double line, and that the Board is not likely to oppose the Bill.

Waterford.—When the first roads were to be constructed in this country there was an agitation against the proceeding, and among the arguments then mentioned was one that if good roads were made saddlers and others would suffer. A similar agitation was started at the commencement of the railway era, and now we have the anti-motorcar agitators in full swing. Those of that ilk at Waterford last Friday passed the following resolution, which we give in full, as it may amuse our readers: "That we, the car-owners and car-drivers of the city of Waterford, respectfully call on the members of the Town Council to oppose the granting to any company of license to run motorcars or other such vehicles as public conveyances, as same would be detrimental to the interests of the car-owners, car-drivers, smiths, farriers, saddlers, shop-keepers, etc., of this city, and we would ask you, as the municipal authority, having the welfare of the citizens at heart, to oppose the granting of such licenses, which would deprive the car-owners and car drivers, as well as a large number of the working classes, of their means of livelihood."

Barking.—At the meeting of the Urban Council on Tuesday the surveyor recommended the Council to divide the contract for the light railways, one for the bridges and approaches, and the other for the permanent way. He estimated the cost of the bridge, as enlarged, at about £13,000, and thought that the whole scheme could be carried out at the estimated cost. Under the light railways and tramways orders the Council have obtained powers to construct and work six tramways within the urban district. The only ones that will be considered at present are: Tramway No. 1, from the end of Barking and Beckton light railways in Axe-street, along the Broadway, and North-street, Queen's-road, and New-street Church-road, Ilford-lane, to the Ilford boundary; Tramway No. 3, commencing in North-street, by the junction with No. 1 tramway, thence along New-road to the boundary with East Ham. It was resolved that the consideration of the tenders for the remaining sections of the electrical portion of the light railway be deferred until the tenders for the bridge are received, and that in the meantime the various applicants be asked if they will allow their tenders to stand for three months.

Kent.—The County Council have adopted a report in which it was recommended that consent should be given to the Folkestone, Sandgate, and Hythe Tramroads Bill on condition that the promoters should contribute towards the cost of the sea defences, from which they will derive protection and benefit. This condition had been accepted by the promoters. The report also contained the following: "The Cinque Ports light railway would extend from Ramsgate to Hastings, and would pass along the main roads within the county at places where the carriageway is less than 20ft. in width. It would run down the whole length of Risborough-lane, no provision being made either for widening the road or enlarging the arch at the northern end of it. Your committee recommend the Council to oppose the scheme unless these objections can be met. In addition to the above, there are Bills to authorise the London County Council to acquire the undertakings of the water companies and to provide a supply of water from Wales. These Bills are identical with Bills which have been previously brought forward for these purposes, and they will be again opposed by those authorities in the county which are specially affected. Your committee recommend the Council to concur, as before, with these authorities in opposing the Bills."

Leeds Tramwaymen's Wages.—In reply to the application for an increase of wages at the rate of ½d. per hour made by the Leeds tramwaymen some time ago, the Leeds Corporation Tramways Committee, says the *Yorkshire Post*, on Monday resolved to recommend certain advances which a special sub-committee, after careful investigation, reports as reasonable. The new scheme embraces the following points: Wages of steam, electric, and horse-car drivers, and trailer car brakesmen to be increased by ½d. per hour; also, the wages of steam-car conductors to be increased by ½d. per hour. Further, a bonus of 20s. per half-year to be paid to each driver on the steam and electric sections who, in the opinion of the Claims Committee, has been free from blame for accidents during the preceding six months. The wages of all conductors other than those on steam cars (above mentioned) to be increased by ½d. per hour. Under this plan steam-car drivers will have 6¾d. per hour after the first six months' service (there being ½d. advance after six months), electric car drivers 6½d., three-horse car drivers 5¾d., two-horse car drivers 5½d., trailer brakesmen 4½d, steam-car conductors 5½d., and all other conductors 5d. (in each case after six months' service). The wages of horsekeepers are to remain as at present, excepting that horsekeepers employed all day on Sunday will have 1s. per week extra. The wages of car-washers and harness cleaners are to be unaltered, but chopmen's wages are to be advanced 1s. per week. The commencing wages of inspectors to be 30s. per week, to be increased at the discretion of the traffic manager to 35s., with further increases by resolution of the committee to a maximum of 40s. per week.

LIGHTING AND GENERAL.

London Gazette.—The trustees have signed a release *re* C. F. S. Pilling, Bolton.

Wembley.—The Council intend to petition against the North Metropolitan Electric Light Supply Bill.

Ealing.—The engineer has been instructed to prepare specifications for a new steam alternator and batteries.

Wood Green.—The Council have sealed a petition in opposition to the North Metropolitan Electric Light Supply Bill.

Wealdstone.—The Council have sealed a petition in opposition to the North Metropolitan Electric Light Supply Company's Bill.

Walsall.—The Corporation last year made a profit of £61 on its electric lighting business. The Council oppose the Lancashire Electric Power Bill.

Haslingden.—A committee of the Town Council is negotiating with regard to the purchase of a site for a refuse destructor and electric light station.

Tynemouth.—The Corporation are inviting offers for the loan of £34,850 for electric supply purposes recently sanctioned by the Local Government Board.

Nuneaton.—The Local Government Board enquiry into the Council's application for the loan for the purposes of electric lighting has been fixed for March 8.

Headon.—The Guardians have asked Mr. Hare and Mr. Stevens to consult with the Works Committee with regard to the advancement of the proposed electric light and laundry scheme.

Harrow.—The electric light company are extending their mains from Roxborough-park along Lowlands-road to Whitehall and Lansdowne roads, opposite the Metropolitan Station.

Western Telegraph Co.—An interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, is declared for the quarter ended Dec. 31, 1899, payable March 25.

City of London Electric Lighting Co.—The directors of this Company recommend a dividend at the rate of 8s. per share, or 4 per cent. per annum. For 1898 a dividend of 6 per cent. was paid.

Friern Barnet.—The Urban District Council have decided to oppose the Bill of the North Metropolitan Electric Power Supply Company, and notice of motion has been given to the effect that the Council themselves apply for an electric lighting order.

Ruthin.—At the quarterly meeting of the Town Council attention was called to the large estimate for street-lighting, and a hope was expressed that unless the gas company would supply the town with gas of a better quality and at a more reasonable rate the Corporation would seriously consider the question of supplying the town with electric light.

Glasgow Telephones.—Mr. A. R. Bennett's report to the Telephone Service Committee of Glasgow Corporation recommends the acquirement of a switchroom for 5,250 wires, and accommodation for increasing the number to double that figure. The inclusive rate for subscribers is mentioned as five guineas. The committee recommend the establishment of the municipal telephone service, and ask power to borrow £120,000.

Appointments Vacant.—A commercial manager is required for works in the Midlands employing about 60 hands.—Assistant electrical engineers are required by the Bray Urban District Council, Pembroke, and elsewhere.—The Brush Electrical Engineering Company, Limited, want an experienced works manager for the Falcon Works, Loughborough.—A partner, a draughtsman, and mains superintendents are required in Barrow-in-Furness and West Ham, and others are sought for. Full particulars of these vacancies appear in our advertisement columns.

Londonderry.—The Lighting Committee have decided, after considering the report of Sir William Preece, C.B., to extend their scheme. Sir William stated that he was distinctly of opinion that, as an act of duty and of sound financial judgment, the Corporation should themselves undertake the supply of the electrical energy for public and for private purposes, and especially for working the tramways. The further consideration of the report has been adjourned pending a full and detailed estimate of the total cost of the whole scheme as approved of by the committee, to be prepared by Mr. Macrory, and submitted to the committee at next meeting for inspection and approval.

Edinburgh.—Bailie Mackenzie, convener of the Electric Light Committee of Edinburgh Corporation, answering a question at the meeting of the Town Council on Wednesday, said he was aware the figures he had given a fortnight ago had created some little consternation in a city in the West. Since May 15 last over £100,000 of capital expenditure in connection with M'Donald road electric station had been incurred, making the total capital expenditure to 15th ult. £545,981. The total in 8-c.p. lamps or their equivalent joined on at the same date was 284,030, thus making the capital expenditure per 8-c.p. lamp at the present time £1. 18s. 4d., as against £1. 14s. 10d. at May 15 last. The figures for the 40 weeks which had gone of this financial year were equal to 1,432 lamps per week, or 57,293 altogether and there were 20,000 lamps waiting to be joined on. At May 15 next the number would be over 70,000, a thing unheard of in connection with any similar undertaking in the country. At the end of the first year of the undertaking the capital expenditure per lamp was £2. 9s. 11d., at the end of the second year it was £2. 6s. 2d., at the end of the third year it was £1. 16s., and at the end of the fourth year £1. 14s. 10d. The average had been gradually going down until the Corporation began its new undertaking in M'Donald-road.—*Glasgow Herald.*

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Hull.—The number of passengers carried on the electric tramways from the date of their starting to the end of December last was 4,806,598. The receipts amounted to £20,027. 9s. 10d.

Annfield Plain.—A letter from Mr. Alfred Carr, Newcastle, respecting the introduction of electric lighting into the district is before the Finance and Lighting Committee of the Council.

Stirling.—A part of the machinery at the electric lighting station is erected, one of the boilers has been fired, and it is expected that current will be supplied in about a week's time.

Rochford.—The District Council have granted permission to the Salvation Army authorities at the Hadley Farm Colony to erect a telephone from Hadleigh Hall at a nominal yearly fee of 1s.

Morpeth.—Mr. A. A. Campbell Swinton has received instructions from the Asylum Committee of the Northumberland County Council to prepare a specification for the electric lighting of the county lunatic asylum at Morpeth.

Mirfield.—The Council some time ago approached the Huddersfield Town Council asking to be supplied with electricity. The ratepayers are now being canvassed in order to ascertain whether a sufficient amount of support can be secured.

Sheffield.—The Electric Light Committee, at their meeting on Tuesday, instituted preliminary steps to supply the vacancy which has arisen through Mr. William Johnson ceasing to hold the appointment of engineer and general manager.

Grantham.—The Rural District Council have adopted a resolution approving of the application to be made by the Town Council to the Postmaster-General with a view to obtaining a telephone license for the area under the jurisdiction of the Council.

Macclesfield.—The Parish Council have decided that the question of public lighting be brought before the ratepayers at the April parish meeting, due notice of the same being given. The feeling seems to be in favour of an electric light installation.

The "Robertson" Lamp Works, Brook Green.—A party of students from the Institution of Electrical Engineers visited these works on the 22nd ult., and were shown in detail the various operations connected with the manufacture of the "Robertson" lamp.

South Stoneham.—The Post Office Department have written with regard to the telegraph at Bursledon Post Office that the revenue from 1899 had been sufficient to cover the guarantee given by the Council, and therefore they would not be asked for anything for that year.

Parliament.—In the House of Lords the South Staffordshire Tramways, Sheffield District Railway, and in the House of Commons the Dublin Electric Lighting and the Hamilton, Wishaw, and Motherwell Tramways Bills were read a second time during the past week.

Barnsley.—The Corporation's electric lighting installation is now in operation as a commercial undertaking. There are about 70 customers on the books, and it is confidently anticipated that when the first quarter's bills have been sent out there will be a big rush on the part of others.

York.—The Lord Mayor (Alderman J. P. Rymer) and the sheriffs attended at the Corporation's electric light station on Monday to witness the opening of the works. The ceremony was performed by Mrs. E. R. Dodsworth, the wife of the chairman of the Electric Lighting Committee.

Barnard Castle.—The Urban District Council have decided to get an expert to advise them on the clauses relating to the charges and the compulsory sale as contained in the proposal of the company asking for powers to supply Barnard Castle with the electric light.

Shoeburyness.—At the recent Local Government Board enquiry into a loan for water supply a ratepayer suggested that the Council should, if they could see their way clear, replace the gas-engines now in use at the waterworks by steam-engines, with a view to having a factor in the generation of electric light in the near future.

Government Contracts.—We are informed by the British Electric Company, Limited, the producers of stellite fittings, that they have received some important Government contracts, and that in consequence the electrical side of their business is now running night and day, and will continue to do for at least six months.

Epsom.—With regard to the borrowing of £16,100 for electric lighting purposes, the Urban District Council have resolved to make application to the Local Government Board to authorise the issue of 322 £50 nominal debentures payable in equal half-yearly instalments extending over a period of 23 years on the security of the rates.

Wath-upon-Dearne.—In the Chancery Division on Saturday Mr. Justice Cozens-Hardy sanctioned an extension of the powers of the Wath-upon-Dearne Gas and Lighting Company, so as to include "all illuminants" in the provisions of the memorandum of association. This, it was pointed out, would enable the company to supply electricity.

Turbo-Generators.—We are informed that the Newcastle and District Electric Lighting Company have placed an order with Messrs. C. A. Parsons and Co., Heaton Works, Newcastle-on-Tyne, for two 1,000-kw. turbo-generators, each plant consisting of one steam-turbine coupled to two continuous-current dynamos in tandem, and each dynamo to give an output of 500 kw. at 500 volts.

Electrolytic Alkali Co.—The construction of extensive new chemical works at Cledford Bridge, near Middlewich, has been commenced by the contractor for the building, Mr. Wilson, of Runcorn. They are for the Electrolytic Alkali Company, whose present offices are at St. Helens. We learn that orders have been given for engines and dynamos, and the total cost is estimated at £100,000.

Telephone Dispute.—The telephone workers' strike in Leeds and Hull has been settled, the men having accepted the following terms: all labourers receiving under 23s. to be advanced 2s. per week; all wiremen receiving 26s. per week to have the same increase, unless exceptional reasons are shown to the contrary; and all imported men in consequence of the dispute to be reinstated without prejudice

Country House Lighting.—The lighting of Hayes Place, Bromley, Kent, is being carried out by the Phodyne Electrical Company, Limited, to the specification of Mr. Morgan Williams, consulting engineer. The plant will consist of two 15-h.p. gas-engine and dynamo belt-driven sets, together with a battery of 55 accumulator cells. The number of lights at present being installed amounts to 274.

St. Marylebone.—At the meeting of the Vestry last night it was proposed that immediate steps should be taken to improve the imperfect lighting of the public streets by electric arc lamps, and that it be referred to the Parliamentary Committee to consider the possibility of effecting an arrangement with the Metropolitan Electric Supply Company for the wholesale supply of electricity to the Vestry for such purpose.

Deputation Expenses.—We quote the following from the *Bradford Observer*: "Recently Mr. J. H. Whitley, as vice-chairman of the Tramways Committee of the Halifax Corporation, with Mr. Street, the electrical engineer, paid a visit to the United States in connection with the electric tramways schemes, to see and report upon their developments in that country. Their expenses as a deputation amounted to £210. Mr. Whitley has intimated to the Corporation that he will insist on paying his share of the expenses."

Newbury.—A report of the Gas Committee containing the undermentioned paragraph has been referred back to the committee: "A letter from the Board of Trade, enquiring whether the Council had taken any steps to carry out their electric lighting order, was read. The committee recommend that the town clerk inform the Board that the reasons given by the Council for not carrying out the order, conveyed to the Board in January, 1899, still operate, and that no further steps towards carrying out the order have been taken."

Municipal Telephones.—A conference of representatives from various municipalities throughout the country was held on Tuesday at the Westminster Palace Hotel to consider the question of telephones. A resolution was adopted urging municipal bodies separately to communicate with their local representatives in Parliament with a view to obtaining their support for the Corporation of Glasgow in its endeavour to obtain parliamentary protection of its streets against the Post Office, so as to prevent that body affording facilities to any private company to break up the streets for the purpose of laying wires.

Rotherhithe.—At last week's meeting of the Vestry the Finance Committee reported that the clerk had addressed the electric lighting company supplying the town hall with electrical energy. The company's clerk had replied that the electricity charged for had passed through the meter. They were extremely sorry for whatever inconvenience the Vestry might have experienced in common with other customers, but they could not allow any reduction. The vestry clerk had been authorised to tender half the amount charged, and that under protest, whilst the company should be warned that the Vestry may take action for future failures in accordance with the terms of the Board of Trade order.

Fenton.—The Urban District Council on Tuesday adopted the Electric Lighting Committee's report stating that they had met a committee of the Stoke-on-Trent Corporation to discuss the subject of a joint undertaking in the supply of electrical energy for the district. No resolution was arrived at, but it was suggested by the representatives of Stoke that the Fenton Council should inform them what would probably be the minimum and maximum supply which their district would require, and also the minimum number of years for which the Council would accept a supply from Stoke. The Corporation would then be enabled to quote a price or to say what other arrangements could be come to between the two authorities.

Cardiff.—The Chamber of Commerce have passed a resolution in support of the Electrical Power Distribution Bill. The Town Clerk reported at the last meeting of the Town Council that there were 364 Post Office telephonic circuits in the Cardiff area—which comprised Cardiff, Penarth, Barry, Cowbridge, Newport, Pontypridd, and Pontypool—the rentals of which amounted to £3,767. 12s. 6d. per annum. An amplified report is to be printed for circulation among the members, and will be considered at a special meeting of the committee. It was mentioned that the proposed lease was for 25 years, which would be 14 years beyond the time of the expiration of the National Telephone Company's agreement with the Government.

Kingston.—At the last Town Council meeting the Town Clerk read a letter from the Maldens and Coombe Urban District Council in regard to the supply of electricity in Coombe by the Corporation, stating that they could not give a more favourable reply than before. The Lighting Committee was authorised to give a preliminary order for boilers for the electric light works at the estimated cost of £2,700, subject to the subsequent confirmation of the Local Government Board for the borrowing of the money. It was stated that the increased demand for the electric light had rendered it necessary to consider whether the present plant was

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sufficient; and as far as engines and dynamos were concerned, the plant was sufficient for the present.

Yeadon. The District Council having considered the report of Mr. Enright on the best methods of carrying out the electric lighting order obtained in 1894, have decided to visit a number of places, similar in size and population to Yeadon, where the electric light is in operation, and have also instructed their clerk to ascertain whether the Leeds Corporation, which has been asked to carry out the suggested scheme of tramways, would supply Yeadon with electricity for lighting purposes, either in bulk or per light. Mr. Enright proposes a scheme entailing a capital expenditure of £12,600 for 4,500 8-c.p. lights, with an estimated annual expenditure of £1,540, and an estimated income of £2,035.

Battersea.—At a meeting of the Vestry on the 28th ult. the Lighting Committee reported that they were not yet in a position to report definitely as to the charges to be made for electricity to be supplied, but that they did not propose that the charge should exceed 5½d. per unit, and recommended that applicants be so informed. With regard to meter rents, the committee recommended that the following charges be made—viz.: a meter for 25 8-c.p. lamps, 12s. per annum; a meter for 50 8 c.p. lamps, 13s.; a meter for 100 8 c.p. lamps, 14s.; a meter for 200 8-c.p. lamps, 15s.; a meter for over 200 8-c.p. lamps, 16s. The committee have given directions for a movable office to be provided by the works department for the use of Prof. Kennedy's representative upon the work of laying the electric light mains, etc.

Rowley Regis.—The Electricity and Lighting Committee at the last meeting of the Council discussed at considerable length the provisions contained in the order recently obtained from the Board of Trade by the Midland Electric Corporation for Power Distribution. That body had powers within the district of the Council, and might light some (if not all) the streets with electric lamps. The committee also took into consideration the question of establishing destructors for house refuse and that of generating electricity by means of those destructors. The matter being in a premature stage, it was not deemed advisable to form any conclusions upon it. It was decided to defer the matter for a month or two, and then reconsider it with such other information as the councillors might in the meantime be able to collect.

Court of Common Council.—At the last fortnightly meeting a long discussion arose on letters from the Charing Cross and Strand Electricity Supply Corporation, Limited, on the subject of vesting the City of London Electric Lighting Order, 1899, in a new company. The Streets Committee recommended that the company be informed, in reply to these communications, that, provided they obtain the sanction of the Board of Trade to the formation of a new company, the Corporation will offer no objection to the proposal, on the express understanding that it would in no way prejudice the Corporation or electric light consumers, and on an undertaking being given that the expenses in connection with the formation and the carrying on of such new company should form no part of the purchase money in the event of the Corporation deciding to purchase the undertaking. The recommendation was not agreed to.

Hart Accumulator Co.—We have received from this Company a copy of their new catalogue and price-list. The list contains a large amount of information concerning the accumulators supplied by the firm, and instructions for working and erection, etc. A very good way is chosen to give distinctly the figures for each individual cell, so that the numbers in the different columns representing capacities, discharge rate, dimensions, price, etc., shall not be confused. This is effected by printing the figures for one cell in green and for the next cell in red. The list includes cells for both traction and lighting work, and also for central stations. At the end of the list are particulars as to portable batteries, acids, and sundries. A very good feature of the list is that each type of cells has a page to itself, and the back of this page is plain, so that it is entirely distinct from the lists on other pages. We also learn that this Company have this week received orders for the supply of central-station batteries to be used in connection with the electric lighting schemes for the following towns or districts: Hertford, Penarth, Durham, Lewes, Weston-super-Mare, Barnet, and Gateshead.

Barking.—At the Urban District Council meeting on Tuesday, the Clerk said he had written the Local Government Board in reference to the sum of £700, balance of the loan of £15,780 now awaiting their sanction; and to the proposed appropriation of additional land at the town yard for electric lighting purposes. He had applied to the London and South-Western Banking Company, Limited, for advance temporarily of a portion of the loan of £15,080. The consulting engineer presented his estimate of the cost for laying a main in Fanshawe-avenue and Park-avenue, on the Longbridge-road Estate, including extension of a feeder from a point south of the railway, at a cost of £748. He also advised the Council to shortly again consider the scheme for free wiring. It was reported that since the previous meeting 208 applications had been made for lights; 738 8-c.p. lights and 33 street lamps had been connected. The question of wages and hours of labour in the electricity department was considered, the resident engineer submitting a statement of wages and working hours at other similar works. The engineer was instructed to prepare a statement of the total works cost per unit generated at the station, and the cost per unit of the several items making up such work.

New Companies.—The Electro-Chemical Company (1900), Limited, has been registered with a capital of £200,000 in £1 shares, the object being to acquire as a going concern the undertaking of the Electro-Chemical Company (incorporated in 1894), and to develop and extend the same, etc.—The Electra House, Limited, has been registered with 20 members, each liable for £10, the object being to acquire, turn to account, and deal with lands, buildings, and property in the City of London or elsewhere. The number of directors is to be three. The first are J. D. Pender (nominated by the Eastern Telegraph Company, Limited), C. S. Colvin (nominated by the Eastern Extension, Australasia, and China Telegraph Company, Limited), and D. H. Goodsall (nominated by the Brazilian Submarine Telegraph Company, Limited).—The Electrical Regulating and Lighting Syndicate, Limited, has been registered with a capital of £75,000 in £1 shares, the object being to acquire certain patents, to carry on in all or any of their respective branches the businesses of electricians and electrical engineers, and, with a view to the above objects, to adopt and carry into effect an agreement expressed to be made with Messrs. W. Emmott, F. Whiteley, T. R. Bottomley, and J. Longthorpe.

Yarrow.—A report of the committee of the whole Council, which was adopted last week, stated that, in addition to supplying lighting and motive power, each of the applying companies was willing to develop a tramway system, and whilst the terms offered by all were reasonable, the committee considered that the proposals made by the County of Durham Distribution Company were the most favourable, and they recommended the Council to consent to their application for a provisional order, subject to the terms agreed upon, with reference to prices, revision of prices, purchase power, the active promotion of a tramway system, etc. The prices offered were: (1) to private consumers, 7d. per unit for the first 100 hours per quarter on the maximum power demanded, and 1d. per unit for subsequent hours; (2) for motive power, at an average of less than 2d. per unit; (3) for public lighting, (*a*) incandescent lamps of 25 c.p. at £3 per annum, (*b*) arc lamps at £20 per annum. They recommended that the Tyneside Company's Bill be opposed unless a clause was inserted agreeing not to come into the borough without the sanction of the Town Council, and also that a petition against it be sealed, in order to comply with parliamentary Standing Orders. The Walker and Wallsend Company have undertaken to insert the required clause in their Bill.

Bristol.—At an adjourned meeting of the Bristol Town Council held on Tuesday last, a report of the Electrical Committee was upset. At the opening of the meeting Mr. Baker objected to the electrical engineer, Mr. Faraday Proctor, being in the Council-room while a meeting was in progress. The Lord Mayor sustained the objection, and Mr. Proctor withdrew. The report of the committee was to the effect that an architectural and engineering draughtsman should be engaged to assist in the city electrical engineer's department, and asking the Council to confirm the appointment of Mr. K. O. Hale at a salary of £200 per annum, rising annually by £30 to £260 per annum. Alderman Inskip moved the addition of the words, "but not so as to dispense with the employment of a competent architect for the works in course of construction by the committee." We gather from the discussion that it was proposed to leave the constructional details of all except the foundations in the hands of the city electrical engineer, assisted by the draughtsman above referred to. The amendment practically ensures the employment of the architect who previously had in hand the whole of the buildings, in spite of Alderman Pearson's statement that a good portion of the new works will be built solely of iron, and hence are engineering matters. The amendment was carried by 41 votes to 16. Alderman Pearson then asked the Lord Mayor to accept his resignation as chairman of the committee, but the Lord Mayor said that he could not do so.

Guildford.—We learn from the *Surrey Advertiser and County Times* that "up to Thursday last it had been found impossible to form an estimate of the damage sustained at the works by the floods. The water, of course, caused considerable interference with the working of the machinery on Friday. In one building are situated three 40-h.p. machines for generating the electrical energy. Two of these were running in the morning, but as the water continued to rise their working was stopped, and the water was so deep that the coils were just under water. In the building adjoining are two 100-h.p. machines, which stand considerably higher than the machines referred to, and on the first-mentioned being stopped one of the latter was set to work. The water, however, about half-past three in the afternoon, reached such a height that sufficient draught could not be obtained to keep steam up, and accordingly this had to be shut down. As a result, there was no electric light in the town between Friday afternoon and Saturday morning, when some of the machinery was started again. Some of the machines were still not able to run on Thursday morning, and it must therefore be a matter of time before the damage can really be ascertained. In reference to the explosion which took place on Saturday afternoon at the corner of Friary-street, we understand that this occurred in the connecting boxes at the Friary-street corner of High-street through the water breaking down the insulation of the cables. The cover was turned over, and the damage, which was but slight, has now been repaired."

Bedford.—The balance-sheet in connection with the electric light works for the year 1899, adopted at the Council last week, showed very satisfactory results. The Chairman stated that the profit made at the works during the year was £3,516. 14s. 4d., and this had been devoted to paying the interest and instalments of principal, with the result that the ratepayers had had to find only £228 during the year as part payment of instalments of principal. The committee would have liked to show that they had done without a penny from the rates, and that when they had repaid their instalments of loan and interest they had a balance in hand, but that was impossible, because they would remember the year before last they passed a resolution to reduce the price of the current 1½d. per unit, and had the price remained as it was they

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would now have had an extra £1 600 to add to their revenue. But they had reduced the cost of their output, and he thought they had worked with great economy. Then there was the fact that the price of coal had gone up 25 per cent., but the committee had made their coal contracts last summer, and had they not done so they would have come to a standstill. During the dark days of last year they consumed about 100 tons of coal per week, so it would have been a serious matter had they not been able to get it. At the present time at the central station they had engines of 1,500 n.h.p., and had entered into a contract for another engine of 500 b.p. In 1898 the output was 360,000 units, but last year it rose to 550,000 units, and they now had 600 consumers, which was an increase of 174 on the year. The total number of 8-c.p. lamps now in use was 27,000; there were 530 public lamps; cables were laid in 13 miles of streets for private consumers; there were 200 miles of cables in all, and they had 14 sub-stations.

London County Council.—At Tuesday's meeting the following report of the Highways Committee was adopted: "The Council on July 13, 1897, and Feb. 15, 1898, approved estimates, amounting in all to £25,300, for the installation of the electric light on the Victoria-embankment and Westminster Bridge, including the erection of the generating station, the provision of machinery, and the laying of the necessary mains. Tenders have since been accepted by the Council for the erection of the generating station and the supply of the necessary boilers and dynamos, and this part of the work is now in progress; and we propose shortly to invite, by public advertisement, tenders for the supply of, and the work of laying, the electric lighting mains. As, however, the embankment footway near Blackfriars Bridge and at some other places is being opened in connection with the works of the Charing Cross and Strand Electricity Supply Corporation, we think that it is advisable that the mains required for the Council's electric lighting installation at these places should be laid at the same time. For this purpose the expenditure of a sum of about £250 will be necessary, including the cost of the cables and the carrying out of the works. We recommend that the Council do sanction the expenditure on capital account by the Highways Committee of the sum of £250 in respect of a portion of the mains in connection with the electric lighting installation for the Victoria-embankment and Westminster Bridge, estimates in respect of which were submitted to and approved by the Council on July 13, 1897, and Feb. 15, 1898." The following notices of intention to lay mains were agreed to: the Metropolitan Electric Supply Company, low-tension mains across and along Southampton-row, and along Bloomsbury-place and square, and mains of extra high tension along portions of Tower-street and Little Earl-street, and along Shaftesbury-avenue subway from Cambridge-circus to High-street, St. Giles; the County of London and Brush Provincial Electric Lighting Company, low-tension mains along the east, west, and north sides of Queen's-square, etc.; the Kensington and Knightsbridge Electric Lighting Company, extra high-tension mains, in Doulton casing, surrounded by concrete, along Hunt-street, St. Ann's-road, St. James's-square, St. John's-place, Portland-place, Ladbroke-road, Lansdowne-road, Uxbridge-road, Holland-walk) Duchess of Bedford's-walk, and Hornton-street; and the Vestry of St. Pancras, mains along Britannia-street.

Rugby.—The following amended circular has been issued to the householders concerned by the Urban Council: "The Council finds that some misunderstanding has arisen as regards their former circular in reference to the cost of wiring, etc., in houses to which light might be supplied, and desire to clear up any misapprehension on the subject. The statement there made of an estimated cost of 50s. per light for wiring—say, for from 10 to 20 lights from the street main to the lights—was intended to embrace all accessories, including a meter and a certain amount of redecoration and ornamental work. For the simpler forms of lighting, as for shops, offices, etc., the cost would be considerably less, and they have communicated with certain firms undertaking such work with a view to get more precise information. Leaving out the meter, which might be hired or paid for in some other way, or possibly omitted under certain circumstances, and omitting all artistic fittings, a surface wiring with wooden casing or with wires cased in lead for shops and offices, where cord pendants only are required, can be done in a reliable manner for, perhaps, 15s., but the Council are told that 20s. is a very common price. When a number of lights are placed near together, say 20 to 30, in a shop, the total cost of wiring would be then only slightly increased, so that the cost per lamp would go down to, say, 12s. or less. In fact, the cost obviously varies considerably, according to whether the lamps are in close proximity to each other, or widely distributed over a building, and the cost of putting in four or five lights only, as some have suggested, could not be done at a cost per lamp so low as when a larger number are put in; and if some £8 or more have to be added for a meter, the small number of lights makes each become costly. The cost for reception-room fittings will vary largely, according to the taste of the owner, and the difficulty of leading the wires unseen; one case, that of a large private house, was mentioned to us where the wiring cost 20s. and the fittings 40s., making a total of 60s. per light. We may therefore advise possible consumers to take 20s. for shops as a basis of calculation; and for dwelling-houses, that an estimate from some firm, after selecting the fittings, should be obtained. There are methods of paying for the wiring by means of an increase of, say, 1d. per unit of electricity used, with a minimum payment per quarter. In such cases the Council, or a company, would find the capital for, and do, the wiring, but on the consumer ceasing to take the current, or leaving, he becomes liable to pay up the balance of capital due.—By order, T. M. WRATISLAW, clerk."

PROVISIONAL PATENTS, 1900.

FEB. 19.

3237. **Improvements in electricity meters.** Chamberlain and Hookham, Limited, and Sydney Holmwood Holden, 18, Southampton-buildings, Chancery-lane, London.

3254. **Improvements in and connected with underground conduit and surface contact electric railways.** Alfred Mills Taylor, 62, Heathwood-gardens, Old Charlton, Kent.

3258. **Improvements in electric switches.** Arthur Freemore Spooner, 323, High Holborn, London. (Benjamin Léon Neveur, France.)

3264. **Improvements in and relating to the armatures of electric meters, also applicable as a meter for electric currents.** Charles Perdrisat, 45, Southampton-buildings, Chancery-lane, London.

3272. **Improvements in and relating to electrical ignition devices for gas and like internal-combustion engines.** Edward Wells, 70, Chancery-lane, London.

FEB. 20.

3303. **Improvements in cord-grips for lampholders and other electrical purposes.** Harry Basleigh Bond, 24, Temple-row, Birmingham.

3315. **Improvements in and relating to electric heating apparatus.** Alfred George Brookes, 55, Chancery-lane, London. (Boston Electric Heating and Power Company, United States.) (Complete specification.)

3343. **Improvements in telegraphic transmitting, receiving, and translating arrangements.** Alexander Muirhead, 323, High Holborn, London.

3352. **Improvements in or relating to incandescence bodies for electric glow lamps.** Alexander Just, 46, Lincoln's-inn-fields, London.

3361. **Improvements in the manufacture of secondary batteries.** John Garfield Hathaway, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3371. **Improvements in and relating to electric heaters and switches therefor.** Edwin Forsythe Porter, 77, Chancery-lane, London. (Complete specification.)

FEB. 21.

3441. **An improved system of telephonic communication and signalling.** Max Byng and Francis George Bell, 73, St. Stephen's-road, Upton Park, London. (Complete specification.)

3461. **Improvements in electromagnetic brakes.** The Westinghouse Brake Company, Limited, 322, High Holborn, London. (Frank C. Newell and Edwin M. Herr, United States.)

FEB. 22.

3468. **Improvements in electrical generating machinery.** Thomas Kay, Moorfield, Stockport.

3469. **Improvements in cutting the slots or teeth in the armature cores of dynamo-electric machines and the like.** Harry Noble and Pearson Lund, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

3481. **Improvements in and relating to resistances for electric circuits.** Leonard Newitt, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

3501. **Improvements in electric alarums.** Walter Charles Hill, 48, Heathwood-gardens, Little Heath, Old Charlton, Kent.

3520. **Improvements in means for regulating pressure in electric mains.** Henry William Butler, 47, Lincoln's-inn fields, London.

3524. **Improvements in features for the anodes in electrolytic apparatus.** William Phillips Thompson, 322, High Holborn, London. (Hermann Becker, France.)

3532. **Improvements in electric rollers for therapeutical and massage purposes.** John Wilson Gibbs, 40, Chancery-lane, London. (Complete specification.)

3534. **Improvements in electric supply meters.** Evershed and Vignoles, Limited, and Sydney Evershed, 1, Queen Victoria-street, London.

3535. **Improvements in electricity meters and electric clocks.** George Hookham, 18, Southampton-buildings, Chancery-lane, London.

3545. **Improvements in and relating to the insulation of electrical conductors.** Max Frank, 46, Lincoln's-inn-fields, London. (Complete specification.)

FEB. 23.

3561. **Improvements in electric ignition for internal-combustion motors.** William John Crossley and James Atkinson, Openshaw, Manchester.

3569. **Maximum demand indicators for electrical circuits.** James Foster Moore, Edward White, and John Mowbray Donkin, 13, Dundas-street, Sunderland.

3570. **Improvements in electricity meters.** Frank Edward Beeton, 3, Glen-villas, Folkestone-road, Dover.

3576. **Electric roundabouts.** William Henry Pike, 1, Trinity-street, College-green, Bristol.

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3588. An improved device for finding the electric poles. Frederic de Mare, 18, Fulham-place, Paddington, London.

3600. Improvements in switches for overhead electric wires. Arthur Ellis and William Thomas Smith, 6, Bank-street, Manchester.

3607. Wire frame for electric lamp shades. Joseph Henry Cresswell, 375, Camden-road, Holloway, London.

FEB. 24.

3643. Improvements in electrically-driven fans or air propellers. William Tattersall, 2, Market-street, Bradford.

3665. Improvements in or relating to the "trolley-head" employed in connection with electrically-propelled cars or vehicles to ensure of the correct working position being effected when operated by the attendant to stop and start the said cars or vehicles and apparatus therefor. James Fielding and Edwin Warburton, 8, Quality-court, Chancery-lane, London.

3833. Improvements in electricity meters. Henry Reason and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published March 17.

1899.

3786. Electric incandescent lamps. Lorrain. (Macdonald.)

4078. Machine tool particularly applicable for refacing or turning commutators of electric generators and the like. Honeywood.

4121. Miners' safety lamps and means for electrically igniting the same. Best.

5356. Electric arc lamps. Bennett.

5514. Electric light apparatus for taking photographic portraits. Morgan.

5874. Telephones. Siemens Bros. and Co., Limited, and Schloemer.

5934. Wave motors or devices for utilising the power of sea-waves more particularly for the generation of electricity. Gehre.

6349. Telegraph and such like posts. Siemens Bros. and Co., Limited, and Perry.

8168. Mounting incandescing electric lamp bulbs. Moul and Lind.

3358. Electric storage or secondary batteries. Niblett and Sutherland.

8497. Bulbs for electric incandescence lamps. Bartenstein.

16164. Interrupters for electric currents. Simon.

11374. Apparatus for lighting miners' safety or other enclosed lamps by electric currents. Warrington and Brown.

11682. Electric switches. Marsh and Vandam.

16290. Apparatus for closing and opening electric circuits applicable to the temporary illumination of rocks on coasts, and of staircases, and other analogous purposes. Levy.

20298. Electrical indicating and measuring instruments. Waddell.

25295. Electrical resistance measuring instruments. Fleming.

25464. Electric alarms. Wescher and Wollenhaupt.

1900.

1019. Electrically or magnetically operated locks. McCabe and Goughenour.

1026. Electric heater for heating water or other fluids. Lawton.

1147. Electric meters for rotary dental tools and the like. Jensen. (Browning Manufacturing Company.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Feb. 24	4,074	3,824	+ 250	31,096	30,030
Blackpool-Fleetwood	,, 24	143	207	- 64	1,112	1,267
Bradford City Trams	,, 25	372	282	+ 90	26,633*c*	—
Bristol Tramways Co.	,, 25	2,648	2,589	+ 59	—	—
City & South London	,, 25	1,115	1,102	+ 13	9,014	8,960
Dover Tramways	,, 24	141	142	- 1	1,170	1,143
Dublin U.T., elec. cars	,, 23	2,880	760	+1,120	—	—
Dublin S.D. Electric	,, 23	613	655	- 42	—	—
Halifax Corporation	,, 25	560	302	+ 258	27,487*a*	9,428*b*
Hull Corporat'n E.S.	Jan. 13	682	—	—	—	17,711*c*
Liverpool Corporat'n	Feb. 17*d*	6,208	5,939	+ 269	45,216	40,394
Liverpool Overhead	,, 25	1,360	1,280	- 80	11,500	10,333
Sheffield Corporation	,, 25	1,905	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1, 1899. *b* Since June 29, 1898.
c Total receipts. *d* Partly electrical. *e* Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	..	12-13
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6-6½
—— 5 per cent. Mortgage Debentures	100	—	98-100
British Electric Works, Ordinary, 50,001-95,000	1	—	15/16-1 1/16
—— 6 per cent. Cum. Pref., 1-50,000	1	..	¾-1
—— 4½ per cent. First Mortgage Debentures	100	—	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	4½-5½
Brush Electrical Engineering, Ordinary	2	—	1½-2½
—— Non. Cum., 6 per cent. Pref.	2	..	2½-2¾
—— 4½ per cent. Debenture Stock	100	..	108-112 xd
—— 4½ per cent. 2nd Debenture Stock	100	..	102-105
Callender's Cable, Debentures.	100	—	111-115
—— Ordinary	5	..	14-15
—— 5 per cent. Pref.	5	..	5½-6
Crompton and Co.	2	—	3½-4
—— 5 per cent. Debentures	—	..	98-101
Edison and Swan United, Ordinary	2	..	2-2½ xd
—— 5 per cent. Debentures	5	..	2½-4½ xd
—— 4 per cent. Deb. Stock, Red.	100	..	93-95
Electric Construction	2	..	2½-2¾
—— 7 per cent. Cumulative Pref.	2	..	2¾-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	104-107
Giffre Electro-Chemical and Power, Ordinary	1	—	¾-1½
W. T. Henley's Telegraph Works, Ordinary	5	—	14-15
—— 4½ per cent. Preference	5	—	5½-6
—— 4½ per cent. Debentures	100	..	110-114 xd
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	..	100-104
Telegraph Construction and Maintenance	12	..	37-41
—— 5 per cent. Bonds	100	—	102 105
Telegraph Manufacturing, Ordinary	5	—	9-10
—— 5 per cent. Cum. Pref.	5	..	5½-6
Willans and Robinson, Ordinary, 1-80,000	5	..	9½-10½
—— 6 per cent. Cum. Pref., 80,001-60,000	5	—	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-⅞
Bournemouth and Poole, Ordinary	10	..	12-13
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8½-9½
Charing Cross and Strand	5	..	10-11
—— 30,001-50,000	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5½-6 xd
Chelsea Electricity Supply	5	—	7½-8½
—— 4½ per cent. Debentures	100	—	110-112
City of London, Ordinary	10	..	10½-11½
—— 6 per cent. Cumulative Pref.	10	—	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9½-10½
—— 6 per cent. Cum. Pref.	10	..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Ed.	—	—	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	8	—	8-8½
London Electric, Ordinary	2	—	1½-2½
—— 6 per cent. Pref.	5	..	4½-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	101-103
Metropolitan, Ordinary	10	..	14-15
—— 62,501-85,000	10	—	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	—	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	—	95-97
Notting Hill Electric Lighting	10	—	16-17
Oriental, 1879	1	—	1½-1¾
—— £5 Shares	5	—	7-7½
—— £4½ Shares, New	4½	—	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	..	6¾-7½
River Plate Electric Light and Traction, Deb.	100	—	75-85
Royal Electrical Company of Montreal	1£	..	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100	—	104-106
South London, Ordinary	2	—	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	15-16
—— 40,081-52,080	5	..	15-16
—— 7 per cent. Pref.	5	—	8½-9½
Westminster, Ordinary	5	—	13½-14½ xd
Electric Railways.—			
Central London, Ordinary	10	..	9½-10
—— Pref. Half-Shares	5	..	4½-5
—— ,, ,, deferred	5	—	4½-5
City and South London, Consolidated Ordinary	100	..	58-61
—— ,,	5½	—	4-5
—— 4 per cent. Debenture Stock	100	—	125-130
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, '96	100	—	132-137
Liverpool Overhead, 5 per cent. Pref.	—	—	12½-13
Waterloo and City, Ordinary	100	—	101-104
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	17-18 xd
Brisbane Tramway	100	—	104-106
British Electric Traction, Ordinary, 1-80,000	10	..	16½-17½
—— 60,001-75,000	10	—	16-17
—— 6 per cent. Cm. Pf. 80,001-60,000	10	—	13½-13¾
—— 5 per cent. Perpetual Debenture Stock	100	..	125-128
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	—	105-108
Costa Rica Electric Light and Traction, 5 per cent. First Deb., 1-1,000 of £100 and 1,001-1,600 of £50 each	—	..	75-85
Isle of Man Electric Power, 1-95,000	1	..	15/16-1 1/16
—— 6 per cent. Preference, 100,001-170,000	1	..	15/16-1 1/16
Kidderminster and District Lighting and Traction, Pref.	8	..	8-8½
New General Traction, Ordinary	5	—	3½-4
—— 6 per cent. Cum. Pref.	5	..	4½-5½
North Staffordshire Trams	6	..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	18-19
—— Preference	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	½-¾
National Telephone, Ordinary	5	—	5½-5⅝ xd
—— 6 per cent. Cum. First Pref.	10	—	14-15 xd
—— 6 per cent. Cum. Second Pref.	10	..	14-15 xd
—— 5 per cent. Non. Cum. Third Pref.	5	..	5½-5¾ xd
—— 3½ per cent. Deb. Stock, Red.	100	..	97-100
Oriental Telephone and Electric Company	1	—	¾-1

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NOTES.

Aluminium Solder.—A new solder for aluminium has recently been patented which claims to have several advantages over its predecessors. The exact composition of the solder is not before us, but it is a composition of tin, zinc, and bismuth. The largest constituent is tin. Naturally, the solder can be used for other metals as well, but it is said to adhere exceedingly well to aluminium.

Bombay Lighting.—We are informed by the *Indian Engineering* that the report of the committee of the Bombay Corporation on the proposals for the supply of electric light and power in the city has been approved and adopted. It is stated in the report that none of the applicants had brought forward any very definite proposals as to how they would utilise and work the concession they required, and it was necessary that more definite proposals should be before the committee to enable them to deal with the matter properly.

Fire Tests.—We are informed that the fire tests conducted by the British Fire Prevention Committee will include further tests with floors constructed under the minimum requirements of the London Building Act. There is to be also a number of reports on the various forms of patented or specially made partitions, various firms having applied for tests of their partitions to be made. The testing operations have been somewhat retarded owing to the inclement weather, but will be resumed in the middle of March, the tests being held fortnightly.

Association of Yorkshire Engineer Students.—The annual dinner of the Association of Yorkshire Students in connection with the Institution of Civil Engineers was held on Thursday week at Leeds, about 40 members being present. The chair was occupied by Mr. T. P. Reay, M.I.C.E., president of the association, and among the guests were Sir James Kitson, Bart., M.P., and Mr. T. De Courcy Meade (president of the Manchester Association). The meeting was a very patriotic one, owing to the news of the relief of Ladysmith having just reached Leeds.

Institution of Junior Engineers.—A large number of members of this institution last Saturday visited Messrs. Maudslay, Sons, and Field's Belleville Boiler Works at East Greenwich. There they saw the machinery for the preparation of the different parts forming the elements. The method of erection was explained, and the special features of construction pointed out. The Cowper-Coles apparatus for galvanising the tubes, etc., was also seen, and the system of working it described. At the conclusion of the inspection the vice-chairman, Mr. E. A. Berry, expressed the acknowledgments of the institution for the interesting visit which had been made.

Slow-Speed Steam-Turbine.—The Pelton Engineering Company, of Cleveland, are said to be making an experiment with a slow-speed steam-turbine, running at from 800 to 1,000 revolutions per minute. Experiments which have been made are said by the *Electrical World* to point to a very low consumption of steam per horse-power hour. The company is about to use one of these turbines for driving its own works, so as to obtain practical experience over an extended time. A statement is made that the steam consumption is only two-thirds of that required by an ordinary steam-engine, but one, naturally, is inclined to doubt this in view of the slow speed at which the turbines run.

The Recent Storms.—An attempt has been made in certain quarters to induce the National Telephone Company to allow rebate on the rentals they charge for telephone connections with respect to those periods in which the instruments or wires are out of order. The company objects to this proposal, which, we understand, was made in consequence of the serious interruptions following on the recent storms, and we believe that provisions to the effect that the charges should be due, even if no service is given, are inserted in the agreement. Such clauses, however, should not be strained too far, but where the interruption is due to snowstorms and blizzards objections can hardly be raised to them.

The 1,000-Miles Motorcar Trial.—The trials which are being arranged by the Automobile Club for the end of April and the beginning of May include, as we have mentioned before, a run of 1,000 miles in Great Britain. The details of the route are now being gradually fixed up, and we understand that the following places will be visited: Bristol, Birmingham, Manchester, Edinburgh, Newcastle, Leeds, and Sheffield. The itinerary of the route in the Northern Counties and the Border district lies through Manchester, Kendal, Carlisle, Keswick, Lockerbie, Peebles, Edinburgh, Dunbar, Berwick, Newcastle, Durham, Northallerton, and York. At almost every place visited there is, we understand, to be an exhibition of the cars.

Tramway Accidents.—The general manager of the Birmingham Railway and Electric Company, of the United States, describes in the *Street Railway Review* the system he has adopted of rewarding the conductors and drivers of electrical cars for good service. Thus the conductors, who have to clean their cars, receive a reward of 1¾dol. per month provided they are not reported more than three times during the month for having a dirty car. The drivers, on the other hand, receive 3½dol. per month in addition to their regular wages if they are not reported for any accident during that month. Sample pages of a record book are given, and are somewhat amusing to read. Thus the first entry starts: "John Doe, motorman—September, 3·33dol.; October, killed cow at Red Bank, 0·00dol.; November, pulled down wire at Big Cut, hit Jones's dray at Fifth Avenue, 0·00dol." In December, however, the unlucky John Doe was again credited with 3·33dol.

Physical Society.—At the meeting of this society held last Friday, after papers had been read on "The Relative Rates of Effusion of Gases," by Dr. F. G. Donnan, and "The Distillation of Liquid Air," by Mr. E. C. C. Bayly, a paper on "The Reversibility of Galvanic Cells," by Mr. T. S. Moore, was read by Dr. Lehfeldt. In these experiments the reversibility of cells such as the Daniell and the Clark, which are assumed to be reversible, was tested by allowing the cell to send a current, and by sending a current through the cell the E.M.F.'s of the cells were determined by means of a Crompton potentiometer, and from the E.M.F.'s on open and closed circuits the internal resistances of the cells were calculated. Prof. S. P. Thompson asked if experiments had been made upon Leclanché cells where the products of the action escape. Dr. Lehfeldt said that experiments were not made upon these cells because they were known not to be reversible. A paper on "The Damping of Galvanometer Needles," by Mr. M. Solomon, was postponed until the next meeting of the Society.

Electricity in New York.—The *Electrical Review* which is published in the above city gives in its recent issue a prophesy as to what is to be expected in the way of electric supply in New York 10 years hence. At that date the elevated railway, the new underground rapid transit system, and the surface street railways will, our contemporary thinks, be united under one effective management, and operated throughout by electricity. At the

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same time the electric lighting companies are to be controlled by one central authority, so that vast central stations will be constructed and equipped with polyphase machinery, from which either lighting or traction loads can be supplied. In this way with a few large generating stations situated at the waterside and interconnected by trunk feeders, the faults in one generating station will not entail the breakdown of either the electric lighting, tramways, or railways. Our contemporary finally estimates that over 1,000,000 h.p. will then be required in these central stations, and that electricity will be produced at such low rates that its use will be almost universal.

Water Power and Russian Waterfalls.—We gather from the Continental Press that a commission of the Learned Committee for Mountains has concluded its work in connection with the question of utilising the waste water power of the Kiwatsch, Girbas, and Port Porog falls in Russia. Two engineers have been commissioned to survey the respective falls and submit detailed reports thereon. Pending the completion of these reports the commission has decided to permit private parties, subject to certain restrictions, to participate in the exploitation of these falls. The conditions above referred to are that the number of the lessees shall comprise not less than three and not more than five persons; that only large undertakers shall participate in the competition, and that these must be in a position to arrange for the necessary installation of plant for utilising the full power of the falls; the undertakers shall be bound to distribute the surplus energy generated to all the factories within a certain radius of the falls; and, lastly, the utilisation of the power of the Kiwatsch fall must be so far restricted as to avoid detracting from the natural beauty of the fall.

The Pacific Cable.—With regard to the projects of the Eastern Extension Company in Australia, we note that in the House of Commons on Monday Mr. Hogan asked the Secretary for the Colonies whether he had received protests from the Canadian and New Zealand Governments against the concessions recently granted to this company in Australia as being likely to militate seriously against the financial success of the Pacific cable, in which the Imperial, the Canadian, and the Australasian Governments were joint partners, and whether, in view of those protests, it would still be possible to revoke the concessions and prevent any further complications of a like character; and whether he had received a reply to his message to the Australian Governments on the subject. In reply to Mr. Hogan, Mr. Chamberlain stated that he had received protests of the nature described from Canada and New Zealand. He was informed by the Government of New South Wales that the arrangements with the Eastern Extension Company were not yet concluded, though it was aware that the decision of the recent conference of Prime Ministers was generally favourable to the proposals of the company.

Boiler Inspection.—An instance of the jealousies which exist between rival trades unions is seen in the opposition brought by the Amalgamated Society of Engineers to a Bill called the Boiler Registration and Inspection Bill. An amendment was to be proposed on Wednesday last to this Bill to the effect that boilermakers should be exclusively employed as inspectors. The Amalgamated Society of Engineers point out that while they do not wish to set up any claim for the exclusive employment for the class of workmen they represent, they consider that as a matter of fact the boiler inspectors at present employed by the Board of Trade under existing Acts, as well as those employed by Lloyd's Register or the boiler insurance companies, are chiefly men who have had workshop experience. At the time of writing we do not know whether the amendment will be allowed to stand, but we do agree with the Amalgamated Society of Engineers protest against the undue restrictions as to the class of men who should be employed as boiler inspectors. It would be obviously absurd to employ anyone who has not had extensive experience with steam-boilers, but other experience in addition would be most valuable.

Government Telephone Rates.—The action in the United States with respect to the telephone rates in Columbia has ended in a verdict in favour of the telephone company. It will be remembered that in January, 1898, an Act of Congress was passed fixing the maximum rate for telephone connections in the district of Columbia at £10 per annum. The telephone company refused to agree to this arbitrary Act, and the Supreme Court of the district now states that they are quite right in so doing. The judge rules that the Act in question was unconstitutional, as it infringed the simple principle that the price of any commodity could not be justly fixed by the Government. In this, as in other matters, competition must be looked to to solve the question of what were the lowest paying rates for telephones. It is interesting to note in this connection that a number of independent telephone companies in the United States have gone into liquidation because they started business on rates which did not allow of any margin for depreciation and contingencies. Our municipal authorities will have to guard against a similar mistake when the Post Office at length issues licenses to enable them to establish telephone exchanges.

Indiarubber from Sierra Leone. — The United States Consul in the above district of West Africa reports favourably on the indiarubber industry. He states, however, that the native collectors, in their endeavour to increase the amount of rubber they collect, are now frequently bleeding the roots of the tree as well as the body. This is said to be fatal to the trees, and at the same time the rubber collected from this source is of inferior quality. The Consul suggests that this inferior root rubber should be refused altogether by the buyers in the local market, and by the foreign markets, in order to prevent the destruction of the forests. Unfortunately, the demand for raw rubber prevents this being done, as it otherwise would be. The report also contains some interesting information as to the impurities often found in rubber from the Sierra Leone district, and discriminates between those which are introduced inadvertently and those which find their way into the rubber from the desire of the collector to increase his income without correspondingly increasing the labour of collecting. The report states that the Governor and officials are fostering a plan for planting rubber trees and vines in the colony.

Glasgow Telephones.—The Glasgow Corporation last week considered a report by Mr. A. R. Bennett, the telephone engineer, on telephones for Glasgow. He states that a complete exchange for 5,250 metallic circuit lines—viz., 5,000 subscribers within the city and suburbs, 200 in outlying places in the telephone area, together with 50 public telephone offices—should be undertaken. At the same time provision should be made as regards floor space in the switch-rooms, plans of the switchboards, size of distributing poles, and number of conduits in the vicinity of the switch-rooms, for another 5,250 lines, making a total of 10,500 lines for which the groundwork would be laid. As regards available floor space and its possible future extension, a probable further expansion to 20,000 lines should be borne in mind. He estimated the total expenditure at £121,000. The special committee recommended that the Corporation should remit to them to secure

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premises for switch-rooms, to proceed with the organisation of a telephone department and the establishment of a municipal telephone system on the lines indicated in the report; and also to apply for the consent of the Secretary for Scotland to the Corporation borrowing £120,000 for telephone purposes in terms of the Telegraphs Act, 1899.

Water Power from the Rhine.—It is stated in the technical Press of Germany that the proposed new water-power scheme for utilising the fall of the Rhine at Laufenburg is approaching realisation. Several firms have united for the purpose of carrying out the scheme, including the following: the Druckluft und Electricitäts-Gesellschaft, of Berne; Messrs. Felten and Guilleaume, of Mühlheim; and Messrs. S. Z. de Ferranti, of London. We are given to understand that the desired concessions have already been arranged. It is intended to put down a large turbine plant at Laufenburg in conjunction with an installation of electric generators, and from the latter power would be distributed to the neighbouring factories, etc. To this end the company has two schemes under consideration, the first being the construction of a dam, and the alternative scheme includes the making of a tunnel. Of these two schemes it is probable that the first mentioned will obtain the preference unless insurmountable difficulties should arise. The plans provide for the construction of a dam across the Rhine which would, at the same time, include the turbine chambers and power-house. There would be 18 turbine chambers with a corresponding number of turbines and dynamos. It is estimated that with this scheme 30,000 h.p. would be obtainable at low water.

Water Power in Switzerland.—It is only natural, having regard to the prevailing healthy state of the electrical industry, that water rights and concessions should at the present time be in great demand. This state of things applies especially to Switzerland, where agents of both native and foreign firms are traversing the country in all directions with a view to acquiring water rights. But although the waste power to be had is still very considerable, it is stated that the difficulties of obtaining concessions are becoming much greater. It appears that the local authorities are endeavouring to reserve to themselves the rights over the water power still available in that country, and seem to be determined not to concede these rights to the first applicant, as has hitherto been generally done. The Canton Granbünder, we are informed, possesses an immense wealth of waste water power, and in the near future may be expected to legislate in the matter. The Government has already submitted a draft concession-agreement to the local authorities under its jurisdiction, and this is to serve as a pattern for others. This concession provides for rights extending over 50 years. The rental of the water power is to be at the rate of from 3s. to 5s. per horse-power year, the rent being based upon the power conceded, and not upon the amount actually utilised.

London Telephones.—A paragraph has been going the round of the daily Press to the effect that the Post Office system of telephones is expected to be practically completed in the City area, and in Westminster, Chelsea, Belgravia, South Kensington, and Kensington to Notting Hill; West Kensington, Brompton, Fulham, Wimbledon, Putney, Barnes, and Mortlake, Kew, Richmond, Twickenham, Kingston, Norbiton, and Surbiton; Hammersmith, Turnham Green, and Chiswick before the end of the year. It will be remembered that in the last session of Parliament £2,000,000 was voted for this work, and the paragraph states that large contracts have already been entered into for the plant and underground wires. While we should be only too pleased if the prediction should be correct, we are afraid that in view of the enormous amount of street work which would have to be carried out, and also the various details in connection with the construction of the exchanges themselves, there is not much likelihood of the prophecy being realised. In the meanwhile, no information whatever has been obtainable as to the scale of charges fixed to compete with the National Telephone Company. We believe that the National Telephone Company is eagerly awaiting the publication of the scale of charges so as to rearrange their prices. If only the company will undertake a keen competition, it is quite possible that the telephone system in London may still remain largely in their hands.

A Long Telephone Span.—We notice in the *Electrical Review* of New York some interesting illustrations of some steel erections used by the American Telephone and Telegraph Company for supporting their wires when crossing the Connecticut River about five miles north of Middletown. We gather, by the way, that overhead wires were chosen on account of the retarding effects which take place in submarine cables. In this case a span of 1,300ft. had to be arranged for, and it became necessary to erect a steel structure 182ft. high on the one side of the river. There was a high bank on the other side, which reduced the erection there required to 82ft. The steel structure, which is 182ft. high, consists of four steel stanchions tapering up to a rectangle at the top. These are braced together at 18 points in the height and cross braced at every section. At the present time 20 wires have been thrown across the river, but provision is made for double that number. On account of the long span and the natural swinging of the wires in windy weather, great care has to be taken that they are sufficiently strained. Special precautions are taken to ensure their not swinging much, so that there may be no crossing. The wires are 0·165in. in diameter, and the copper alloy of which they are composed has a tensile strength of 82,000lb. per square inch. These structures are built to scale to a bridge-builder's specification, and have been most carefully designed to resist wind pressure.

Railway Accommodation.—With the continued complaints of overcrowding at certain times of the day on suburban lines, one naturally looks on electric traction as a means of overcoming these complaints. This could be done by allowing a higher average speed to be maintained over the lines, and also by increasing the length of train which it would be possible to run at certain times during the day. We regret to hear, however, that one of the latest lines to be opened which uses electric traction—*i.e.*, the Waterloo and City Railway—is now added to the list of the lines on which overcrowding occurs. This is, perhaps, only to be expected, seeing that the rush between Waterloo and the City takes place during limited hours in the morning, and the City men on their way home also expect to be carried within a limited time, and without overcrowding. In answer to a question in the House of Commons, Mr. Ritchie stated that the Board of Trade was not allowed to interfere in such a matter in the management of a railway as the accommodation provided on the line. He stated, however, that the number of trains run is as great as can be run with safety, and that the company have accordingly been obliged to make regulations limiting the number of passengers going on to a platform at any one time. This certainly tends to prevent serious accidents occurring through crowding on the trains when they first come into the stations, but it leaves the more serious complaint that the line is not capable of meeting the traffic demands during certain hours.

Canvassing.—The experience gained by the Grays Council with respect to a premature canvass for electric lighting consumers is only what one would expect. When

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the Council approached the Local Government Board for a loan they asked for information concerning the probable number of consumers of electric light, and Mr. Preece was requested to have a canvass made of the district. Accordingly some 445 application forms were sent out, with the result that applications for only 104 8-c.p. lamps were received. The result, however, of a personal canvass was much more gratifying, as 45 residents out of 75 interviewed were in favour of having electric light introduced into the district, and Mr. Preece accordingly reported that there was every probability of an immediate load being obtained if the installation were laid down. It was made clear, however, at the Council meeting that the inhabitants naturally objected to signing an application form without knowing when the electric light would be available. For instance, an inhabitant would not care to undertake to have 20 or 30 lamps installed in his house without knowing whether he might have to wait two or three years for the supply. This has been proved again and again in England with respect to electric light canvasses. When the mains are actually laid in the streets, and the supply is ready, there is no difficulty whatever in getting consumers to come on, but, as in this case, a premature canvass plays directly into the hands of the gas companies. We trust that at Grays the Council will decide to put down the works on faith.

Chromium.—The following is an abstract of a paper by Mr. Wilhelm Hittorf in the *Zeitschrift fuer Physikalische Chemie.* The abstract is taken from the *Journal* of the Chemical Society. The peculiarities in the electromotive behaviour of chromium are further investigated, and the author advances many arguments in support of the view that the inactive state cannot be due to the formation of a film of oxide. Owing to the existence of the different classes of chromium compounds, the metal may exhibit any potential between the two extreme values; the highest value corresponds with the active state in which chromium gives rise to the lower compounds. This active state is assumed when the metal is placed in sulphuric, oxalic, hydrofluosilicic, or the halogen acids, at temperatures which are lower the more concentrated the acid; it is also active in fused halogen salts or in their boiling solutions. The metal becomes inactive when immersed in solutions containing free chlorine or bromine, or in strong oxidising agents. The limiting values, however, last but a short time after removal from the liquids, the metal speedily assuming an intermediate state; the most stable active state is that produced by fused halogen salts. The activity is also lowered in all cases when the metal serves as an anode for a current produced either externally or internally, and, with sufficiently strong currents, chromic acid is produced, either by decomposition of water by anion and subsequent union of the metal and oxygen, or by the intermediate formation of a compound of the anion and chromium. When the metal is used as a cathode, it rapidly assumes the active state. The author points out that Berzelius and Wöhler had previously observed differences in chromium under different conditions.

A Four-Motor Snow-Plough.—The *Street Railway Review* illustrates a heavy four-motor snow-plough which is being used by the Interstate Consolidated Street Railway Company, of North Attleborough. The value of such a plough is largely determined by its weight for adhesion and by the power of its equipment, and both these factors have been carefully observed in the plough before us. The total weight of this electrical snow-plough is 20 tons, distributed as follows: the body, four tons; the two ploughs, two tons; the trucks and motors, 14 tons. In addition to this, salt and sand will be carried, which will bring the total weight on the wheels up to 22 tons. There are eight driving wheels. The equipment consists of four G.E. 1,000 motors with four turn armatures. The shaft of each armature carries a 22-toothed pinion, which gears into a 62-toothed driving wheel, giving a speed reduction of 2·81. The trucks are designed for great strength, with a minimum number of parts. Very few parts are used, and the truck is enclosed by a steel frame, which completely envelopes the motor wheels and brake rigging, and prevents snow from falling back in between the wheels. The ploughs themselves are fastened directly on to the truck, so as to come almost on to the ground at all times. It was a matter of great difficulty to arrange these ploughs so that they could be fastened on to the truck and controlled inside the car without interfering with the truck swinging. The details of how this is done are clearly shown in our contemporary's illustration, and are worth a careful study by those interested in snow-plough work. The length of the ploughs is about 10ft., and they are about 4½ft. high. We gather that up to the present a sufficiently heavy snowstorm to properly test this plough has not occurred.

Tramway Poles.—The decision of Vice-Chancellor Hall, of the Chancery Court of the County Palatine of Lancashire, with respect to the application of a Liverpool tobacconist for an injunction ordering the Corporation to remove a pole and fuse box in front of the plaintiff's premises, opens up a wide field for dispute in connection with electric traction work. The case is reported somewhat fully elsewhere in this issue, so that our readers may see the facts for themselves. In view of the evidence of the city engineer, that the position of the poles in front of the plaintiff's premises was selected as the most suitable place to avoid obstructions from gas and water mains, it appears to us that the objections raised by the plaintiff fail. The evidence also seemed to be clear that the Corporation officials had not maliciously fixed the pole and fuse box so as to obstruct the foot-path in front of the plaintiff's premises. Still, the Vice-Chancellor held that there was no reasonable ground why the post should not have been placed elsewhere, and therefore the verdict was given for the plaintiff. We are afraid that a decision of this kind will induce frontagers along tramways using the span-wire construction to object to having iron poles in front of their premises. Each could individually prove that there was no great reason why he should be singled out to have the path in front of his house obstructed by a pole. The result would be an enormous amount of litigation, and in the end it would most likely entail a defective system of supporting the trolley wire. We hold that every care should be taken to place the poles so as to inconvenience the public as little as possible, but we think that the decision as to this position should be left in the hands of the borough engineer in cases such as have arisen in Liverpool.

A New Primary Battery.—The introduction of a new primary battery to be used for electric lighting purposes is, as a rule, accompanied by a flourish of trumpets, and we are glad to note that at last a new cell is introduced by an engineer with almost an apology for bringing the matter forward. We refer to an article in the *Revue d'Electricité* by Mr. L. Pedroni. In this article the author describes previous trials he has made with different types of primary cells. The new type is designed to have the following advantages: low internal resistance and constant potential when at work. We gather from the description, which is not any too full, that the cell is of the Daniell type, with particular arrangements to secure the sulphate of copper solution.

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The author states that with 20 elements he got 22 volts. He has taken an ampere for a long time from the cell without the E.M.F. falling appreciably. He had not instruments to make actual measurements with the cell. He quotes, however, from some experiments made at Geneva on these cells, which when connected to a resistance of 13 ohms for 888 hours still gave 1·08 volts per cell without a variation of more than $\frac{1}{100}$ volt. The author states that with the arrangement the sulphate of copper solution is entirely prevented from getting at the zinc, and that this accounts for the good results obtained with the battery. After six months' working no traces of copper were found on the zinc side. He proceeds to make calculations as to the cost of maintaining the battery, and claims that a 10-c.p. lamp would not cost more than 1d. per hour. At 3·5 watts per candle-power this is equivalent to about 2s. 5d. per unit. We quite believe that such a result is possible, and that in certain cases, if the battery is not difficult to keep in repair, it could be used commercially for small isolated systems of lighting, such as, for instance, the lighting of a few rooms in a country house.

Pneumatic Dispatch. — At the meeting of the Society of Arts last week Prof. C. A. Carus Wilson read an interesting paper on the use of pneumatic tubes for the distribution of mails. The lecture was illustrated with a number of interesting drawings showing the arrangements used both in England and in the United States for transmitting packages economically over considerable distances. Naturally, reference was made to the large tube which was constructed in 1865 by the Pneumatic Dispatch Company for connecting the General Post Office with the Euston Railway Station. This enterprise was not a commercial success, but the tube itself is still intact. In this case we understand that rails were used, and that in consequence of the size of the tube it was not possible to get a good fit, and considerable leakage of air consequently took place. The author gave some useful figures as to the air pressures required to get a given velocity, and also as to the power required for driving a train electrically through a confined space. In connection with the tube from the General Post Office to Euston, Prof. Carus Wilson calculates that with 40 per cent. clearance, 20 h.p. would be required to maintain the whole column of air in motion at 40 miles per hour. If the speed of the carrier is increased to 60 miles per hour, 60 h.p. would be required. In mechanical driving an increase in clearance involves a decrease in power required, whereas the reverse is the case when the carrier is propelled by air pressure. In reply to a question raised in the discussion, it was pointed out that if electricity were employed, the car must run on rails through a tube of considerable diameter, and that with the large-size car then involved it was not possible to bring the tubes into local stations so conveniently as with pneumatic driving and smaller tubes. The description given of the means of ejecting the carrier at any required station with the pneumatic system as used in New York was described fully.

A Unique Transformer.—A transformer of 450 kw. capacity has recently been put to work at the works of the Acheson Graphite Company, in connection with the Niagara Power Company. This transformer is used in the industry of making graphite from amorphous carbon or coke. The current is received into the works at a voltage of 2,200, and is there transformed down to 12 volts, the current with the above output being 37,500 amperes. The design of the transformer is so arranged that its voltage can be increased up to 30 if need be. The transformer was manufactured by the Westinghouse Company, and is oil insulated and water cooled. It is placed in an iron tank 6ft. high and 5ft. 4in. in diameter. The secondary circuit consists of a single turn of massive copper bars connected in parallel. The cross-section of each bar is 6in. by $\frac{7}{8}$in., and eight of these are used in parallel. The primary windings are interleaved between these bars so as to reduce the leakage effects. The power factor of the transformer is said to be 85 per cent. The method of varying the secondary pressure from 12 volts to 30 consists in altering the number of turns in use in the high-voltage windings. The heavy connections of the secondary are not changed. In this way the alteration of voltage is accompanied by a considerable change in the magnetic flux used. We are not told whether the heating of the transformer is very largely affected by this. A switchboard is provided, on which are 20 switches corresponding with the same number of steps from maximum to minimum turns in the primary winding. When changing over from one voltage to another a resistance is introduced across the turns which it is proposed to cut in or out, so that sudden changes are not made, nor is it necessary to break the current. It is stated that as the number of turns is reduced the copper loss in both primary and secondary is also reduced, but, of course, the iron loss is increased. In this way the total power loss remains almost constant throughout the range of the secondary voltage. We are indebted for the above particulars to the *Electrical Review* of New York.

The Telegraphs in the Philippines.—We notice in the *Electrical World* a very interesting report by General A. W. Greely, of the American Army Signal Corps. It is stated in the report that the men of the Signal Corps have been under fire in no less than 61 engagements in the Philippines. In the 10 months ended June 30 last year a record for military telegraphing was established, the number of messages sent being 260,000. Since then, however, the number of messages greatly increased, until in November the daily number stood at 4,000. An extension of field operations during January has, however, still further increased the number of telegraphic messages, and the average was over 5,000 per day. A great novelty in the world of telegraphy is to be found in the field outfit of the Signal Corps. Each signaller carries a box about 9in. square, in which is what is very appropriately termed a "buzzer," this instrument affording communication with the base by either telegraph or telephone. The buzzer is a vibrator, operated by a high-tension current generated from a dry battery and an induction coil also carried in the box. The wire used is carried on a portable reel, and consists of a 7-ply wire of two gauges, made with six steel wires wound round a copper wire. The buzzer is stated to be a most valuable adjunct for communication, as it operates through miles of wire under almost any conditions, whether laid in swamp or on the ground. It has worked the cables of the Signal Corps when there were very serious leaks owing to mechanical injury. An incident is described in the report with respect to the adaptability of this instrument, whereby an ordinary fence line over a mile long was used as the conducting line, buzzers at the ends giving distinct signals. At Manilla, it appears, there is an excellent office, having a 100-wire switchboard and a dynamo and storage battery system, etc. In this office all messages are taken on the typewriter. There are, it is stated, over 100 Signal Corps telegraph offices in operation on the Island of Luzon alone, and the telegraph system is replaced on all short-distance lines by telephones. In this way nearly 200 Bell telephones are operated by the corps in Manilla and the neighbourhood.

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THE WILLESDEN WORKS OF THE METROPOLITAN ELECTRIC SUPPLY COMPANY.

The Willesden works of the above-named company were opened to a distinguished gathering on Thursday week. The news of the relief of Ladysmith, coming in the morning, made the occasion a most happy one. It occurred to us, when going round the station, that the supply from the machinery at Willesden would be as great a relief to the other stations of the company as Lord Dundonald's entrance into Ladysmith was to the inhabitants. The Metropolitan Company was formed in 1887, and secured in 1889 and 1890 provisional orders for the lighting of the large areas included within the dotted lines on the map (Fig. 1). To supply these districts it was decided to use the alternate-current system, and stations were accordingly built at Manchester-square, Sardinia-street, Rathbone-place, and Amberley-road. A small station was also established at Whitehall Court. Owing to the state of the electrical industry at that date, the company had to try new types of electrical plant and central-station equipments. The usual troubles of pioneers followed, and it is a credit to the engineers that at the present day the consumers connected to the Metropolitan Company's mains demand a larger maximum output than those on any other system in the kingdom. This large number of consumers has been obtained in spite of competition in many districts, and in spite of fires, injunctions, etc. In fact, the various works in London have nearly all had to be remodelled, and have during the past two winters been supplying very much larger loads than was thought possible when they were first designed. The darkest period of the company's existence as regards its supply occurred about Christmas, and was due to the Willesden works not being able to relieve the older works as soon as was hoped. Now, however, that the erring contractors have supplied the missing links, promised before and not delivered, the plant at Willesden can take a share of the load. As a result the consumers will get a reliable supply again, and we trust that the company will also benefit from the more economical arrangement of plant for generating the commodity they supply.

The site on which the new works are erected is partly in Willesden and partly in Acton, and is about 8½ acres in extent. It is bounded on the north by the main line of the London and North-Western Railway, on the east by the Midland branch from Child's Hill to Gunnersbury, on the south by the Grand Junction Canal, and on the west by Acton-lane (Fig. 1). It is conveniently situated, therefore, for access by railway, water, and road. Thus a siding connects the company's coal stores with the London and North-Western Railway. A wharf has been erected along the canal, and arrangements have been made for storing large quantities of coal as a reserve for all the company's works. The buildings as designed will ultimately consist of east and west boiler-houses, each 384ft. long by 88ft. wide, and a central two-bay engine-house, 384ft. long by 112ft. wide. This will cover a total area of upwards of 2½ acres. There will be four chimney shafts, one only of which, having an internal diameter of 13ft. 6in. and a height of 165ft., is at present erected. The estimated capacity of the works when completed will amount to 45,000 i.h.p., or 27,000 kw., and will be capable of providing for the requirements of a connection of 1,620,000 lamps. The present buildings, which will form the south-east block of the completed works, consist of about one-third of the east boiler-house and rather more than one-third of the east bay of the engine-house. They contain plant sufficient to supply a connection of 270,000 8-c.p. lamps, or one sixth of the total estimated output. A second section of equal capacity is now in course of construction, and further sections of similar size will be added as required. The boiler-house, as now erected, measures 164ft. by 88ft. It is equipped with 16 Babcock water-tube boilers, eight on each side, with a heating surface of 3,500 square feet per boiler. The boilers are fitted with superheaters. Special attention has been paid to the coaling arrangements so as to reduce hand labour to a minimum. The coal and ash handling gear was all supplied by the Temperley Transporter Company. The coal arrives either in barges brought alongside the quay or in railway trucks. In the barge or truck men are employed for filling the skips, which are of the type shown in Figs. 2 and 3, and of a capacity to contain 15cwt. of coal. The transporter lifts the loaded skips out of the barge to the traveller on the transporter beam, a height of about 55ft., at a speed of 200ft. per minute. When the skip reaches the transporter beam, it is carried by the traveller (illustrated in Fig. 4) along the transporter beam at a speed of from 600ft. to 800ft. per minute, the hoisting rope being supported at intervals of 55ft. by the rope carriers, which are seen on the general drawings (Figs. 5 and 6). The full skip *en route* to the bunker-house is stopped over the weighing machine shown on the bridge, and after being lowered upon the machine for weighing, is again

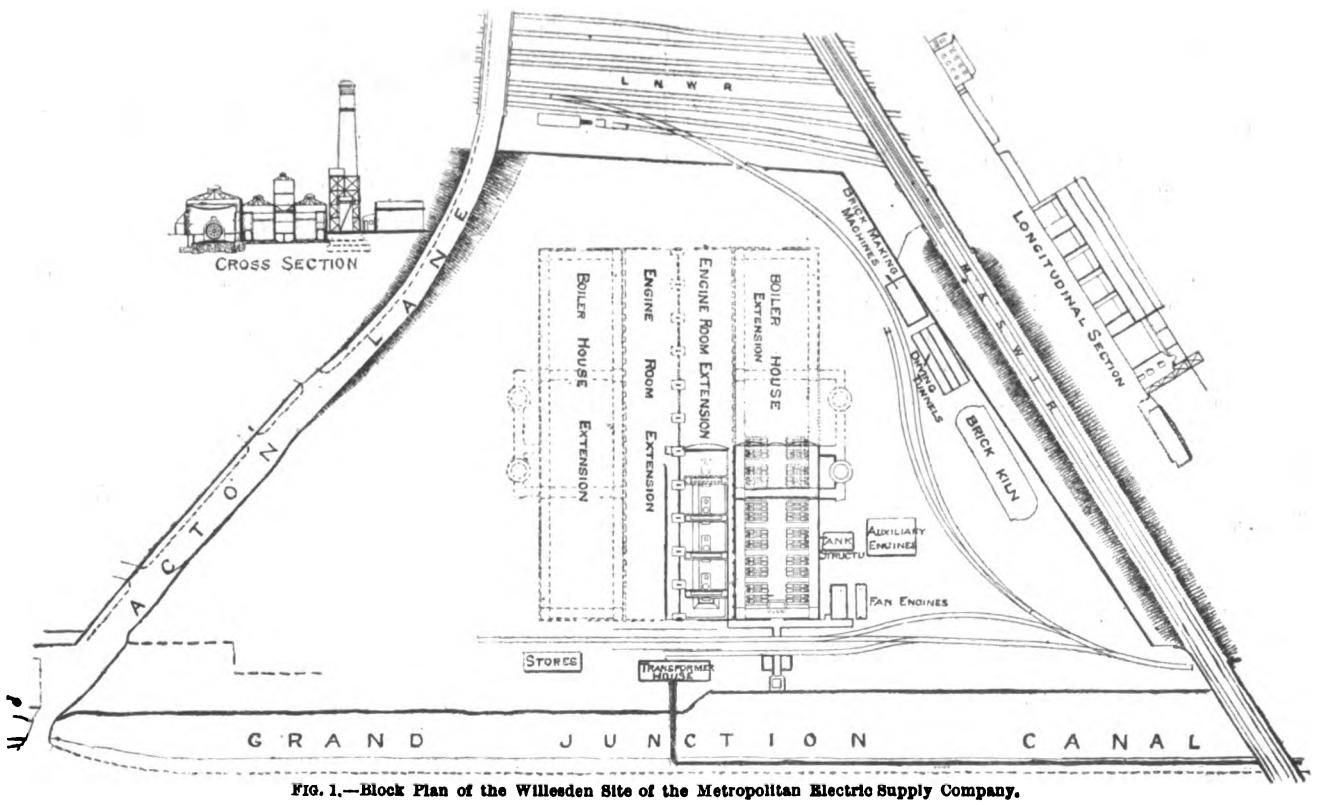

FIG. 1.—Block Plan of the Willesden Site of the Metropolitan Electric Supply Company.

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taken up by the transporter and continues its journey to any required position over the bunkers at which it is desired to deposit the coal. The coal is automatically deposited into the bunkers by mechanism which unlocks the self-tipping skip upon the driver commencing to reverse the direction of travel of the skip along the transporter beam.

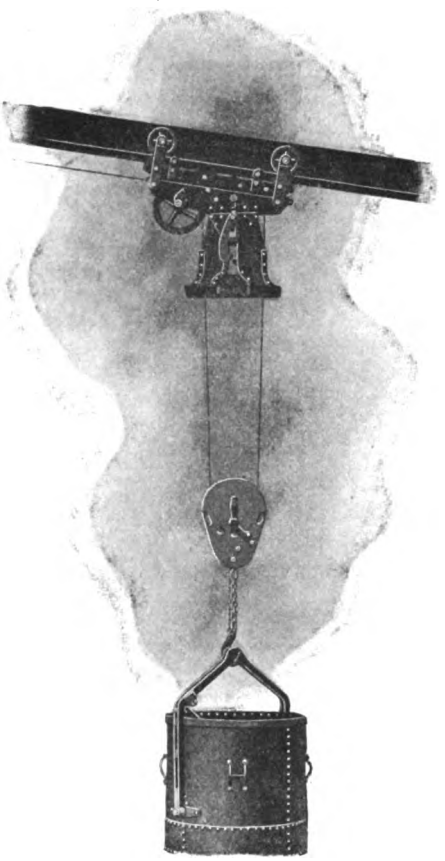

FIG. 2.—The Automatic Dumping Skip of the Transporter when being Lowered.

The empty skip is returned along the beam by the over-hauling gear, which is counter-weighted, at a speed of from 800ft. to 1,000ft. per minute, and upon arriving at the end of the transporter beam projecting over the barge is lowered by means of a brake and deposited gently into the barge. The next full skip is then taken up by the transporter, and the cycle of oprations just described are repeated. The transporter will perform from 30 to 40 trips per hour, the number of trips varying with the distance to be travelled in each case. The maximum distance to be travelled by the loaded skips at present is 274ft., but the machinery is arranged for an extension of the building to double this amount. The transporter can be used in the same way for dealing with the supply of coal which arrives in railway wagons. The coal is discharged from the railway wagons into skips which are lifted by the transporter through an opening in the platform of the bridge; the loaded skips are deposited on the weighing machine, and afterwards automatically emptied into the bunkers, the empty skip being returned to the railway truck. The manner and speed of working when discharging from the railway wagons is similar to that described for the discharging of barges. The transporter is also used for taking away the ashes, which are loaded into skips, taken up by the transporter, travelled along the beam, and lowered to the barge, but without allowing it to touch the heap in the barge. Then, upon commencing to lift, the skip automatically discharges its contents. The electric transporter winch (illustrated in Fig. 7) is fixed within the housing shown on the right-hand side of the tower, elevated at a position which gives a commanding view of the barges, the railway tracks, and the bunker-house. Within the tower a pair of elevators are provided for taking up Decauville wagons containing coal. The wagons, upon reaching the level of the bridge, are traversed over the weighing machine and afterwards tipped at any portion of the coal bunkers, the empty wagons being returned in one elevator whilst the full wagon is being raised in the other. The electric engine for working the elevators is placed in the house shown on the left.

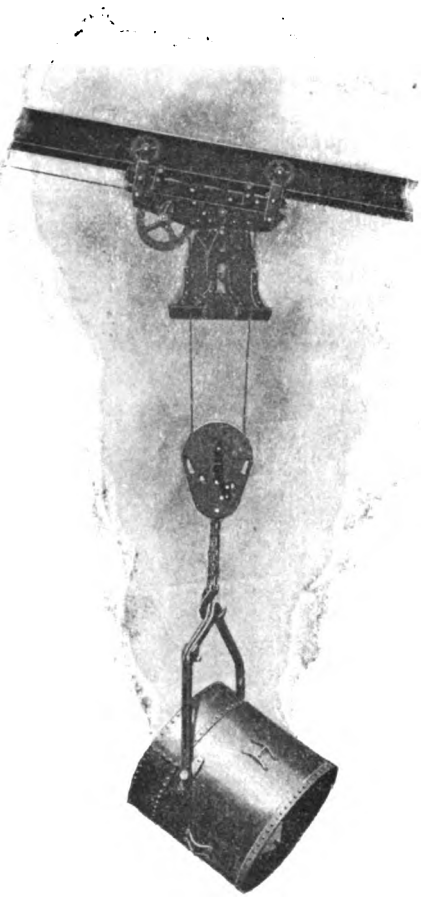

FIG 3.—The same Skip Righting itself After Emptying

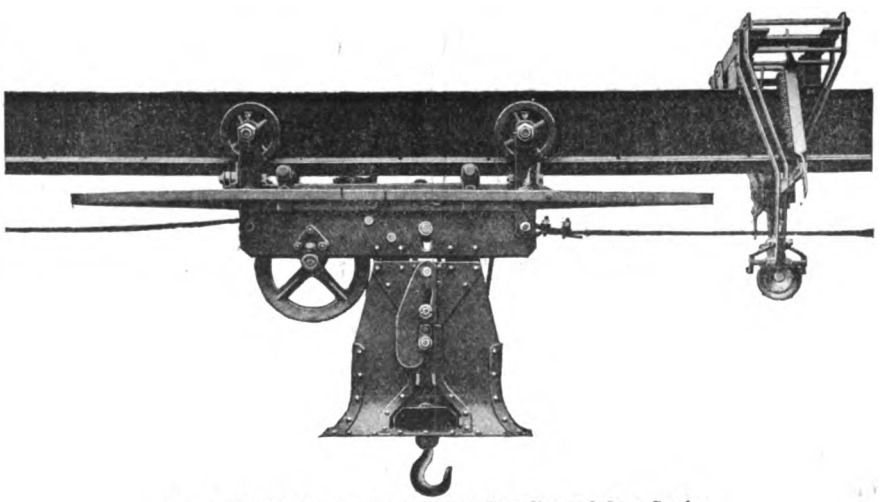

FIG. 4.—Double-Purchase or Fallblock Traveller and Rope-Carrier.

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In this way a duplicate system of coaling is secured. It is worthy of note that with this system of elevating and transporting, the man at the winch is able to control the exact position along the transporter bar at which he will dump the coal, and, in fact, to regulate in any way the movement of the skip. Whether he requires to hoist ashes or coal, in no case is any adjustment required along the transporter beam. The coal on arrival is dumped into the coal bunkers situated over the centre of the boiler-house, from whence it runs by gravity into the hoppers of the mechanical stokers. Eight of these are at present fitted with the automatic Vicars stokers, and the remaining number of boilers are hand-fed. As soon, however, as the transporter gear is complete, we believe that the whole of the stoking will be done mechanically. The whole of the ashes from these boilers pass down into a big gangway under the boiler-house floor, along which they are wheeled to the far end of the transporter beam. The water supply used on the works is obtained from the Grand Junction Canal, but an emergency connection is also made to the mains of the West Middlesex Waterworks.

The present dimensions of the engine-room are 175ft. by 72ft. It is divided from the boiler-house by a substantial brick wall, the remainder of the construction being for the most part iron; and it has an iron and glass roof. It is fitted with an electrically-operated traveller capable of lifting 30 tons. The electric motor on this crane is of the direct-current type, and is supplied from some auxiliary plant in an adjoining building. The foundations for the machinery consist of concrete 19ft. in thickness. It may be here mentioned that a large quantity of excellent brick-earth having been excavated in the course of constructing the engine beds, it has been decided to lay down a small brickmaking plant of the most modern type, which will enable the company to make its own bricks for future extensions, and thus deal profitably with a waste product which would otherwise have entailed a serious expense to remove.

The three engines at present erected are of the Westinghouse vertical compound type, each of 2,500 i.h.p. They are fitted with automatic expansion governors. These engines are designed to run at any speed from 116 revolutions up to 145. This was necessary in order that the plant may be used at present in conjunction with the older stations of the company in London. The frequency in this case naturally is to be the same, although the Metropolitan Company have not worked their generators in parallel in the London stations. The need for constant frequency is due to the fact that in many types of electricity meters a change of frequency involves a change of constant. The dimensions of the cylinders of these engines are as follows: the high-pressure cylinder is 36in. in diameter, while the low-pressure one is 55in., and the stroke in each case is 36in. The valves used to distribute steam, both of

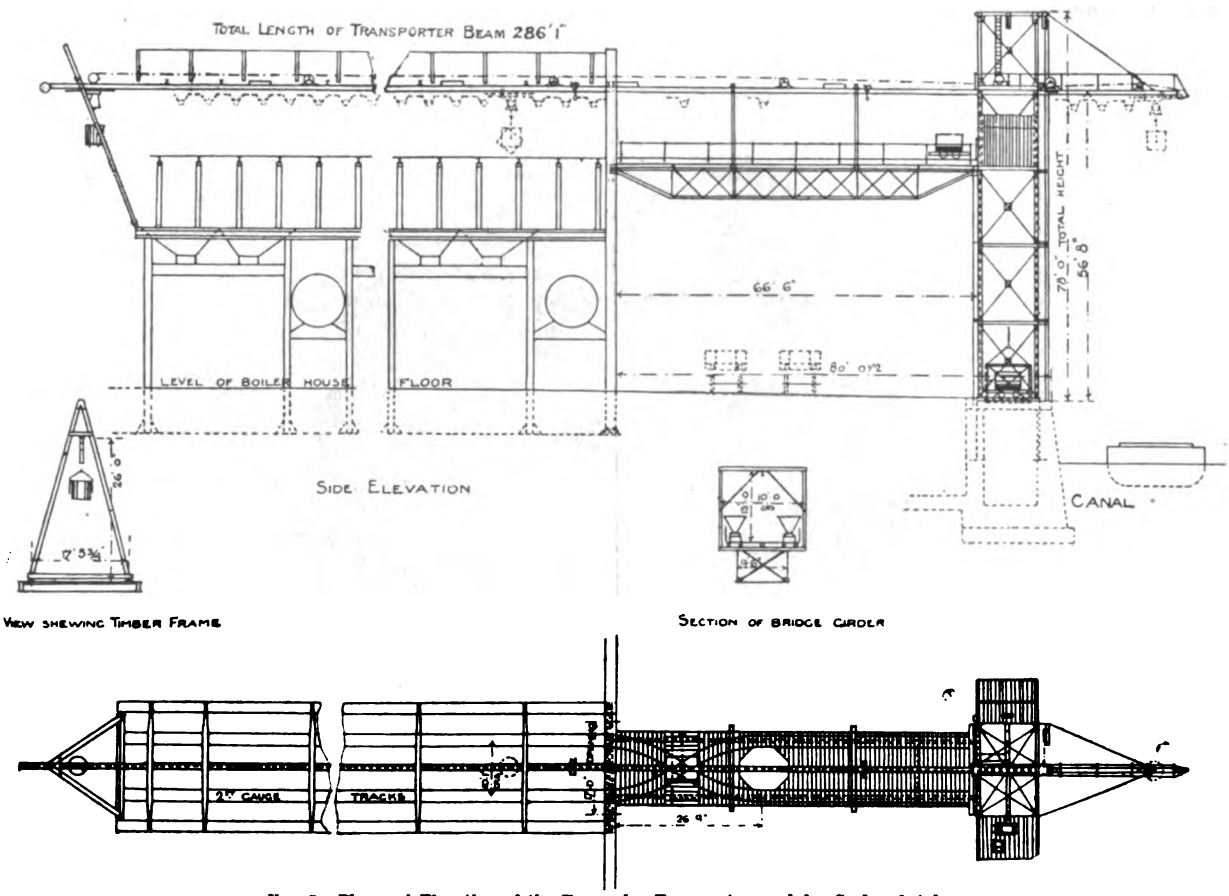

FIG. 5.—Plan and Elevation of the Temperley Transporter used for Coal and Ashes.

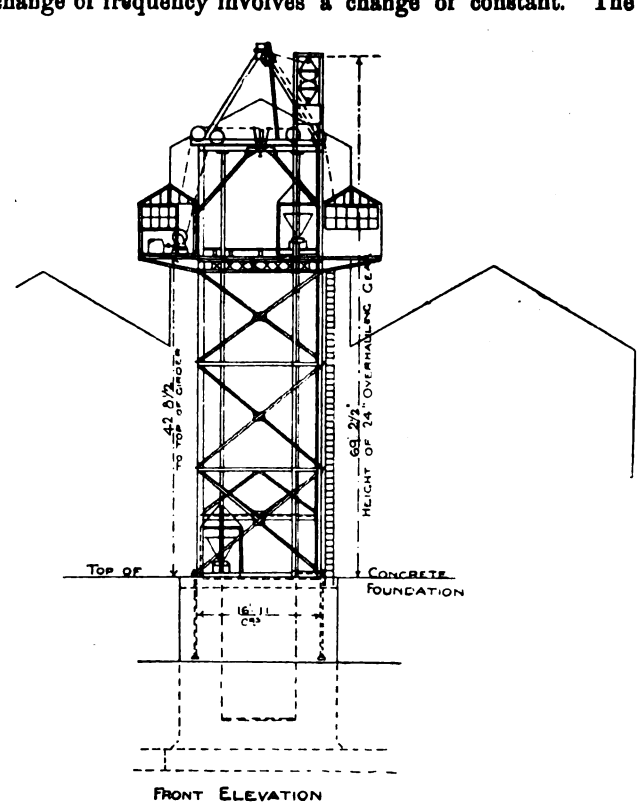

FIG. 6.—Front Elevation of the Transporter.

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the high and low pressure cylinders, are of the piston type. The main crankshaft is 40in. in diameter on the bearings and 20in. where the armature is supported. The main bearings of the engines are water-cooled, and are provided with adjustments in all directions. The oiling system designed for these engines is most complete, there being forced lubrication to practically every point. The governors are guaranteed by the makers to hold the engines to within 3 per cent. at any required speed, and they are also capable to adjustment over a wide range. Up to the present, however, the adjustment of these governors for parallel running has not been completed. These engines are run condensing, or, in cases of emergency, they exhaust to atmosphere. An independent condenser is provided for each engine. These are of the surface-condensing type, the circulating water being cooled in a Barnard's cooling tower. Each of these three cooling towers is about 12ft. square inside and 37ft. high. The circulation of air up the towers is maintained by two fans at the base of each tower. The fans are 12ft. in diameter, and run at 120 revolutions per minute. They are driven by three Bumsted and Chandler engines. Each cooling tower is guaranteed to cool 80,000lb. of water from 130deg. to 80deg. F. per hour. The circulating water supply at the top of the tower trickles down over galvanised wire mats, through which the current of air passes. The general design of the engine and condensing plant can be seen in Fig. 9.

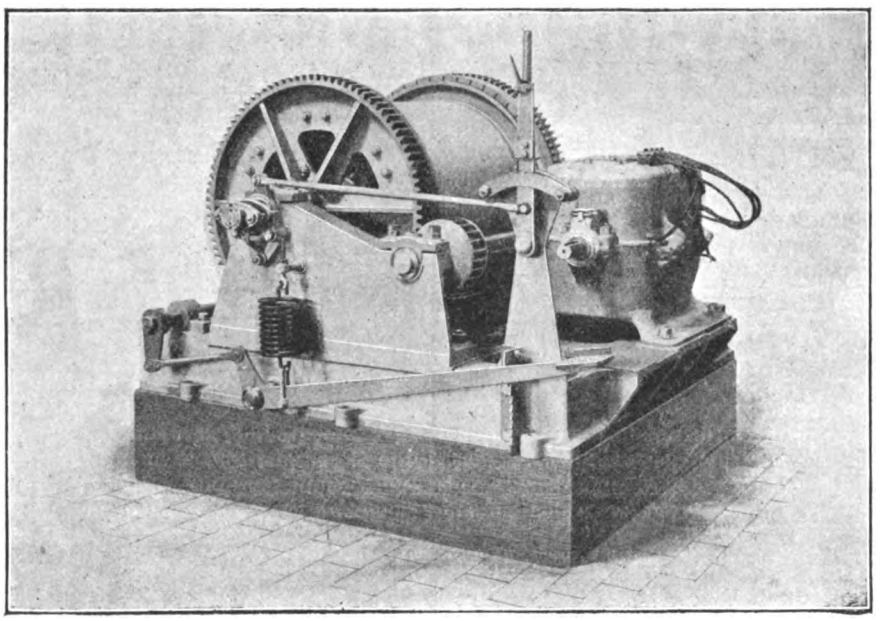

FIG. 7.—Electric Hauling Gear with Two Speed-Motions.

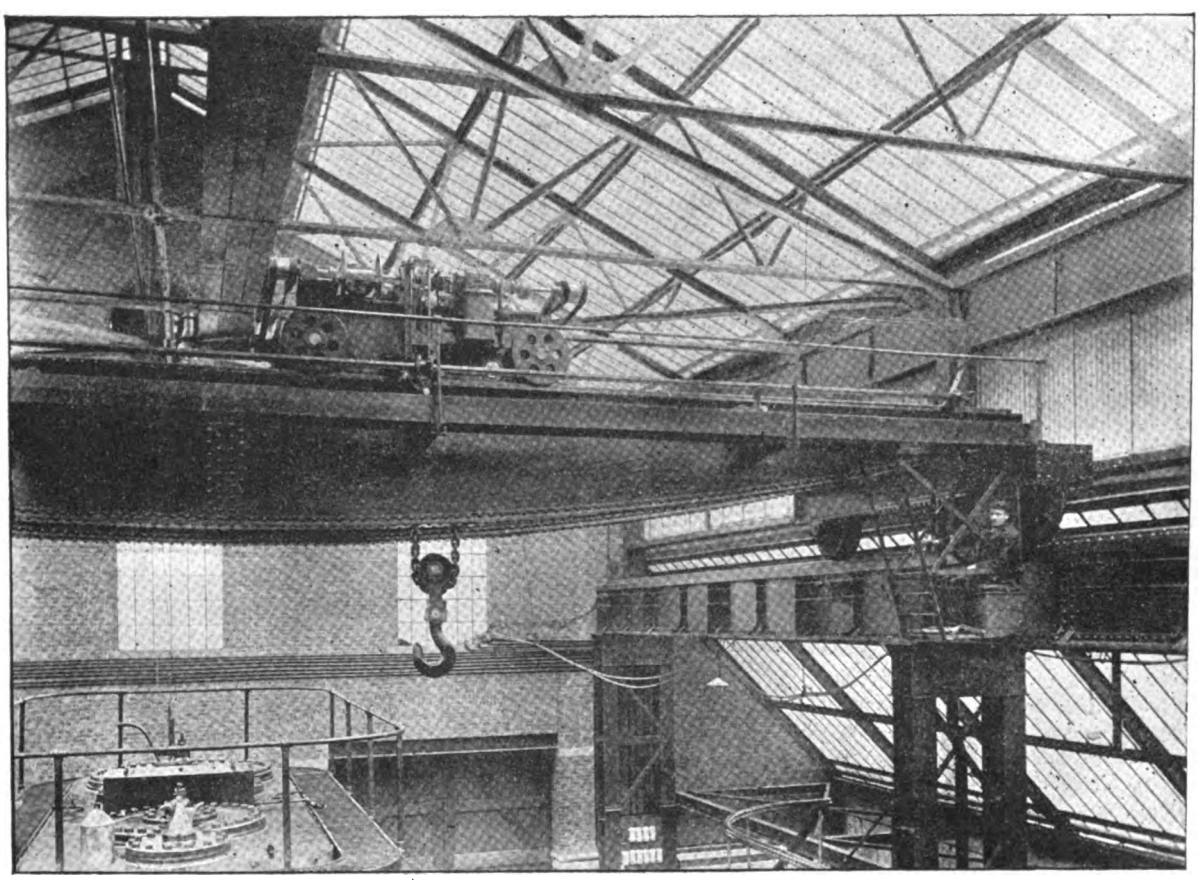

FIG. 8.—View of the Electric 30-ton Crane showing Driving Gear and the Conductors conveying Current to the Crane.

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The three large two-phase generators, which are coupled direct on the shafts of these steam-engines, were also supplied by the Westinghouse Company. The machines are built up to act as flywheels of these engines. Each of the alternators is capable of generating 1,500 kw. at a pressure of 500 volts. Naturally, half of this output is given off in each phase. The field-magnet system is fixed, and consists of 62 laminated iron pole-pieces supported in cast-iron frames. A good idea of the general design of this machine, as well as of the arrangement of them in the station, can be gathered from Fig. 10. The revolving armatures consist of steel laminated cores, which are recessed to receive the heavy copper armature bars. The field windings consist of copper tape wound on edge and most carefully insulated. The armature circuits are kept quite distinct, there being four collecting rings on the armature spindle.

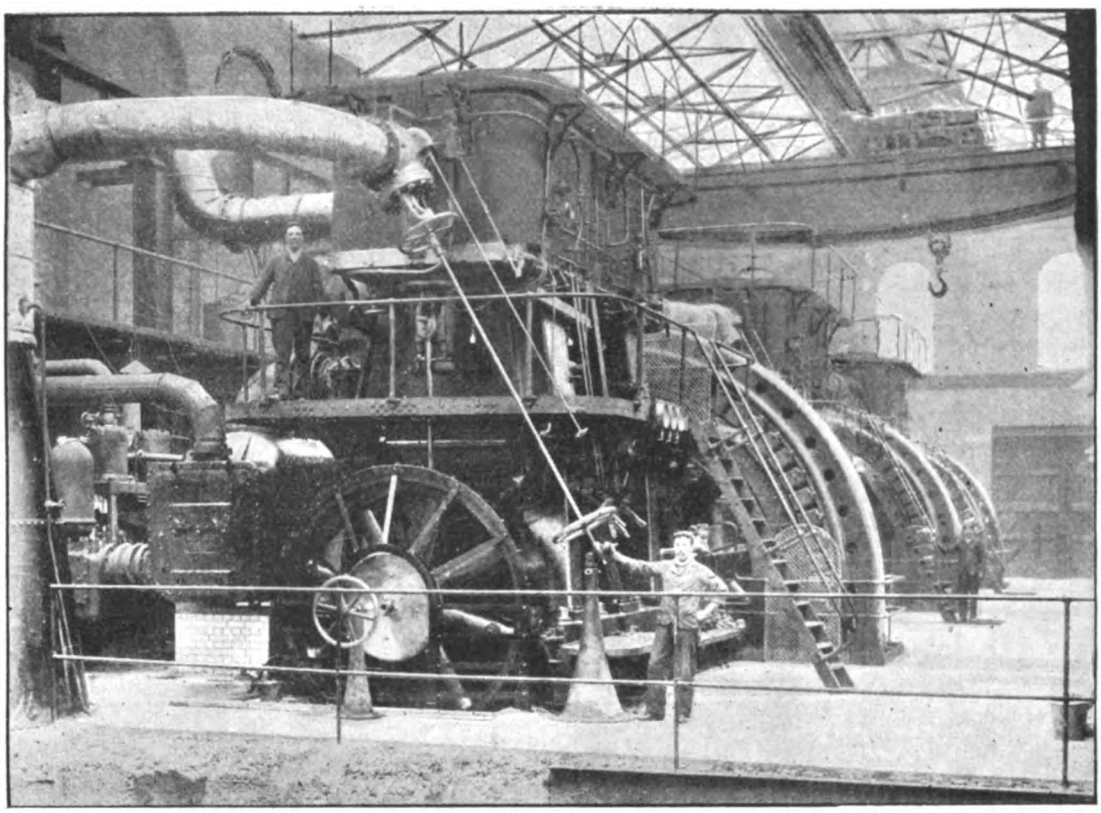

FIG. 9.—View of the Westinghouse Engines at Willesden.

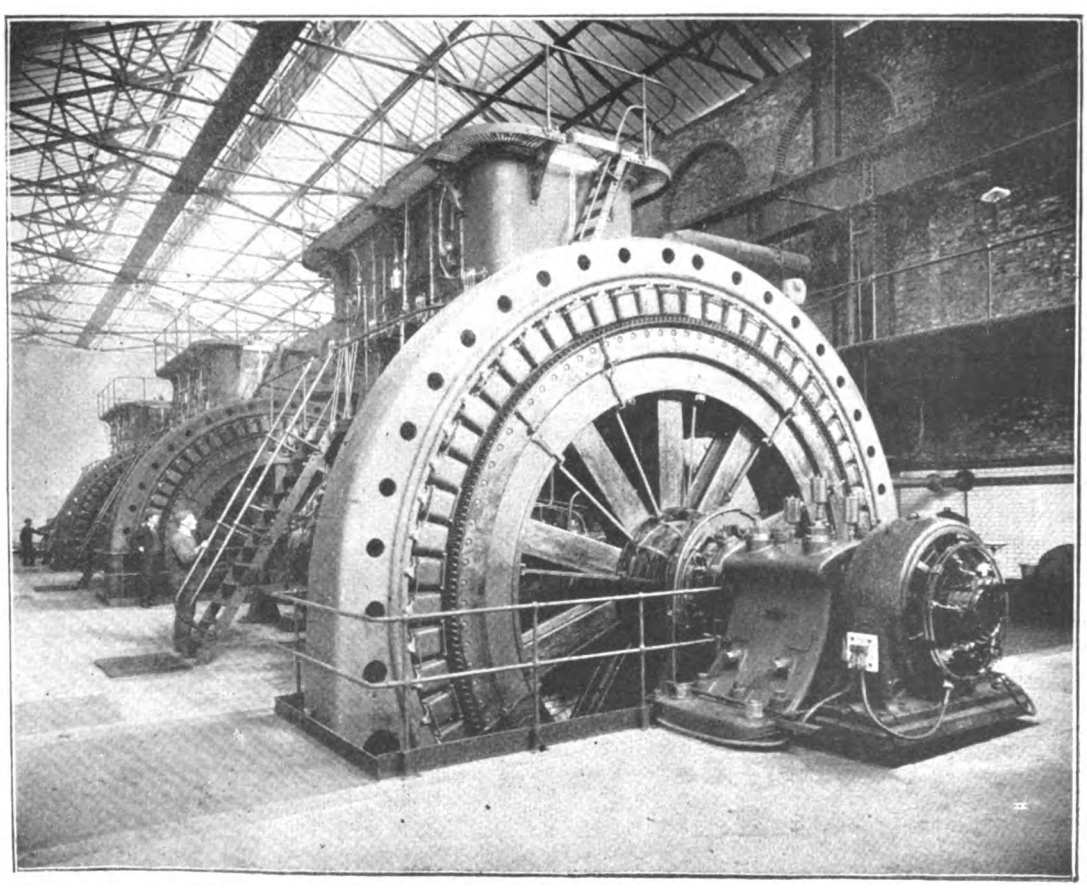

FIG. 10.—General View of the Engine-Room showing the Westinghouse Two-Phase 1,500-kw. Alternators.

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The exciting current for the field magnets is provided by direct-current machines coupled to extensions of the main shaft. The main switchboard controlling these three large alternators is placed in the gallery overlooking the engine-room. The following instruments are provided for each machine: Three automatic circuit-breakers, which interrupt the circuit when the current exceeds a predetermined amount. These can be seen at the top of the switchboard (Fig. 11). The handle which projects over the measuring instruments enables these circuit-breakers to be closed simultaneously. In release, however, they act independently, so that a short-circuit in one phase will not interrupt the supply from the other

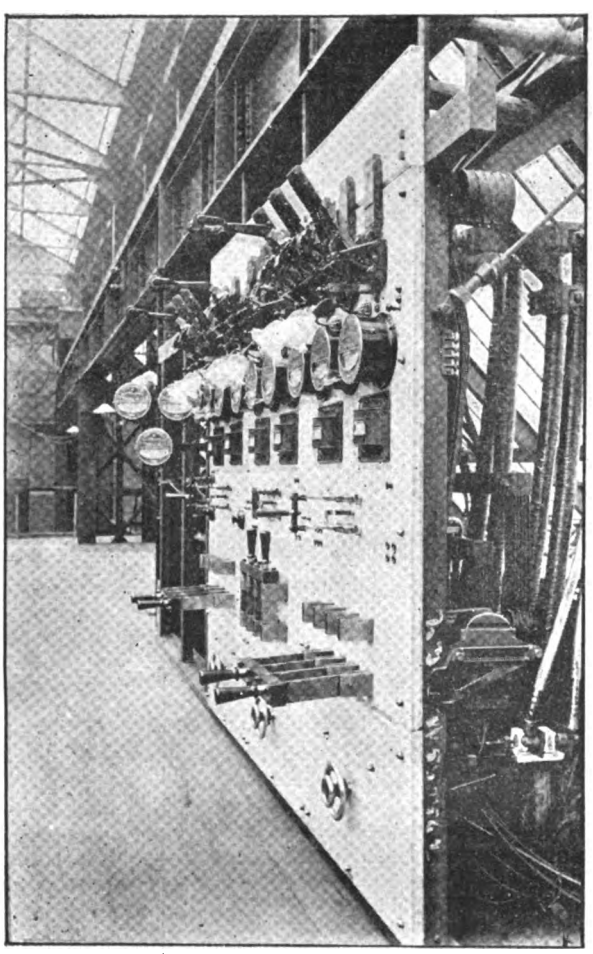

FIG. 11.—Side View of the 500-volt Main Switchboard.

phase of the alternator. We are not quite clear why three are used, seeing that in this way one wire of one phase is not interrupted. Below these automatic switches come three ammeters, two of which are placed in the alternate-current circuits, thus measuring the output from each phase while the third instrument is in the exciting circuit. Under these, again, are the wattmeters for indicating the actual output in power, as distinct from volt-amperes in each phase. The switch placed transversely beneath these wattmeters is the field switch, by means of which excitation for any alternator can be rapidly transferred from the exciter to the battery of accumulators, which is provided as spare. This throw-over switch, which is of the Westinghouse type, is so designed that the change can be made without putting the exciter in parallel with the accumulators, or without interrupting the exciting current through the field. For this end a spring contact is arranged in between the pivots of the two contact bars of the switch. A projecting bar on one of these is so arranged that it makes contact with the spring just before the circuit of the exciting dynamo is interrupted. An auxiliary resistance is by means of this contact switched across the exciting terminals of the alternator, and this resistance completes the circuit until the switch reaches its final position connecting the accumulators on to the alternator field circuit. During the short interval of time in which the switch is moved over, the energy of the magnetising field is quite sufficient to keep the exciting current at practically its normal value. Underneath this switch comes the main switch of the alternator, which consists of four contact bars arranged with laminated spring contacts at the point where they engage the jaws. The two handles seen on the lowest panel are used to regulate the exciting circuit of the direct-current machines, and the resistances in series with the exciting circuit of the alternator. Fig. 12 shows the back of the board and the resistance by which the field strengths are varied. Owing the large current generated by these alternators, the omnibus bars at the back of the board are all constructed of laminated copper in order to avoid the Kelvin effect which occurs when a large solid conductor is used to convey alternating currents. The cables leading from the switchboard to the transformer-

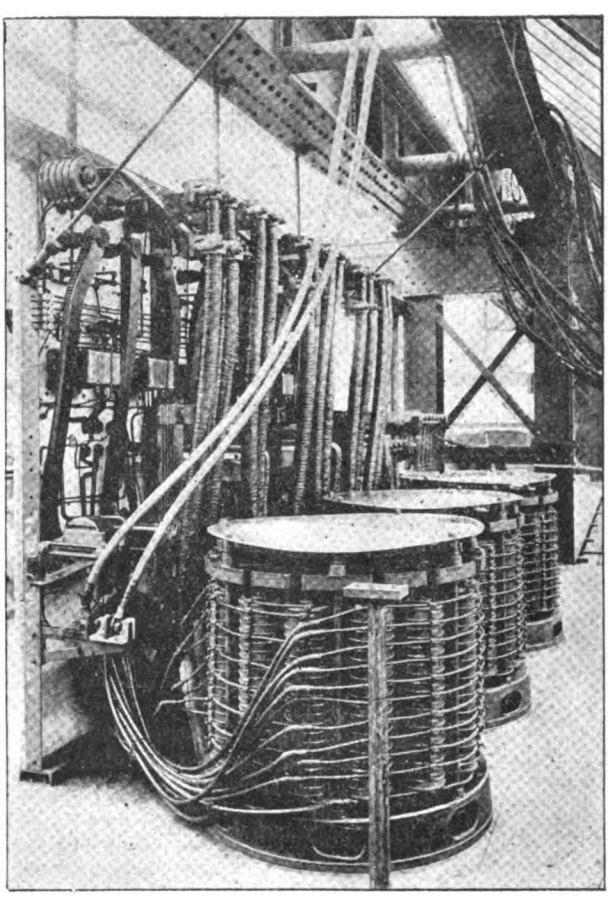

FIG. 12.—Back View of Switchboard showing Bus Bars and Field Rheostats.

house are of the British Insulated Wire Company's make, and are of exceptionally large section.

(To be continued.)

ELECTRICITY IN COUNTRY HOUSES.

We have received from Messrs. E. Scott and Mountain, of the Close Works, Newcastle-on-Tyne, a volume entitled "Electricity in Country Houses," which constitutes, in our opinion, the high-water mark in such literature on electrical subjects. The volume in question is devoted to illustrations of country house work carried out by the firm, and in each case a small amount of letterpress is given to explain the character of the work and of the plant used to supply electrical energy. We know of no volume which would be more likely to induce an owner of a country house to undertake the electric lighting of the same, as he has particular evidence before him of the artistic way in which the same can be effected. One cannot but think but that Messrs. Ernest Scott and Mountain have been particularly favoured in having the lighting of such a number of mansions in the North of England and in Scotland, and it is greatly to their credit to say that in so doing they have made the electric lighting arrangements harmonise with the general architecture

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A short *résumé* is given as to the advantages of electric lighting, electric heating, and of electric motors for driving small machinery, such as is often required in large isolated houses. The installation in Grey Towers and Herrington Hall are then described. A view of the dynamo-house at the first-named installation shows careful attention to engineering details, and the cleanliness of the engine-room is evidently enhanced by the general arrangements. We notice that the accumulators in this installation are placed in single rows on brick piers, which enables them to be easily inspected or removed for repairs, should there be any occasion for the same. The first illustration we give is of the Biggins Hall. The next illustration was taken at Measham Hall, an old country mansion, about three miles from Darlington. At this installation the whole of the laundry machinery is driven by electric motors, Fig. 3 showing the arrangement adopted for driving the mangle. A large number of other illustrations are given, showing how very well electric lighting can be adapted for drawing-room lighting and for lighting the dining-rooms, etc. The motive power used by the firm in each case is determined by its situation. Thus we notice that at Scuttersciffe Hall water power was available, and turbines have consequently been employed. The outside of the turbine-house is illustrated. This shows the flume and the stone dam which had to be erected to secure the necessary head of water. At the end of the volume testimonials are given from several of the firm's customers, which were only to be expected from the illustrations of the work carried out. We note that the book was published by the Mathieson Photo Block Company, of London, and the work does them credit.

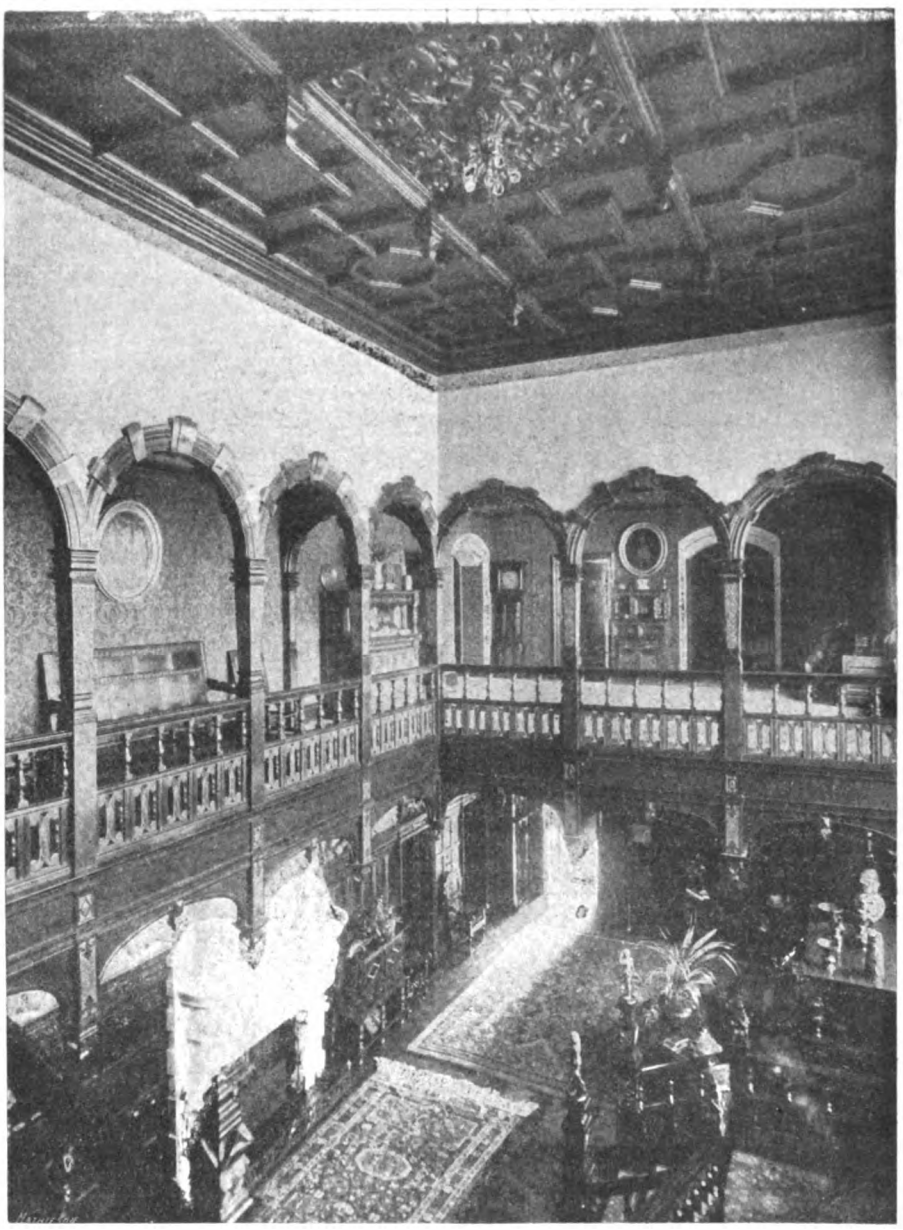

Fig. 1.—The Biggins Hall.

CENTRAL STATIONS.*

BY C. STANLEY PEACH, F.R.I.B.A.

(Concluded from page 311.)

Now as regards the commercial aspect. There are now 438 bodies (municipalities or companies) in the United Kingdom possessing provisional orders for the supply of electricity, of which 191 are now supplying current; 50 more will shortly do so. Nearly 300 central stations have been erected in the course of the last 11 years, of which all but a few are complete, and many more will shortly be commenced. Machinery of over 400,000 h.p. has been put in, over 100,000 h.p. being in London alone; the current generated is sufficient to illuminate over 12,000,000 lamps of 8 c.p. each or their equivalent; over 160,000 consumers are taking current for various purposes, and the districts allotted contain upwards of 20 millions of inhabitants. The capital invested in the industry exceeds £32,000,000 (of which about £8,000,000 is represented by London companies), and, with that of the allied manufacturing industries called into existence and supported by it, £58,000,000.

* Lecture delivered at Carpenters' Hall, March 1, 1900.

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This brings us to the end of both the legal and commercial history of the subject. It has taken perhaps rather more than a fair share of the time at our disposal, but the points which are vital to a successful design for a central station are to be found in the history of the industry, its development, present magnitude, and the future which lies before it, and to this end this portion of the subject must not only be studied, but thoroughly mastered. A simple illustration will make the development clear. [Mr. Peach then showed on the screen typical plans of electricity works in London, calling attention to the great increase in size since the works were laid down in Little Chapel-place, Westminster, in 1886.] Thus, the Broadway station had a cubic capacity of 16,384 cubic feet, St. Luke's station a capacity of 1,736,128 cubic feet, the Battersea station a capacity of 2,300,000 cubic feet. The station of the Central Electric Supply Company when completed will have a capacity of no less than 15,500,000 cubic feet. This illustrates the development by size in a general way, but the engineer could tell you of much greater and far more important mechanical and electrical changes and progress which it is neither my province nor within my power to explain. These changes do, however, affect and modify both the design and construction, and though we cannot to-night deal with the cause, we shall see the effects in the arrangement and construction of the buildings as the views of some central stations and of the principal divisions are exhibited. As they pass before you I will explain the general arrangements which obtain at the present time, and point out special features which assist in our final consideration of the subject. In this way you will, I trust, get a much better idea of the matter than any verbal description of them room by room could give you. The views will be presented as nearly as possible in chronological order, commencing with the earlier stations. [At this point, slides giving views of the principal rooms of the following stations were exhibited on the screen: Chapel-place, Eccleston-place, Davies-street, Millbank-street, Mason's-yard, Carnaby-street, City-road, Chelsea, City and Waterloo Railway.] Round the room are a large number of designs, and among them some specially interesting plans, which will repay examination. Those of the South London Company's station show the combination of a central station with a dust destructor, kindly let for exhibition by Messrs. Kincaid, Waller, and Manville, the engineers and architects. There are also other plans and details which will give you a fair idea of the arrangement and construction of many kinds of stations, both in London and the provinces; the Macdonald-road station of the Edinburgh Corporation, of which the drawings were kindly lent by the architect, Mr. Cooper, and Prof. Kennedy, the engineer, being one of them. The first part of this station is now complete, and, as you will see from the plans, the station, when finished, will be a large one. The elevation possesses considerable architectural merit, and it has not by any means a factory appearance. The stations of the Corporations of Oldham, West Hartlepool, Belfast, and many others, will give you some

FIG 2.—View in Measham Hall.

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idea of what is being done in other parts of the country. It now only remains to deduce some points which must be borne in mind in the design; to indicate some of the conditions which affect the construction, and to suggest some of the methods which are likely to prove suitable to meet the requirements of the special kind of buildings which are necessary in connection with the industry. Now, as I have already indicated, most of the points are to be found in the history of the circumstances which have created the necessity for the buildings rather than in the "bricks and mortar" of any building of the kind already existing. The first deduction to be drawn is that these undertakings being for commercial purposes economy is of paramount importance. But by economy is not to be understood mere cheapness, which is so often mistaken for it. In the case of central stations, a building of which cheapness is the great feature nearly always is the least economical in the long run. Many of these buildings put up in the early days have already been pulled down and new ones built in place of them, and numbers more will meet the same fate in a few years. As we proceed, you will see for yourselves, I trust, in what way economy can best be obtained. I think we may take it that in central stations it can best be secured by justly estimating the limitations of the present while bearing in mind the requirements of the future, and that it is only by doing this that we can produce suitable arrangements for conducting the business to commercial advantage, which is the essence of the whole matter. The buildings must never become obsolete, because their value at the end of the term granted by the provisional order depends on their fitness and the possibilities for further use existing in them at that time. Fitness and durability, then, rather than mere cheapness, should be the aim, and should influence the plan, the kind of construction adopted, the selection of every material, and the disposition of the material in the structure. The points, therefore, which I recommend for your consideration to-night are those which tend to produce a structure which will not only be fit during the term of the provisional order, but that will remain suitable for its future work when its present owners may be called upon to assess the value of their undertaking; and these points may for convenience be dealt with under four main heads—viz.: (1) adaptability, (2) strength, (3) incombustibility, (4) architectural treatment. Now, adaptability is a wide term when applied to a central station, and it comprises a great deal more than provision for expansion over a site of which the limits are known, or extension in any probable direction. It must not be forgotten that, although great progress has been made, we are, nevertheless, at the very beginning of public supply of electricity from central stations, and that finality is as remote as ever. The Act of 1899 cannot fail to produce great changes, and unless the buildings which are now about to be erected are designed with a view to the future, as well as to meet the immediate requirements of the present, the same waste which took place when many of the earlier central stations were built will again result.

By what means adaptability is to be obtained is, of course, a matter of individual judgment. In many instances the object will be met by constructing the buildings with the fewest number of fixed points of support, by arranging all other parts of the enclosing structure or the divisions of the structure in such a way that they can be easily and quickly removed without interfering with plant which is working, without the necessity of shoring, and without causing dust or dirt; in providing a sufficient margin of strength in each part of the structure at the time that it is erected to admit of indefinite increase in size, or, what amounts to the same thing, constructing these buildings in bays which are independent of their surroundings and derive no lateral support from them; in apportioning to the several departments such relative proportions that they are compact in the first instance, and remain so both in relation to one another and to the whole building no matter what extensions take place. This point is of the greatest importance, and it has not hitherto received the amount of attention it deserves. If it be carefully considered in the design, it will greatly facilitate the engineer's work, especially in arranging the pipes, which are the veins and arteries of the whole system of machinery. Every part of the structure and contents of the building should also be accessible. Nothing should be crowded, and there should be ample space everywhere. Means should be provided for taking in or out any piece of plant or machinery without interfering with the work of the station or other pieces of machinery. The plan should be as simple as it is possible to make it, for simplicity and repression are the merits of this class of work. In short, adaptability consists in making the building as flexible as possible. Naturally, it is no easy task, but it is a feature which the engineer will expect the architect to provide; and the great power station which is coming into existence now, if constructed without adaptability as an essential feature, will prove an incumbrance rather than a benefit to its owners, for it will be found impossible, except at enormous expense, to alter, enlarge, or adapt it hereafter without practically shutting down, which would be a very serious thing, indeed.

The second point is strength. It has been pointed out that strength is necessary for adaptability, but apart from

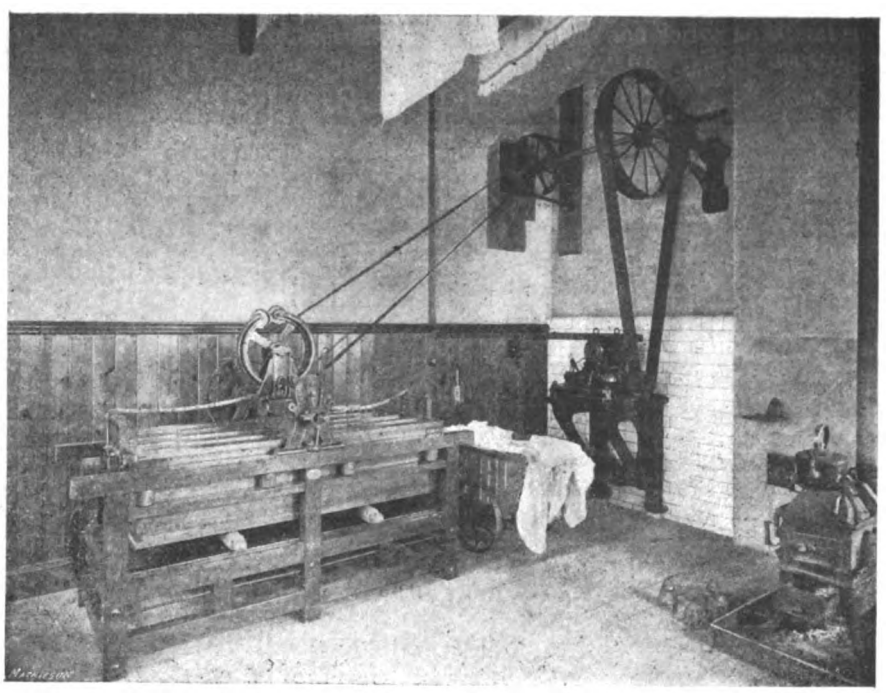

FIG. 3.—The Laundry, Measham Hall. (See "Electricity in Country Houses.")

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that, it is an important element in central-station construction. Almost every thing which causes decay or destruction is present in these buildings to a greater extent than usual. The elements, fire and heat, water, wind, the mechanical forces, vibration, rough usage, accident, and various chemical actions, all unite in testing the strength of these structures to the utmost. As a rule, the site which is found most suitable for industrial purposes is not the site best fitted for building. Foundations which are good enough for 99 buildings out of 100 are quite inadequate for a central station. Central stations are often erected on the banks of rivers or canals, generally by the side of railways, and in the future this will more frequently be the case. Clay soils with soft underlying strata will consequently be frequently met with, and a subsoil must be treated in a special way, otherwise failure must result. So rapid is the development of the industry that for many years to come they must necessarily be constructed as quickly as possible. All these things must be taken into consideration when deciding how the necessary strength is to be provided. You all know that it is not obtained by mere mass of material, nor even by the qualities of the materials themselves, but that the arrangement of the structure has a great deal to do with it. A bird's nest is built of the weakest materials, but it requires a considerable effort to tear many kinds of nests in half. A beaver's hut and its dam are constructed of small branches, generally rotten, and cemented with earth without admixture of lime or cement, but the hut resists great pressure, and even a heavy flood rarely injures the dam. These are simple illustrations, but they make my point clear, which is that arrangement is one of the most important elements of strength which must be constantly borne in mind in designing these structures. The same end may be reached in directly opposite ways, either by concentrating the weight of the structure and the load it has to bear as much as possible, or by distributing both to the greatest extent. By the first method it is easier to remove parts of the structure without unduly stressing what remains. By the second the strength of the structure remains constant, and extensions can be carried out without interference with the comparatively small number of points at which the load is carried; and, as I pointed out when dealing with adaptability, the latter is the system that will probably meet with more general approval. The drawback to concentration of load is that mechanical vibration, which is always present in these buildings, affects the structure unequally, and in long walls and great heights two distinct movements are set up, one horizontal and one vertical, which start from arbitrary centres and cause curious and awkward settlements at the extremities, or at points of resistance, or where buttresses or cross walls occur, and precautions must be taken accordingly. Distribution of load does not get over the trouble which arises from mechanical vibration. It merely removes it from one part of the building to another part where it is even more difficult to deal with, or transfers the worst effects from the structure to the plant, which is a far more serious matter. Heavy engine foundations undoubtedly tend to reduce the amount of mechanical vibration transmitted to the structure, and separation, if it were possible to make it complete, would undoubtedly still further reduce it. But complete separation has not yet been attained, and it is open to question whether the partial separation which at present is much in favour is of sufficient value to compensate for the want of tie in the lower parts of the structure which the use of separation in any form entails. At any rate, in some central stations, where instead of partial separation an efficient tie has been constructed at the foundation level, the effects of mechanical vibration, with the same kind of engines and a similar arrangement of plant, are not worse than in those buildings in which such partial separation has been adopted. Many things which may be included in the generic term "elastic foundations" have been suggested and tried as a means of overcoming this troublesome factor, and although in isolated instances of a single small engine such devices have met with some measure of success, I believe that in no instance have they been effective in central stations, and that in every case where they have been adopted not only has no good effect been obtained, but other and more serious difficulties, such as damage to steam-pipes and plant, have resulted from them. They have now accordingly been generally abandoned. Many years ago this subject was very carefully investigated, and enquiries were made into, I believe, 18 cases in which various foundations of this kind had been tried. All were failures, and have since been removed. The worst of this system of construction is that it is delusive, and for a year or so things frequently go on all right, and generally the mischief is not discovered until it has become serious and something happens. In connection with marine work the subject has also been most carefully studied, and so far no arrangement of elastic or cushion foundation has been discovered which is beneficial. The best results hitherto obtained, not only in the United Kingdom, but also in America and on the Continent, have been by using heavy foundations of great rigidity. The unequal temperatures which exist in these buildings must not be disregarded, and the structure as a whole and every part in relation to every other part must be free to move somewhere. Some fixing, of course, is necessary, and where the members of the structure should be fixed and where they should be left free to move should receive careful attention. The combination of freedom with fixing presents many difficulties. An admirable system was devised for the construction of the Crystal Palace, which will well repay examination. Of course, it would be impossible to adopt exactly the same system in central stations, but the ingenuity of the jointing of that building is such that it cannot fail to suggest modifications which may assist in overcoming these difficulties in more modern types of construction. The individual members of the structure should be rigid in themselves, more particularly so in these buildings than is usually required. It is difficult to secure strength of structure in buildings which are badly balanced, or unequally loaded, as central stations necessarily must be. Girders continuous over many points of support, or rigid connections where separate girders abut, are to be avoided. It is impossible in the time at our disposal to even enumerate many other points of importance which should be considered in the arrangement of the materials in order to ensure strength, but sufficient has been said to indicate the general lines that should be followed. Materials must be selected for durability as well as for strength, because it is difficult and expensive to either repair or even clean down these buildings, and the proceedings necessarily involve risk to the machinery. Maintenance must also be kept as low as possible.

The important objects which these buildings are expected to serve can only be secured by avoiding possibility of risk of interruption of every kind, and inasmuch as that of fire can be eliminated by the use of incombustible materials no other kind should be used. The contents of the buildings are already practically incombustible, and therefore this point does not present any serious difficulty at present.

Architectural treatment forms rather a part of the three preceding points than a separate division, since it comprises the use of materials by reason of their fitness, the development of the construction as a means to a definite end, and extends to the arrangement of the whole building in the simplest and most convenient manner. It commences as soon as the engineer has settled in a general way what accommodation is to be provided for the machinery and plant, and he has given the architect a general idea of what he proposes to do. If offices are required, this part of the building will naturally be designed by the architect, and as you have seen in the views of the Carnaby-street station, nothing is wanted beyond the usual and convenient arrangements met with in the offices of any other important company. It is as well to provide room for extension, as the requirements of the staff increase as the undertaking develops. The arrangement of rooms, and the comfort of the engineering staff, the ventilation and hygienic arrangements of the buildings, are the province of the architect. Ventilation and light must be considered together, and every part of the building must not only have free circulation of air, but daylight must pervade every part. Artificial light can never compensate for the absence of daylight, and mechanics' work, which may be wanted at any time, or in any part of a central station, is more quickly and better done by daylight than at any other time. And last, but

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by no means least, it rests with the architect to make the most of those points of the building which can legitimately be accentuated to produce architectural effect; he can arrange the masses of the building in good proportion, and can make the most of the characteristic features of the various materials which it is necessary to use, in order to obtain a pleasing effect, and by utilising the features of the construction to the best advantage can give these buildings such severity and dignity as their magnitude demands, and without which they can only be masses of building which will disfigure instead of improve any neighbourhood in which they may be erected.

I have endeavoured to place the points before you rather in the form of notes capable of general application than to attempt the elucidation of the minor details of the subject in order that the application may be wide, and therefore more useful to the greater number. I trust that I have been able to interest you, and that some of the information may prove useful. It is probable that opinions will differ upon many of the points on which I have touched, but every point has been carefully considered, and in every case I have endeavoured to give you the results not only of my own experience but that of others. I am confident that electricity has a future before it, not perhaps as great as that which steam had, but still a great future, and that gradually the buildings connected with it will be more important and of much greater general interest than they are at present. I trust that some of the points that I have mentioned may assist in solving some of the difficulties which are certain to arise in buildings for new purposes called for as scientific research gives rise to new industries, and if this should be so the time which we have spent in considering central stations to-night will not have been wasted.

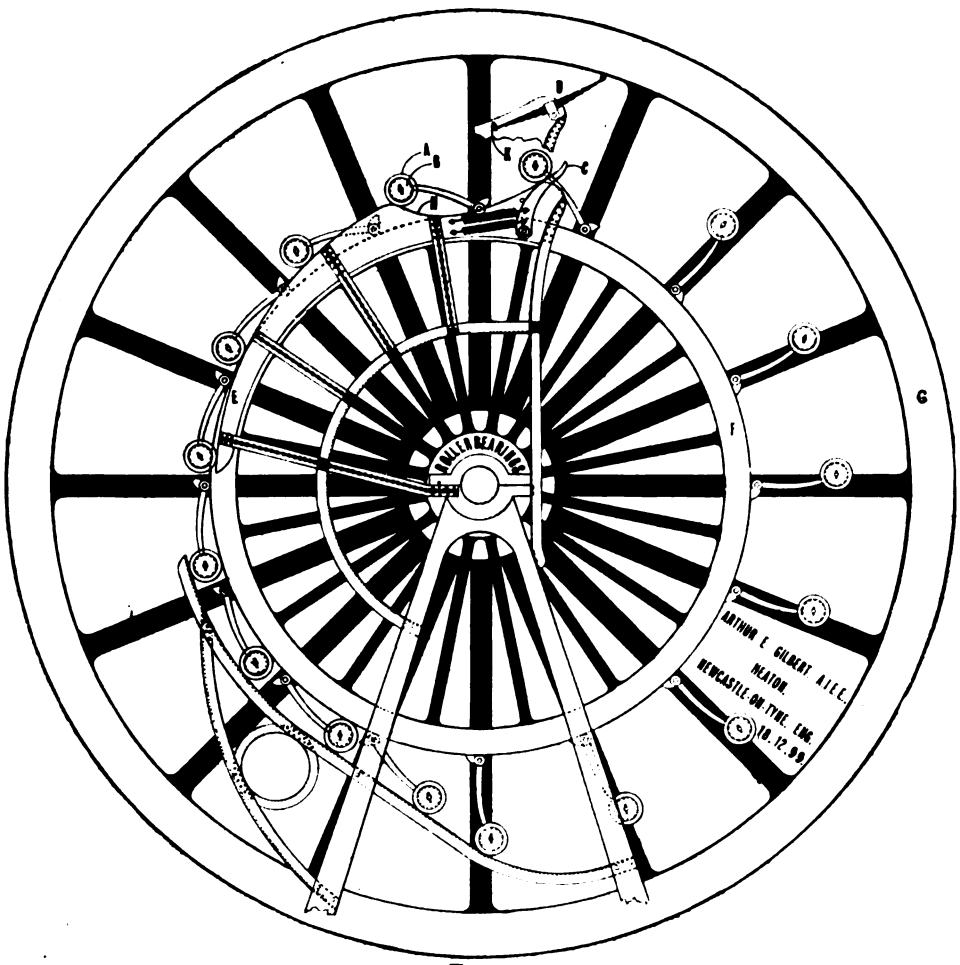

FIG. 1.

PERPETUAL MOTION.

Mr. A. E. Gilbert, A.I.E.E., of Newcastle-on-Tyne, has forwarded to us the drawings of two arrangements he has devised with the object of getting energy out of nothing. Fig. 1 shows the third and Fig. 2 the fourth machine Mr. Gilbert has designed with this object. He proposes to use the apparatus to drive a dynamo. Mr. Gilbert adds that the idea has been in his mind for 20 years, and that he expects his solutions will open the eyes of those who maintain that it is impossible to get power out of nothing. The inventor gives the following explanations:

In Fig. 1, A is a wheel with solid 6in. indiarubber tyre to impart elasticity at H and C, thereby causing the weight, B, to bounce or bound over the centre of gravity; B is a solid weight, 2ft. diameter; C is a spring tongue to kick weight over; D is a modification of C; E is an incline for A to run on and over; F is the driving wheel, 50ft. diameter; G is the flywheel, 88ft. diameter, fixed on the same axle; H is a switchback to give impetus to the small weights; the angle of the spring may be regulated at K. It is also stated that similar small weights may be fitted at the off side of the ring, F, in the same manner. E is supported by angle-iron or steel framework as shown. Should more power be required, place another ring, F, at the off side of the flywheel, G. Mr. Gilbert adds that you will then have 32 weights, but by placing two F's at near and off sides of G (all fixed on same shaft), you have 64 weights (a pretty good horse-power), and so on. The rings, F F, would, of course, be keyed on to the shaft, so that the weights fall in rotation.

In Fig. 2, A is a stationary wheel, 13ft. diameter, supported independently; B is a wheel, 1ft. in diameter, revolving round A; C represents guide bars, revolving with H; D is a wheel which revolves with B and works between C; E represents thin steel safety discs over driving rollers; E^1 is a similar disc for lifting roller; F is a steel tube with inside rib (this may be in the form of a railway rail for strength); G is a solid weight, 2ft. diameter; H is a flywheel, 60ft. diameter.

The above is all the description Mr. Gilbert gives, and he considers the success of the apparatus apparent from the drawings. We should say he has been led to this erroneous conclusion by neglecting first principles, and by considering in his calculations only the distribution of weight when the wheel is stationary. A numerical summation of the forces when

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the wheels are revolving shows that, far from there being an available balance of energy, the apparatus will require outside power to overcome friction. A simple statement of the first principles of mechanics only is required to show the fallacy, as no body constrained to move in the fixed course in a neutral plane can by gravity do more external work in the downward path than has to be imparted to it in the upward path. We think, however, that some of our readers may care to go into these two designs more in detail, and we shall be pleased to publish a few short criticisms on the same, and to pay for the matter so printed at our usual contribution rates (10s. per column).

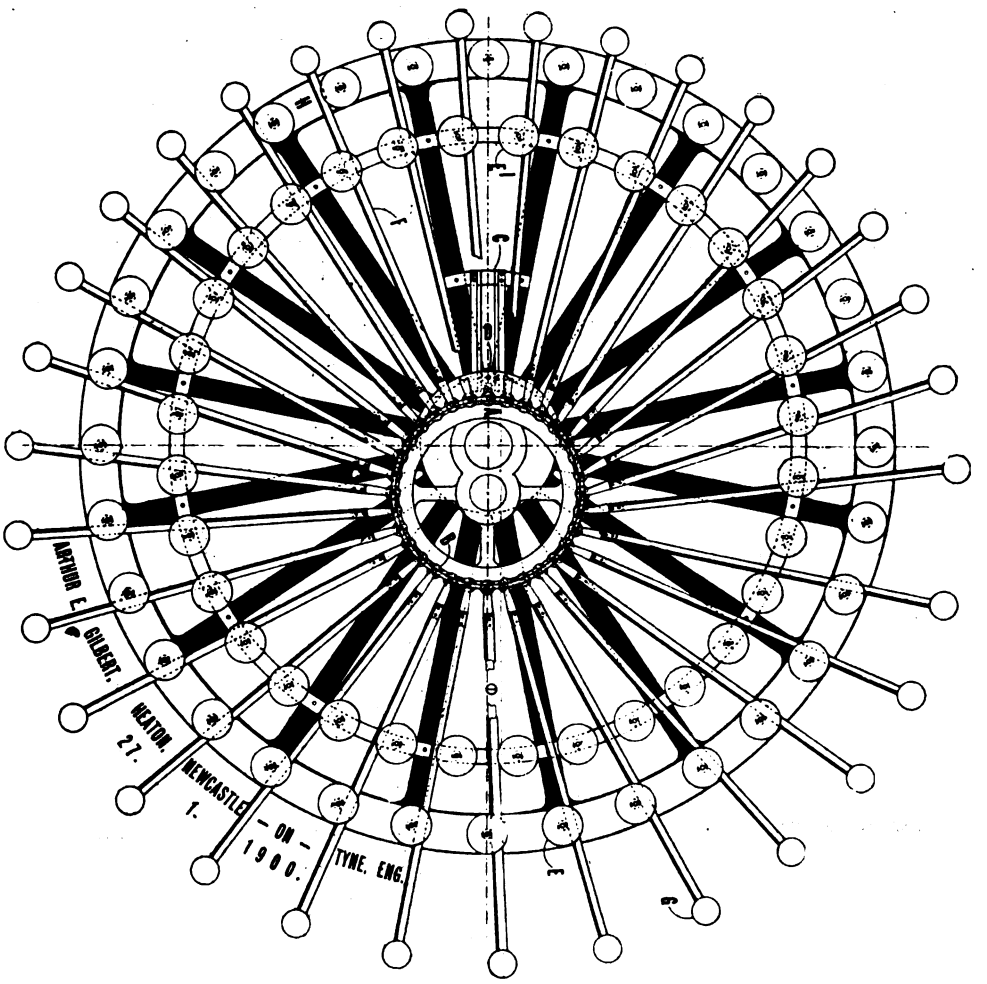

FIG. 2.

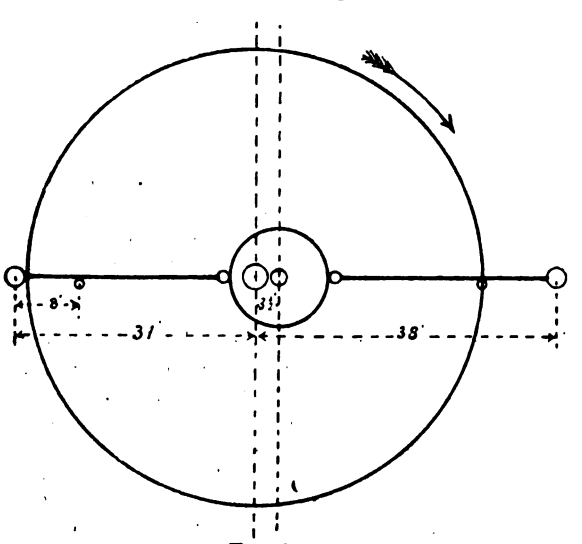

FIG. 3.

We have written to Mr. Gilbert asking him if he has had any models of this machine at work, and if he has made any calculations as to the horse-power which he expects to get from either of the types. He replied by sending us a detail of the machine illustrated in Fig. 2, which detail we reproduce in Fig. 3. He states that from the diagram it can be seen that $38' - 31' + 8' = 15'$ more leverage is obtained on the driving side than on the lifting side of the main wheel axis. This somewhat confirms our view that the designer has not considered the question of the weights moving, neither does he make it clear in what way the rods carrying the weights are constrained to revolve round the eccentric fixed axis. As regards the horse-power, Mr. Gilbert thinks this should be left alone at present, as when once the working of the machine is considered and pronounced possible by our readers, the actual horse-power can be worked out by any "smart mathematician." He also forwards us the design of another machine, which we regret we have not space to publish. Mr. Gilbert asserts that, having gone deeply into the scheme both in model making and drawings, his machine will work continuously without any external aid, and that it will rank among the marvels of the nineteenth century. He thinks that in building the working models there will doubtless be required little improvements here and there to make the machine perfectly mobile. We leave any further explanation of the faults in Mr. Gilbert's conclusions to our readers.

Porcelain Work.—The *Western Electrician* states that a new process has been tried, with satisfactory results, for working porcelain by means of the electric furnace. By this process the porcelain is heated when in a fine and dry powder up to a temperature of about 3,200deg. C. At this temperature it fuses and is then run into a specially prepared mould, the interior of which is polished so as to give a glaze to the porcelain. In this way when the article leaves the mould it is practically completed, and no further work is required to finish it. If, however, defects should be found, they can be glazed over in the usual way, or by powdering the article with glass when the temperature has fallen below 1,800deg. C. The process is said to be an economical one, if the cost of electricity is low, but we are not told whether the porcelain produced is mechanically strong, or whether fine screw threads can be cast in it.

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THOSE POWER BILLS.

The poor are always with us, so it seems are the Power Bills. Step by step, however, the latter are going onwards and upwards till some day we may expect them to appear fully fledged. A glance through the speeches on these Bills on the second reading last week will show how well members can say what has been put into their mouths without having any due appreciation of the real facts of the case. It is time to be cynical, and to say that no one attempted to go into the merits of the case, nor do we intend to do so. Both parties can make a good fight, both have much to say in their own favour, but for once we are special pleaders. Our text is progress, and the two questions to be decided are, in what direction does progress lie, and how are we to most quickly move in that direction. Assume, as we have previously done, that compromise—and that of a simple character—will bring the antagonistic parties into line, is there any reason why a clear course in the direction of progress should not be obtained? Now look back—the time is not long, at the longest from 1878. We began with arc lighting, and promoters went mad about its advantages and the supineness of authorities in not adopting it when presented to them. The stations were small affairs, and would be looked upon now as useless. Then came incandescent lighting, and a change. The light was adapted to both outdoor and indoor work. Again came the outcry, "Municipal supineness and municipal inertia." "Give us monopoly!" cried the promoters. "Won't," said the authorities, neither troubling to ascertain that, for the time, at any rate, the work must be in most instances of the nature of a monopoly. The lesson of any manufacture is the same—increase the output (there may be limiting conditions) and you decrease the cost. That is the point under consideration. The authorities did move, and have not done badly. The cry about the Continent and America being ahead is both true and untrue, and that being so, the half-truth about the statement is the worst lie possible to disprove. Be that as it may, progress that has lessened cost of manufacture, and so smaller charge to the consumer, seems to be in the direction of larger factories, but we may say at once that the information as to limiting conditions is very much a matter of conjecture, and there is absolutely no proof except promoters' words that some of these schemes are in the direction of progress. If they were all sanctioned to-morrow, the investing public would be fools to risk their money till some one or two had been thoroughly tested. We have close at home one fairly large station that has concerned itself a good deal with generating and supplying in bulk. The reference is to Deptford. That station has been a kind of a stand-by to several of the other London schemes when they have wanted help. But there are great differences between the Deptford station and the new station of the Metropolitan at Willesden, and the proposed generating centres of these power schemes. Still, these two examples go to point out that under certain conditions generation in bulk is a step in

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advance. There are only two ways of getting this advance: (1) by individual enterprise; (2) by municipal or corporate action. Consider the latter first. Is it conceivable that an authority controlling an artificially bounded area—an area only partly concerned in these large schemes—will of its own initiation enter into the design and carrying out of such a scheme? Candidly, it seems useless to expect such a thing. The authority's attention is taken up with its own work, and it mostly lets its neighbours look after their own. Only when roused by some outside action does an authority try to over-ride or combine with its neighbour to work to a common end. Thus we cannot look for initiation to authorities, and must come back to individual action. There is no help for it. Parliament may fret and fume, may obey for a time the dictation of the local authorities, but in the long run is powerless to dam the stream of progress. The result is inevitable. It can be seen by all who look into the question, and the only trouble is vested interests. The signpost of electrical progress points to large stations generating in bulk. Vested interests stand in the way, and must be considered; hence the sole problem is the terms of compromise—how not to injure what has already been granted and yet permit of forward action.

THE SEND-OFF DINNER.

The send-off dinner to the active-service contingent of the Electrical Engineers (R.E.) Volunteers duly came off at the Prince's Restaurant on Saturday last, March 3, 1900. Major Crompton brought his merry men from Chelmsford, and they were received by the hon. colonel (Lord Kelvin) and the other hosts. Smart and soldierlike were the men, and under the words of command but few minutes passed before greatcoats were stacked and a move made to the dining-room. Captain Erskine arrived early, and duly arranged the seats, so that not the slightest hitch in the proceedings occurred. The room set apart by the management of the Prince's was comfortably filled, and after the chairman (Lord Kelvin) said grace, the company sat down to a dinner that was pronounced excellent, to wines that were more excellent, and subsequently listened to speeches that were most excellent. We have often heard the British "hurrah," but never remember a greater volume of sound more heartily and honestly given from an equal number of men than was heard again and again throughout the evening. But we must on. Here is a list of the hosts:

Mr. H. Alabaster, Mr. Ll. B. Atkinson, Mr. W. W. Beaumont, Mr. S. W. Beevor, Mr. C. H. W. Biggs, Mr. T. Blisset, Mr. B. B. Blount, Mr. Bond, Mr. M. Byng, Mr. A. H. Carter, Mr. W. G. Carter, Mr. A. Colson, Mr. H. W. Couzens, Mr. Cowen, Mr. W. J. Crampton, Mr. C. W. S. Crawley, Mr. H. G. E. Cross, Mr. M. C. Dent, Lieutenant K. Edgcumbe, Mr. H. Edmunds, Captain R. S. Erskine, Mr. S. Z. de Ferranti, Prof. G. Forbes, Mr. Neil Forsyth, Mr. E. Fox, Mr. T. E. Gatehouse, Mr. J. M. Gorham, Mr. R. K. Gray, Mr. W. E. Gray, Mr. R. Hammond, Mr. H. E. Harrison, Mr. J. H. Harrison, Lieut.-Colonel H. S. Hassard, Mr. W. C. C. Hawtayne, Mr. M. Heaphy, Mr. Hedley, Mr. H. Hirst, Mr. A. Hodgson, Captain B. Hopkinson, Mr. A. H. Howard, Lord Kelvin, Mr. H. R. Kempe, Dr. A. B. W. Kennedy, Mr. A. J. Lawson, Mr. H. Lea, Mr. E. H. Leaf, Mr. W. G. McMillan, Mr. W. M. Madden, Mr. W. L. Madgen, Mr. E. Manville, Mr. C. P. Martin, Mr. Moore, Mr. W. M. Mordey, Dr. A. Muirhead, Major S. Flood Page, Mr. J. B. Peace, Lieutenant J. E. Pearce, Prof. J. Perry, Mr. E. J. Piper, Mr. G. A. Poynton, Mr. G. L. Preece, Sir W. H. Preece, Mr. H. Reason, Mr. F. R. Reaves, Mr. F. E. Rendle, Mr. T. E. Rich, Mr. E. Rorke, Mr. T. J. Rorke, Mr. A. W. Sclater, Mr. S. Sharp, Mr. J. N. Shoolbred, Mr. A. Siemens, Mr. C. H. Stearn, Mr. A. S. Suckling Baron, Mr. J. W. Swan, Mr. J. Swinburne, Mr. A. A. C. Swinton, Mr. E. Talbot, Mr. H. A. Taylor, Mr. A. P. Trotter, Captain Underwood, Prof. W. C. Unwin Captain R. Wallis-Jones, Dr. Walmsley, Mr. F. Webb, Major-General Webber, C.E., C.B.

Here is a list of the guests:

Major R. E. B. Crompton; Captain F. L. Lloyd, R.E., Captain A. Bain, Captain H. M. Leaf; Lieutenant J. J. F. O'Shaughnessy, Lieutenant A. H. Pott; Second-Lieutenant J. H. Stubbs; Sergeant-Major Brown, R.E.; Sergeants Ruse, R.E., H. S. Phillips, W. S. Entwistle, T. H. Brown, and A. Charlton; Corporals H. F. Bigge, H. H. Bicker-Caarten, F. W. Dalton, and J. H. Stone; Second-Corporals A. H. J. Graham and J. P. Williams; Sappers S. W. Melsom, R. W. Holliday, J. M. Bowey, G. F. H. Elliott, F. C. Weakley, J. Rook, D. F. Colson, G. Charlton, E. C. Short, F. J. Wallis, A. Devonshire, C. Landon, W. H. Hossack, C. F. Love, R. H. Brander, H. R. Allen, M. N. Crawford, H. A. Paris, F. J. Young, C. E. Silverthorne, H. Bertram, E. J. Wright, H. B. Tilley, A. J. Hodgson, E. J. West, L. H. Hounsfield, F. J. Phillips, E. C. Horsley, N. W. Pirrie, F. C. Stephens, C. H. R. Thorn, A. R. Peart, R. B. Roberts, A. E. Levin, D. G. W. Hume, and W. C. Cook; also Captain D. Brady, R.E., adjutant, and Dr. Bateman and Surgeon-Major Stephenson, hon. medical officers.

The measure of the enjoyment of the hosts was simply the measure of the enjoyment of the guests, and we venture to say that no man present will forget during the term of his natural life the scene at this dinner. It conclusively showed the bond of brotherhood that exists between all members of the electrical profession, whatever their position, and how keen an interest is taken in our representative volunteers.

After dinner Lord Kelvin returned thanks, and then in a few graceful words gave the toast of "The Queen," a toast which was enthusiastically received amid the strains of the National Anthem.

Let us proceed rather out of the regular order here to say that during the evening Mr. T. E. Gatehouse favoured the company with several violin solos, while Mr. T. H. Harrison gave a couple of songs and Mr. E. Rorke gave a recitation. It is unnecessary to speak of the ability of these gentlemen—that is well known. Their kindness in so assisting was highly appreciated. Nor must we forget the thanks due to Mr. Edmunds, who acted as treasurer, and, indeed, as general factotum; Mr. McMillan, who acted as secretary; and Mr. Wallis Jones, who arranged the musical proceedings. These gentlemen have borne the brunt of all arrangement, with the result that it was good. Each guest was presented with mementoes in the shape of a silver matchbox and a flint-steel-tinder arrangement to take the place of the matches when the box was empty, and the nearest shop far away.

After "The Queen," smoking became general.

The toast that followed was "The Prince and Princess of Wales and the other members of the Royal Family." In proposing this, Lord Kelvin referred to the evidence seen everywhere of the great and continuous interest the members of the Royal family take in all that concerns the welfare of the country, and just now especially in the welfare of our military forces in the field, their sensitiveness to all forms of suffering, and their desire to cheer and comfort all those who need consolation.

The toast was heartily received.

The general tone of the speeches can be summed up in Gerald Massey's lines:

> This triumph of the spoken word
> Is well, my England; but give heed,
> The world leans on thee, as a sword,
> For freedom in her battle need.
> Star of a thousand battles red,
> Be thou the beacon of the free,
> Turn round thy luminous side and shed
> God's light o'er land and sea.
> Through flood, or flames, or bloody sweat,
> Keep thou the old flag flying yet.

Sir W. H. Preece, in proposing "The Navy, the Army, and the Auxiliary Forces," probably made one of the best speeches he ever made, and that is saying a good deal; while Major-General Webber, in responding, suggested that the engineers ought to rank as the fourth arm of the service—equally with infantry, cavalry, and gunners. Then came Lord Kelvin with the toast of the evening,

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and he surprised most of us who really had some idea of his ubiquitousness that long ago he served as captain in the Lanark Volunteers, and he told us that their uniform was a colourable imitation of that worn by the volunteers around him. Hence it was as a comrade to comrades he spoke to them, pointing out the danger and difficulties before them, foretelling that in their arduous duties they would need all the knowledge they possessed as well as fortitude, and would in the end return crowned with honour, victorious, and he trusted without loss to their number. It was the re-echoed God-speed and a safe return. Needless to say, the toast was cheered to the echo, and Major Crompton, in his reply, spoke of the uniqueness of the equipment. He could not tell a full tale, because whatever he said would be flashed even as far as Pretoria, and he preferred to keep his secrets till in front of the enemy. The reason for taking steam traction engines was that only steam could as yet be relied on. Petroleum spirit was impossible in camp. The searchlights were of a new design, and possessed features he could not divulge, yet he hinted of great advances in the art and possibly great achievements in the field. They were mounted on gun carriages. With their telephonic equipment they hoped to do good work, and although there was a good-natured laugh at the mention of cyclists the corps would show what they could do with these implements and reels of wire in connecting distant points so as to put them quickly into communication. He was proud of his contingent, and doubted if any other contingent in the country could point to the fact that every man presented passed the doctor.

Captain Lloyd also responded. He was received with great cheering, and said he was rather a worker than a speaker. Earlier in the war he had asked to go to the front in any capacity, and when his chance came his first thought was one of exhilaration, then he wondered what kind of men he was to command, and what they knew. After talking to them, he wondered at the patriotism that caused such an able body of men to volunteer—men, many of whom held good positions, earned good salaries, and yet, when the call came, were ready to go to the front for Queen and country.

Then Prof. Perry, in that inimitable way of his, proposed "The Right Hon. the Chairman," who replied, and called for "God Save the Queen," when a pleasant and memorable evening ended.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

Inaugural Address of Dr. Ed. Hopkinson.

To be elected your president is an honour which I highly appreciate, but so soon as I had accepted the invitation of your council and began to reflect on the duties of a president, I felt serious misgivings as to the possibility of discharging them successfully. The first of such duties is the preparation of the inaugural address of the session. Electrical engineering, though in a sense the most specialised of all branches of engineering, is really the most cosmopolitan, depending upon many branches of fine science-mathematics, the whole range of physics, chemistry, and even to some extent the biological sciences, and playing an integral part throughout the vast field of engineering; and so the choice of a subject is a matter of no little difficulty.

I suppose there are in England alone at least a score of societies whose proceedings are more or less of interest to electrical engineers, and whose members are annually addressed from the chair; in fact, taking account of the various sub-sections of such societies, I apprehend there are no fewer than 50 presidential addresses yearly. Surely the time has come when these might be curtailed both in number and length, and the time more usefully spent in other directions, for how is it possible except for the very few in the vanguard of science to say aught that is new, and that which is old it is vain to repeat. I might indulge in retrospect and recount the statistics showing the vastness and rapidity of the progress of electrical engineering, but I see that one of your past-presidents has laid it down that this of all things is to be avoided as weariness, or I may number myself with the prophets and speculate on the future; but should I not be encroaching on the prerogative of my successor who may occupy this chair next year, and may consider the change of the century a fitting occasion for retrospect and forecast. I choose a lower level to-night, and propose to refer in the few remarks I shall address to you to what may be described as the domestic politics rather than the principles of any branch of electrical engineering, and particularly of our own society.

In looking through the list of our members, one cannot but be struck by the very large proportion who are intimately and directly connected with manufacturing engineering concerns. Unlike the London Institution, with which we are now incorporated, we have comparatively few consulting engineers on our roll, still fewer professors, and I know not if we have any amateurs, but the larger proportion of our local members are in one capacity or another actively engaged in the management and control of the many industrial undertakings, either private or municipal, of which Manchester is probably the most important centre in the world. I do not feel, therefore, that apology is needed if I refer to some of those questions which more particularly concern the welfare and progress of such undertakings, and which we either in our corporate capacity or as individuals may largely influence.

English electrical engineering has been and is passing through a momentous epoch of its history. Before recovering from a strike of unprecedented length and extent, a period of extraordinary expansion in the general trade of the country, and quite sudden realisation by the public of the advantages of electric lighting, electric traction, electric transmission and distribution of power, and many other applications of electric energy, has led to great demands on both manufacturers and undertakers, for which it cannot be said they have by any means been fully prepared, with the result that large orders for electrical plant have been placed abroad. Patriotic English newspapers are full of lament and recrimination against those who are responsible for placing such orders; unpatriotic papers, of gibes against the backwardness of English manufacturers and the decadence of English manufacture; and the foreign Press indulges in more jubilation over an order for a locomotive or a dynamo secured from England than over ninety-and-nine which the development of their own country requires. It is not our business to join either chorus, but it quite naturally concerns us to seriously enquire into the causes of these events. Let us take it for granted, for a moment only for the sake of argument, and we will return to the assumption later that the conditions in England are generally as favourable for manufacture as they are in other countries; then it is obvious that undertakers, including under the term more particularly municipalities and public companies, who are undertakers in the parliamentary sense of the word, ought not to deprive their own ratepayers and constituents of work and order abroad, except by reason of inability of otherwise obtaining delivery in reasonable time or of serious difference in price. Primarily dependent, as they are, for their own prosperity upon the full employment of the working classes of this country, they cannot regard with indifference the passing of any work out of the country which can be done in it; nor can they throw the odium of unpreparedness entirely upon the manufacturers, as it is, I venture to think, as much their business and their interest to so forecast the future as to take such steps for increase of their plant to afford ample time for properly digested plans of extensions, and for the execution of the work, as it is the business of the manufacturer to provide the appliances for construction. Would the nation relieve the Admiralty or War Office of responsibility if they suddenly found that they wanted ships and guns with such rapidity and in such quantity that they had to buy in Germany. Would it not rather hold that the departments had shown lack of foresight and due preparation?

I asked you a moment ago to grant, for the sake of argument, that the conditions in England are generally as favourable as in other countries. Are they?—a large question with many answers. In one respect it must be admitted they are. English manufacturers find no inducement, either in price or in quality, to buy their coal, iron, or steel except in relatively infinitesimal quantities from abroad. But are

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our conditions of labour and our capabilities of design and management equal to those of foreign competitors? I cannot refer to the first without some apprehension, lest I should step on forbidden ground, knowing that opinions are various and feelings strong; yet for this very reason I think the problem cannot be too freely or openly discussed. Let us compare some of the conditions of labour which obtain with us and those which obtain in the United States. Given a particular piece of work, done in a particular way and with given appliances, I have never seen any evidence to prove that the work is done more cheaply in America. The American workman has higher wages and probably accomplishes somewhat more in a given time, so that the net result is probably about the same. That the output of an American workman is somewhat greater than that of his English brother is partly due, no doubt, to mere physical causes, a more bracing climate during the greater part of the year, and the fact that American workshops are, as a rule, better lighted, heated, and ventilated than most English shops, and that more attention generally is paid to hygienic conditions, partly to the greater stress which characterises American life generally, and has grown to be inherent in the national character, but chiefly due to the fact, in my opinion, that American workmen are in general very much better educated than English workmen—not in the sense of mere technical knowledge of their work, but are generally more cultured and have a wider mental horizon. I believe it to be a quite general law of human effort that the better educated a man is the harder he will work at whatever his hands find to do, and that apart from the question of skill of handicraft an educated man will produce more in a given time than the uneducated. The cultured man has more to look forward to, when his work is accomplished, and values his earnings and his leisure more highly, and so has greater incentive; and, accustomed during his years of early training to constant effort, it becomes a mental and moral habit to work to the utmost of his capacity. An utterly uneducated Russian weaver can mind but a single loom and is content to work 72 hours a week, for what value is leisure to him? The better-educated English weaver will mind four looms and do the work better. If these considerations be true, we may anticipate the future will bring a gradual increase in the rate of work, as our educational systems become more developed and extended, as, indeed, has no doubt been the case during the last 50 years; but this tendency will bring, and has brought, us to face another problem—viz., the time of working. Concurrently with increase in the rate of work, there has been a steady diminution in the hours of work, and probably we have not yet reached the limit. Here, again, I tread on debatable ground; but I may say at least that whatever solution of the problem we may arrive at, it is at least capable of exact enunciation. The efficiency of a particular manufacturing plant is measured by the ratio of the difference between the market value of the production and its cost to the capital employed. There are various fixed losses or charges, rent, rates, management, and so on which I need not enumerate. There are other charges which are a function of the time during which the plant is worked—for example, cost of power, lighting, etc., and, finally, there is the cost of labour, which, again, is a function of the hours of labour. Maximum efficiency is therefore determined by a linear differential equation. The problem has its counterpart in the determination of the proper size of a conductor for the transmission of electric energy, the solution of which is expressed by Lord Kelvin's rule, or it is perhaps still more analogous to the problem, when is a dynamo working at maximum efficiency? the answer to which is, as you know, when the C^2R losses in the armature are equal to the sum of all other losses. Unfortunately, dynamos never do work at their point of maximum efficiency, as long before then injurious sparking takes place and the armatures are overheated. Possibly similar phenomena would occur in our workshops if you endeavour to apply too vigorously the solution I have indicated. The solution depends primarily on the function you choose to represent the dependence of the cost of labour in the hours of work. I shall not venture to discuss it here—probably personal equation may largely influence it, but if any of you are inclined to work out the problem for yourselves on the lines I have suggested, I would commend to your notice the very excellent and truly scientific investigation recently made by Mr. Crompton into a corresponding and just as difficult a problem—the proper length of crank in a bicycle—pointing out in passing that, in general, a long crank corresponds to short hours.

But to return, we assumed for the argument in comparing English and American labour that the appliances were the same, an assumption at the present time certainly not generally justified by the facts. American electrical industry, at any rate, in so much more concentrated into comparatively few shops on a larger scale than most of our English shops, that there has been far greater possibility of standardisation in every detail, and repetition of types, and consequent inducement to the introduction of automatic machine tools; but our workshops are changing in this respect, and any ground we may have relatively lost may be regained, and certainly will be recovered if those responsible for the laying-out of our electrical undertakings realise that machinery of standard size and manufacture is not only cheaper, but intrinsically better and more accurate in workmanship than machinery built to suit their own particular idiosyncrasies. A cotton-mill is laid out and designed for the accommodation of the maker's standard frames and mules, and a weaving-shed for standard looms running at well-ascertained speeds; and who would think of asking a Lancashire boilermaker for a boiler 29ft. by 7ft. 9in., instead of 30ft. by 8in., because he wanted 5,800lb. of steam per hour instead of 6,000lb.? But too often is the builder of electrical plant forced to design his plant to fit the station and to meet all manner of conditions which ought to have been subservient to the plant.

No doubt the introduction of automatic machine tools in England has been and is attended by many difficulties with the workpeople, but I am optimistic enough to believe that as our workpeople become better educated and more intelligently alive to their own interests, these difficulties will rapidly disappear. This is not by any means necessarily coincident with the larger adoption of piecework, and will not, I think, be solved by this means. Piecework is open to many objections, and often breaks down. Rightly or wrongly, it is always regarded with suspicion by the English working-man, and is often unsatisfactory to the employer. Though in some American shops it has been adopted to large extent with satisfactory results, there is much less piecework in practice in America than is generally supposed. The largest engine-building shop in the world has no piecework whatever; but a modification of it, with which you may, perhaps, not be acquainted, but is well worth study, is largely obtaining in America. I refer to the system known as the "premium" system, where the workman, while receiving in any case his rated wages, has a definite price fixed for each piece of work, and divides with the employer, according to an agreed scale, any profit made by producing at a lower cost than the fixed price.

Once more return to an assumption I made in an earlier part of my remarks—viz., that the management of our English manufacturing or undertaking businesses is on a par with that of corresponding businesses in the United States, and under the word "management" I would include not merely shop and works management, but all that makes for intelligent and scientific design and technical control. I will not attempt an answer as to whether the assumption is justified, but it is worth noting that our American competitors have given proof of their own views on this point by the fact that more than one are establishing works in this country. They at least must have come to the conclusion that the general conditions of manufacture are as propitious in England as they are in the States; that labour difficulties are no greater here than there, but that, by the introduction of the appliances they have so well worked out, the systems of shop management, and the designs and technical control they have elaborated, they look for advantages which justify their emigration. Whether it be a fact or not that we have any leeway to make up in this direction, it is at any rate a profitable reflection to consider how we have lost ground, if lost it we have.

(To be continued.)

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FORTHCOMING EVENTS.

FRIDAY, MARCH 9.

Royal Institution.—At 9 p.m., discourse on "Bacteria and Sewage," by Prof Frank Clowes, D.Sc.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "The Distribution of Stress in the Walls of a Thick Cylinder," by Messrs. J. Duncan, B.Sc., W. A. Wales, and G. J. Day.

Physical Society.—At 5 p.m., ordinary meeting. Papers "On the Damping of Galvanometer Needles" by Mr. M. Solomon; "On the Distribution of a Gas in an Electric Field," by Mr. G. W. Walker; and an exhibition of a surface-tension lecture experiment, by Mr. C. E. S. Phillips.

SATURDAY, MARCH 10.

Royal Institution.—At 3 p.m., Lecture II. of six on "Polarised Light," by Lord Rayleigh, M.A.

Institution of Electrical Engineers.—At 11 a.m., students' visit to the works of the Langdon-Davies Motor Company, Limited.

Institute of Junior Engineers.—At 7 p.m., conversazione at Westminster Palace Hotel. Reception by the President.

Glasgow and West of Scotland Technical College Scientific Society.—Paper on "Notes on the Mechanics of Cycling," by Mr. J. Blacklock Henderson, D Sc.

North East Coast Institution of Engineers and Shipbuilders.—At Newcastle-on-Tyne, graduates' meeting.

MONDAY, MARCH 12.

Society of Arts.—At 8 p.m., Cantor Lecture II. of four, "Photography of Colour," by Mr. E. Sanger Shepherd.

Institution of Mechanical Engineers.—At 2.30 p.m., paper on "Steel Skeleton Construction as applied to Buildings on the American System," by Mr. Brees Van Homan.

TUESDAY, MARCH 13.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Discussion on paper on "A Short History of the Engineering Works of the Suez Canal," by Sir Charles Hartley, K.C.M.G

WEDNESDAY, MARCH 14.

Institution of Electrical Engineers.—At 7.30 p.m., students' meeting. Paper on "How to Order a Steam-Engine," by Mr. Seager.

THURSDAY, MARCH 15.

Chemical Society.—At 8 p.m., ordinary meeting.

FRIDAY, MARCH 16.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to Cathedral Works at Ashley place, Westminster.

SATURDAY, MARCH 17.

Royal Institution.—At 3 p.m., Lecture III. of six, on "Polarised Light," by Lord Rayleigh, M.A.

Institution of Electrical Engineers.—At 11.30 a.m., students' visit to the works of the Electric Welding Company, Pimlico, S.W.

PORTABLE ACCUMULATORS.

With the largely extended use of electricity in medical and surgical work the need for reliable portable accumulators has increased. In the early days the medical man or the surgeon was practically dependent on primary batteries for his source of electricity, and these were by no means easy to maintain. With the improvement, however, of accumulators and the spread of electric lighting on the direct-current system, it is now easy to obtain electrical energy from the mains for charging accumulators, which renders their use most convenient. We have recently had brought to our notice the type of portable battery being manufactured under patents by Messrs. Niblett, Sutherland, and Marcuson, of 16, Chandos-street, Strand. While aiming at high capacities for comparatively small weights, this firm has not neglected the essential consideration of the durability of the cells. In fact, the plates used are of most mechanical construction, and the whole details of the battery seem likely to ensure that the plates will not deteriorate quickly with use. The support for the active material is in these cells entirely surrounded by the paste, which forms a smooth, flat surface. In between the positive and negative plates a porous diaphragm is inserted which has a flat surface on the side adjacent to the positive plate, and a fluted surface opposite the negative. A number of these plates are then put together to form a cell, and are held together by means of elastic bands. By this means a certain amount of expansion can take place in the thickness of the plate without setting up any strains in the supports. We have not had an opportunity of making a test on these cells, but the makers claim that high discharge rates can be taken from them without a serious falling-off in the ampere-hour capacity. They also state that the porous partitions of porcelain which come between the plates do not appreciably increase the resistance of the cell. While these batteries are at present chiefly supplied for medical purposes, they are exceedingly handy for experimental work requiring a current of from one to ten amperes at a comparatively low voltage. As a rule, the batteries are grouped together in a box containing four or six cells, so that eight or twelve volts is obtainable. In connection with these accumulators the firm have also standardised the handy form of variable resistance shown in Fig. 1. The resistance is made up of a series of carbon discs interleaved with discs of metal, which are slightly bent so as to maintain a spring pressure on the carbons. The screw seen at the left hand of the illustration is made with a very fine thread so as to secure fine adjustment. The metal and carbon discs are enclosed in a vulcanised fibre envelope pierced with holes so as to let the heat escape. The addition of the metal discs enables a wide range of resistance to be obtained, which is very desirable in connection with surgical work, where electric cauteries, etc., require heating to an exact temperature.

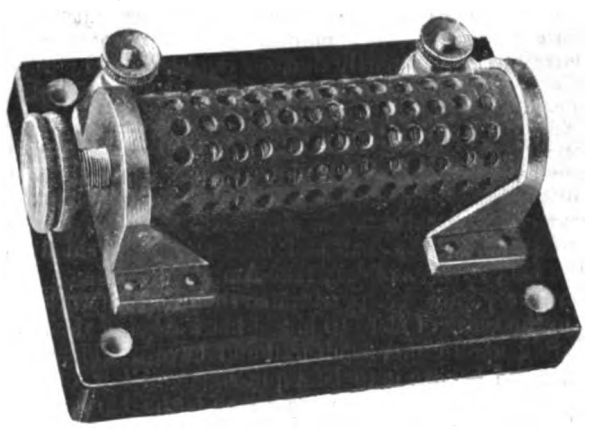

FIG. 1.—Adjustable Resistance for Medical and Surgical Apparatus used in connection with Portable Accumulators.

In order to facilitate the charging of the accumulators supplied by this firm, they have introduced and standardised a charging board, as shown in Fig. 2. The four terminals of this board are used—two for connection to the charging mains, and two to go to the battery. The incandescent lamp in the middle of the board connects in series with the accumulators. When the charging mains have been connected on, the terminals to the battery should be short-circuited, and then the small needle between these terminals indicates which of them should be connected to the positive terminal of the battery. This combination of a pole indicator with the lamp resistance makes it an easy matter to connect up the accumulators in the right way for charging, and prevents the reversing of accumulators, which has often been done inadvertently up to now. As regards the output of accumulators, the makers find that a battery of six cells with a capacity of 30 ampere-hours is most generally useful for medical purposes.

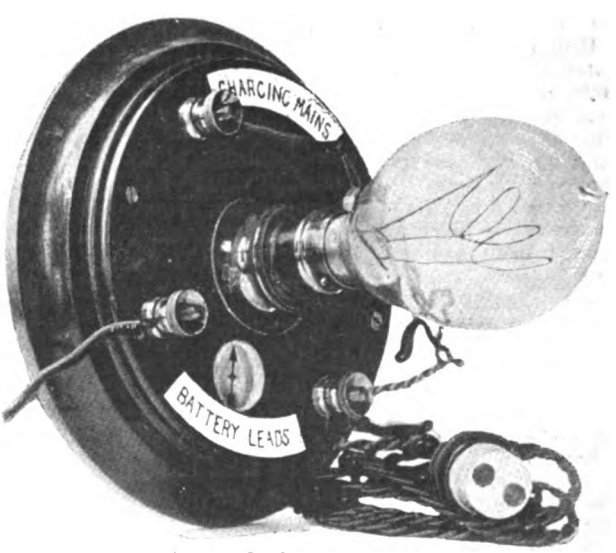

FIG. 2.—Charging Loads for Portable Accumulators.

When at Chandos-street we also saw some high-voltage batteries for insulation testing work giving 100 and 200 volts. These sets weigh considerably less than the standard box of primary batteries, and give the same voltage, and they have the further advantage that an appreciable current can be taken from the cells without damage. For instance, the standard 100-volt testing set will light a 16-c.p. lamp for two hours, so that it can be also employed to test for conductivity. Switching gear is provided on the top of these cases, so that the cells can be grouped in two parallels of 25 in order to charge them from a 100-volt main.

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ELECTRICAL POWER BILLS.

On Thursday week, March 1, the Electrical Power Bills, which have been referred to in detail in previous issues, came up for second reading in the House of Commons.

The Lancashire Power Bill was the first to be brought forward. Mr. MACDONA, speaking in favour of it, pointed out that special clauses were inserted in the Bill to ensure that municipal areas should not be traversed by the company's mains without the consent in writing of the local authority. He was very much surprised at the opposition which had been brought against this and similar Bills, which, he thought, should be referred to a committee in the usual way. Private enterprise in the direction of electric schemes was in danger of being strangled by the municipalities. He thought that such restrictions to private enterprise were keeping back our industries, and hampering competition with Germany, France, and America.

Mr. GALLOWAY, of Manchester, moved that the Bill be read a second time that day six months. He understood that the whole of the local authorities in the Lancashire district were averse to the propositions of the Bill. He explained that the opposition was on the ground that they borrowed money on the security of the rates, and that they should not be subject to competition by private traders. He held that the Bill was in direct opposition to the Electric Lighting Acts and to the Tramway Acts.

Sir J. WOODHOUSE, of Huddersfield, supported the motion for the rejection of the Bill, on the ground that no public advantage had been proved in its favour. He maintained that there was not anything in the Bill to justify the House in departing from the previous policy of the Government. He disputed the first speaker's statement that the public streets could not be used without the consent of the corporation, and stated that by the proposed Bill mains could be laid through Manchester without the consent of the Corporation.

Mr. SETON KARR, of St. Helens, strongly supported the Bill on the ground that only 16 local authorities in the district had electricity works in operation, whereas there were over 100 local authorities who could have established such works. This year there were no applications for provisional orders from Manchester, and he thought that the Bill would provide electricity supply in those districts which had not their own system. He strongly supported private enterprise, which had established our railway system and the various industries throughout the country. He thought the supply of electricity in bulk was too large an undertaking for our municipal authorities, and that the opposition of the municipal authorities was largely due to the action of officials.

Sir WILLIAM HARCOURT advocated that the whole of the Bills in question should be put back for a year, in order that the question might be most carefully considered by Parliament. The procedure as regards railways was not settled until Sir Robert Peel had most carefully gone into the facts of the case. He personally advocated clauses being inserted to the effect that the company would be bound to supply any consumer in their area who might demand connection to their mains. Under the present wording he thought that the company would be apt to supply the remunerative parts of the districts only. He thought that the more correct proceeding would have been for the company to have obtained provisional orders for the places they wished to supply, as they would then have had to consult the individual local authorities. The present Bill avoided this. He thought they ought not to send this Bill to a committee which would give a decision which might act as an inconvenient precedent in the future.

Mr. RITCHIE considered that the statement was true that electrical enterprise in the country was in a backward condition as compared with many European countries, and especialy North America. He would point out that the Bill before them did not enable the promoters to dispense with the consent of the local authority for the distribution of electrical energy in bulk. The promoters only wished to dispense with this consent to the extent of laying mains in the district. For instance, if there were three adjoining districts, it would be unfair for the middle one to prevent connections being made between those districts on either side of it. The promoters of the Bill had given written assurances that they would not supply in any district without the consent of the local authority, and hence it was the case that there could be no competition with the municipal authorities unless this competition were agreed to. On these grounds he thought it would be a mistake if the House refused to allow the Bill to go to a committee.

Mr. HALDANE advocated that the Bill should be referred to a hybrid committee rather than to a select committee, so that the matter could be considered broadly. He held that there was no guarantee that in the future municipal authorities would undertake the supply of power on a large scale. He thought our commercial supremacy was largely bound up in such schemes as those before them.

It was ultimately decided to refer the Lancashire Power Bill, the Durham Electric Power Bill, the South Wales Electric Power Bill, and the Tyneside Electric Power Bill to a hybrid committee. We understand that Lord Balcarres will move to-day that these Bills should be referred to a committee appointed by the Committee of Selection. By this means it is assured that no one of the seven members of this committee will have any interest either personally or in respect to his constituency in the measures to be considered.

BATH ELECTRIC LIGHTING ACCOUNTS.

From the accounts of the Bath electricity works, which have just been issued, it appears that the total expenditure on capital account to Dec. 31, 1899, has been upwards of £63,000. An abstract of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., is given herewith :

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£1,700	16	0			
Oil, waste, water, and stores	554	6	8			
Wages at generating station	780	13	3			
Repairs and maintenance: buildings, £20. 19s. 5d.; engines, boilers, £226. 4s. 7d.; dynamos, £26. 10s. 4d.; other machinery, £79. 10s.	353	4	4			
Other items—discounts	18	16	10			
				3,407	17	1
Distribution of Electricity.						
Wages and other remuneration	2	6	9			
Repairs and renewals of main, £58. 7s. 8d.; less amounts refunded, £47. 7s. 6d.	11	0	2			
Repairs, etc., of transformers, etc., on consumers' premises	28	8	7			
Repairs, etc., at distributing stations	1	6	6			
				43	2	0
Attending and repairs to public lamps				248	12	2
Rents, Rates, and Taxes.						
Rents payable	54	7	0			
Rates and taxes	76	12	7			
				130	19	7
Management Expenses.						
Salaries	1,084	0	2			
Stationery and printing	40	0	0			
General establishment charges	55	12	9			
				1,179	12	10
Law and parliamentary charges				31	11	3
Special charges—insurances, etc.				81	5	0
Total expenditure				5 123	0	0
Amount carried to net revenue account				2,165	15	11
Balance carried forward to provide for bad debts				7	4	6
				£7,296	0	5

Cr.	£	s.	d.
Sale of current per meter at 6d. per B.T.U.	3,019	6	0
,, ,, ,, 4½d. ,,	1,559	10	4
,, ,, ,, 3d. ,,	47	16	9
,, ,, ,, 7d. ,,	34	8	11
Public lighting	2,334	10	1
	6,995	12	1
Rental of meters and other apparatus	258	13	10
Sale and repairs of lamps, etc.	33	1	5
Discounts and allowances	8	13	1
	£7,296	0	5

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	62 548	13	11
Sundry creditors	2,083	15	2
Sinking fund account	1 796	10	8
Balance due to bankers on revenue account	1,627	13	9
	£68 056	13	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	62,843	10	10
Stores on hand: coal, £82. 19s.; oils, waste, etc., £35. 15s. 2d.; general £338. 19s. 8d.	457	13	10
Sundry debtors for current supplied	2 700	12	6
Other debtors	114	5	10
Balance at debit of net revenue account	1,937	11	6
Cash in hand	2	19	0
	£68 056	13	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC

Quantity generated in B.T. units		569,986
Quantity sold { Public lamps	179 261	388,208
Quantity sold { Private consumers by meter	208,947	
Quantity used on works		31 560
Total quantity accounted for		419,768
Quantity not accounted for		150,218
Total maximum supply demanded (kilowatts)		382

Number of public lamps, 88 arcs, 13 50-c.p. incandescents.

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BEDFORD ELECTRIC LIGHTING ACCOUNTS.

The accounts of the Bedford electricity works for the year ending Dec. 31, 1899, have just been published, and give the total expenditure on capital account to date as £67,621. An abstract of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., is given herewith :

Dr.	Revenue Account.	£	s.	d.
Coal or other fuel		2,534	18	6
Oil, waste, water, and stores		354	6	4
Wages at generating stations		688	18	0
Repairs and maintenance		322	10	4
Wages and other remuneration to linesmen, etc.		78	0	0
Attending public lamps		96	12	6
Renewals of lamps		58	1	10
Rents payable		45	0	0
Rates and taxes		137	14	9
Salaries—engineers' department		360	0	0
Stationery and printing		67	10	7
General establishment charges (freightage, etc.)		81	4	11
Boiler insurance, etc.		38	15	0
Lamps used at works, etc.		17	9	3
		4,881	2	0
Amount carried to net revenue account		3,916	14	4
		£8,797	16	4
Cr.				
Discount forfeited, £21. 11s. 4d.; less bad debts written off, £10. 12s 7d.		£ 10	s. 18	d. 9
Sale of current per meter at 4½d. per B T.U.		4 897	11	8
Sale under contracts		1,129	11	0
Public lighting		2,524	8	10
Rental of meters and other apparatus on consumers' premises		193	4	9
Sale of lamps, etc.		3	7	6
Miscellaneous		9	18	10
Power used in pumping water		28	15	0
		£8,797	16	4

General Balance-Sheet.

Dr.	Liabilities.	£	s.	d.
Capital account—amount received		64 248	11	5
Sundry creditors		769	10	3
Balance due to treasurer, £6,100. 11s. 5d.; less cash in hand, £50		6,050	11	5
		£71,068	13	1
Cr.	Assets.	£	s.	d.
Capital account—amount expended for works		67,621	10	5
Stores on hand : coal, £140; oils, waste, etc., £94; general, £101		335	0	0
Sundry debtors for current supplied		2,727	3	3
Other debtors		96	11	10
Balance at debit of net revenue account		288	7	7
		£71,068	13	1

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			702,060
Quantity sold	Public lamps	189,578	540,146
	By contract	90 364	
	Private consumers by meter	260 204	
Quantity used on works			30,000
Total quantity accounted for			570 146
Quantity not accounted for			131,914
Number of public lamps			528
Total maximum supply demanded (kilowatts)			449

THE CHARING CROSS AND STRAND CORPORATION'S FIRE.

The Maiden-lane station of the Charing Cross and Strand Electricity Supply Corporation caught fire on Saturday last, March 3. The fire started shortly before two o'clock in the morning in the basement of the building, running up the cables, and finally reaching the main switchboard. At the time of the occurrence the load was very light, and two engines only were running. There was no indication of any overload, and the officials at the Maiden-lane station do not think that the fire was caused by a short-circuit or other electrical means, and up to the time of writing we understand that the actual cause of the fire is unknown. The Maiden-lane station, where the fire occurred, is the original station of the corporation. In it there are a number of steam dynamos as well as several motor-generators, the current for which is supplied from the company's Lambeth station. There is also another large station belonging to the corporation at Short's-gardens, Drury-lane, in which are motor-generators supplied from the Lambeth works, and both the Maiden-lane and Short's-gardens stations feed into the same network. The Lambeth station, which only runs when required, is shut down at midnight, and was not in consequence running at the time the fire occurred. The network had to be disconnected between Short's-gardens and Maiden-lane, and the supply was resumed in the northern districts from Short's-gardens by 9 a.m. on Saturday. The damage done at the Maiden-lane station is very great, and the whole of the insulation on the cables in the works was consumed. The main switchboard, which was entirely of slate and fixed on iron supports, was cracked and powdered to a remarkable extent. Three of the five steam-engines in the station were injured and rendered unworkable, and great damage was done to the fittings, etc., of the station. It speaks volumes for the energy of the engineer (Mr. Patchell) and the staff under him that by Saturday afternoon two of the machines in the burnt station were started, and during the evening four other machines were dried and put to work. In the evening also the numerous theatres supplied by the company could use all lights which were absolutely necessary, the managers of these theatres meeting the corporation halfway in that only lights which could not be done without were used. The staff have been working day and night in order to repair as far as possible the damage done, and we were informed that within a few days the supply will be given as before, through temporary connections. Of course, until the new switchboard is obtained the regulation of the supply will not be so uniform in the different districts as the company has been previously noted for, but a very good service is to be expected. Too much praise cannot be bestowed upon the engineer and his staff in getting the work in hand as they have done and a fair supply started within so short a period.

In consequence of the fire the Charing Cross and Strand Corporation have issued a circular to the shareholders, which reads as follows : "Sir or Madam, -You will probably have seen a statement in the public Press that a fire took place at the Maiden-lane station of our company on the morning of Saturday last. Considerable damage was done to the works, which, however, is substantially covered by insurance. The only portion of our districts which was prejudicially affected was the southern district, and that in effect only for a few hours. The Board met immediately, and gave instructions to the staff to use every effort to prevent, as far as possible, any stoppage of the supply to our customers. The work was so satisfactorily performed that on the same afternoon we were able to supply the theatres and several other large buildings, and by to-night (March 5) we are practically ready to take up the usual work of the company. My Board think it only right for me at once to communicate this to you, as there have been many exaggerated statements as to the loss sustained and the inability of the company to give a supply. My Board wish to testify to the untiring energy of the secretary, Mr. Seale, and the engineer, Mr. Patchell, and the other members of the staff, in this emergency.—For the Board, W. F. Fladgate, chairman."

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. The matter should be written on one side only of the paper. Questions may be sent at any time.

Questions.

251. Three transformers were being connected in mesh, their primaries to three-phase 'bus bars at 2,500 volts, their secondaries to three-phase bars at 320 volts, and by mistake the primary of one transformer was reversed with reference to its secondary. When alternator was switched on to 'bus bars at proper speed and field only 1,500 volts appeared on 'bus bar voltmeter instead of 2,500, whereas when any one of the three transformers were switched out the volts immediately rose to 2,500. Can any reader explain this ?—W. G. M.

252. Discuss the relative advantages of the different materials available for insulating the conductors on continuous-current armatures giving 100 and 1,000 volts respectively.—G. E.

Answers.

Question No. 245.—Discuss the advantages and disadvantages of three-core and triple-concentric distributors for a low-tension direct-current three-wire system, the cables to be armoured and laid direct in the ground.

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Best Answer to No. 245 (*awarded* 10*s.*).—In discussing the advantages of different types of distributing cables, there are three main points to be considered—viz., the reliability and efficiency of the cable, its first cost, and the cost and ease of connecting consumers' services, joint-boxes, etc.

Reliability and Efficiency.—The three-core cable has a slight disadvantage from the fact that a leak from the positive conductor to the lead sheathing in one distributor, in conjunction with a negative leak to the lead in another distributor, would electrolytically corrode the lead if the resistance offered by "earth" between the two points was low. On the other hand, in a triple-concentric cable the outer conductor is usually the neutral wire of the system, and is earthed, so that any leakage from the positive or negative conductors will strike the neutral before it reaches the sheathing; and as the E.M.F. between the neutral and earth is never high, the danger of electrolytic action on the lead is not great. In the case of the three-core cable, however, the danger would be practically nil if the lead sheathings of all the distributors were metallically connected and earthed. A rather serious disadvantage of the triple-concentric distributor is that two (and with some types of connections, all three) of the conductors have to be cut and connected mechanically every time a consumer's service is joined up. It seems very probable that by the time all the premises in a street have been joined up, the resistance, and consequently the drop in volts, would be higher with this type of cable than in the case of a three-core cable of similar cross section, the resistance of which, of course, would not be affected by making joints on to it.

First Cost of Cables.—The three-core cable is the most expensive, but the difference is under 10 per cent., and there seems no reason why the difference should be as much as that if the cables were turned out in equal quantities.

Cost and Ease of Connecting Consumers' Services, Joint-Boxes, etc.—This is where the three-core cable has the advantage. A service box and connections for a ·25 square inch triple-concentric cable costs about £2, as against about 12*s.* for a service box and connections for a three-core cable of the same size. In addition to this, the triple-concentric box would cost more in labour to fix. This would mean a saving of about 30*s.* per service connected, or, where two services are taken from the same box, 15*s.* per service, which might easily make a difference of £200 to £300 per mile of distributor and services. Another disadvantage of triple-concentric distributor is that it is difficult to connect services to it with the current on, and in cases where the distributor is not fed from both ends it cannot be done. With a three-core cable there is no trouble in connecting up with the current on, as a joint can be made and insulated on one conductor before the insulation is stripped off the other conductor, the third conductor not being interfered with except in the case of a three-wire service. There is no trouble in distinguishing between positive, negative, and neutral wires in either case, as in a three-core cable the insulation of the three conductors is coloured differently, and in a triple-concentric the positions of the conductors distinguish them.

In conclusion, it would seem from the above that the three-core cable has most of the advantages and few of the disadvantages of the triple-concentric cable.—J. R. P. L.

Answer to No. 245 (*awarded* 5*s.*).—The three-core cable has advantages over the triple-concentric, principally because it is not necessary to cut the three-core to put service connections on. With a triple-concentric (the outer conductor being the neutral wire) it is necessary at every other service connection to cut through the outer and middle conductors to make joints on the inner and middle, the other alternate connections to the outer and middle leaving the inner intact. Sometimes all three conductors are used in the same service box when connection is made to two adjoining houses. To avoid cutting the middle conductor it has been proposed to divide the distributor into sections, each connected by a junction box, which changes the polarity of the inner and outer conductors, so that the middle conductor will be + in one section and − in the next, when joints can always be made on middle and outer only and the balance be kept right. Notwithstanding this, service jointing is simpler, cheaper, and safer to do on three-core than triple-concentric, and the chance of low conductivity on the main through badly-sweated connecting sockets is obviated. The distinguishing of the + and − is simple enough, when the neutral is the smaller conductor, by noting its position with regard to either of the others, and where all cables are the same size by special insulating material or colour being used on neutral or by its having some tinned wires in its strand. The service connections are staggered in three-core, one on either side of the centre of joint. Three-core cables are sometimes objected to on account of their bulk, and they are now being made with each conductor drawn down to segmental form, so as to form a circle at their circumference with no waste insulation or worming between, which in the old type preserved the rotundity of the cable for the lead press. This change, while lessening the overall diameter, makes it harder to put services on without stripping the lead farther back.—J. H. C. B.

Question No. 246.—Enumerate the necessary fittings and accessories for a meter-testing room at an electric light station.

Answer to No. 246 (*awarded* 10*s.*).—The equipment of a meter test-room should be carefully considered by every responsible central-station engineer. In many cases (particularly small stations) this matter, which is a most important one, has not received the attention which would have proved profitable in the end. Many central stations have been laid out without any provision whatever being made for the accurate testing of the various types of meters used in the station's supply, the meters in this case being fixed without any test or check upon the certificate of the maker. Some engineers have been content to let the meters out after seeing them start with an 8-c.p. or 16-c.p. lamp, but this simple test, which should not be neglected, is not satisfactory without the test for accuracy, for although the meters might have been correctly standardised before leaving the maker, yet it is possible that disturbances caused during transit may alter the constant of meter 4 or 5 per cent. ere it reaches its destination. From these few remarks the writer has endeavoured to point out the absolute necessity of equipping a meter test-room at every central station, in order to secure good results and satisfaction both to the consumer and to the engineer, a condition of things which is sometimes difficult to arrive at with the former individual. In fixing up the test-room, everything should be designed as simple as possible, in order to easily manipulated and so save waste of time. The room should be as large as possible to avoid cramping the apparatus and other things, and should have a good supply of shelves or a separate stock-room to put the meters in, so arranged that meters tested ready for use may be distinguished from those not tested.

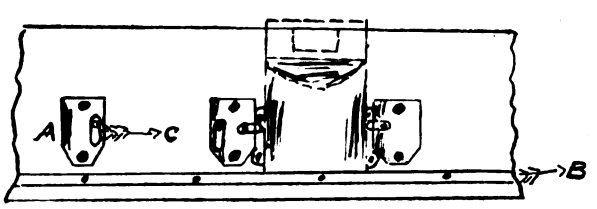

FIG. 1.

Tools.—These should consist of several sizes of spanners, supplied by the makers, large and small screw drivers, a small bench vice, dust-brushes, seals and sealing tongs, and a number of useful watchmakers' tools are required for changing small gear-wheels, etc. The room should also contain a good long bench with drawers, strong and neat, also a form of back board with a ledge for fixing types of meters which are not made to stand up with its spindle vertical without being wedged and packed up true; such a board is shown in Fig. 1.

Instruments.—These should consist of the following: one Thomson balance reading from ·1 to 10 amperes and one reading from 1 to 100 amperes, or higher if larger meters are used, also an ordinary ampere-meter to measure current before putting the balance into circuit, a standard voltmeter

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to read correct voltage across shunt, or, better still, a standard direct-reading wattmeter. These instruments cover the testing of both ampere-hour and watt-hour meters.

Current for Testing.—This should be obtained from four or five secondary batteries, capable of discharging the maximum current required for at least two hours. The difficulty of charging the cells will be overcome by using a small motor-transformer designed to give about 15 to 20 volts at normal charging current. In some instances it might be possible to use the last four or five regulating cells of the larger battery at the switchboard if the test-room is near to it; these cells could then be charged in the ordinary way adopted usually in a three-wire system, but only on the conditions that they are not as a rule required for the supply of the system regularly.

Resistances.—Resistances for keeping current constant are made up in many forms, but a very simple and reliable one, which the writer has used with good results, is shown in the sketch (Fig. 2). E is a frame made of hard wood,

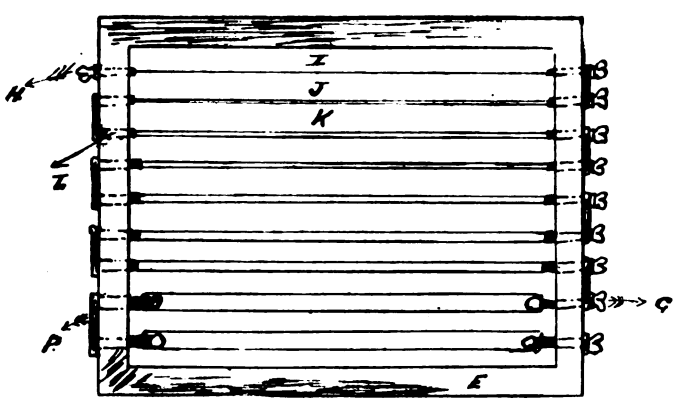

FIG. 2.

about 7ft. long by 5ft. wide, drilled at both ends to receive the metal pins, which are also drilled to sweat the platinoid wires, I, J, and K, into; these are tightened at one end by thumb-screws, and screwed into copper connection pieces, F, at the other end; copper connecting pieces are also used under the washers and thumb-nuts at G. The resistance wires used range from 22 S.W.G. to 8 S.W.G., and finally one or two lengths of strip, 1in. by $\frac{1}{16}$in. thick, may be used for the larger currents. The wires should be spaced at about 3in., thus giving ample room for the sliding connection, which is made by means of a piece of flexible cable sweated to a metal clip made from sheet brass, with a slot filed in the jaws to fit the wires, and a pin and thumb nut fitted so as to screw up the connection tight, as shown in Fig. 3. If there is a quantity of meter testing to be done, a good time-saving device is to have three sliding contacts coupled to a three-way switch so that the position can be found and set for all three loads at which the meter is to be tested—*i.e.*, quarter load, half

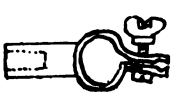

FIG. 3.

load, full load—then by turning the switch to any one of the three contacts, the current will be practically ready for the test.

Connections.—These may be so arranged as to allow the convenient testing of various types of meters. In the case of watt-hour meters the shunts should be coupled in parallel on a separate circuit tapped from the network at the pressure for which the meter is supplied. By suitably arranging the switches either balance can be thrown into circuit, after first adjusting the current roughly on the ampere-meter, which remains always in circuit. A similar method can be used for putting either type of meter into circuit, so that by this means at least six meters of the ampere-hour type and six of the watt-hour type are being tested at the same time. A very great advantage with this arrangement is that either section of meters may be cut out without breaking the circuit, in order to take a short time test on the dials, to see if gearing is correct, the test for the meter's constant having been previously done.

To complete the equipment it is absolutely necessary to have a reliable accurate centre-second chronograph, made to be stopped and started and sprung back to zero by means of the head which winds up the watch, reading to ·2 of a second. A system of stock books and test books should be kept up to date clearly showing the place where a certain meter is fixed, and its accuracy when last tested.—A. H.

Answer to No. 246 (*awarded* 5*s.*).—One important point in connection with the satisfactory testing of electricity meters is undoubtedly the general arrangement of the room to be set apart for that purpose, the dimension and situation of which will, of course, depend upon local circumstances. Yet this room must be sufficiently large to allow of storing as well as testing a number of meters, and should be, where possible, situated on a ground floor to prevent the effects of vibration. The apparatus and circuits will have to be so arranged so as to allow of expeditious and accurate testing being carried out, therefore the lighting of this room will have to be of the best and of a general nature. With regard to the testing branches, the number, of course, will depend upon the extent of the plant in question, but each should be made so that ampere-hour and watt hour meters can be conveniently dealt with. Arrangements will also have to be made so that upon arrival from the makers the meters can be unpacked and taken charge of by a storekeeper, who should record in a book kept for that purpose full particulars as to their capacity, amperes, volts, and maker's number, etc., after which they should be handed over to the meter department, and should then have a label attached to them bearing the corporation's number and stating them to be their property. Then, before the meter is sent out, all these particulars relating to type, make, number, and capacity should be entered in a book kept in this department.

In reference to the actual testing, the primary condition to be secured is a source of energy at the terminals of which the pressure remains constant. A secondary battery answers this requirement, and therefore, whenever possible, a small battery of cells should be installed for the sole use of the meter-testing room; but on no account should these cells be in the same room as the meters are either tested or stored. The charging of these cells is most conveniently performed by means of a small motor-generator fixed near the cells and driven from the town mains. This will, of course, require the usual double-pole fuse, switch, watt-meter, and some convenient regulating apparatus, so as to vary the speed as the charging proceeds. The generator side will also have to be fitted with double-pole fuse, switch, and automatic cut-out, and the generator will have to be shunt-wound, having in its circuit an ammeter and a volt-meter, the latter being arranged so that it may be placed across the terminals of the cells when required. Now, in testing wattmeters a pressure circuit is required, and this can be obtained from the battery across the town mains with suitable resistance in circuit. In all cases there are two distinct tests to be made, each requiring a different arrangement, and the object of each is also different—one being what is called the short-time test, which consists in counting the number of revolutions made by the spindle in a given time and working out the percentage error. On this circuit, therefore, it is of the utmost importance that only the most accurate instrument and adjusting resistances be employed. The batteries will have to be connected to multiple switches, and these switches must be capable of carrying the necessary currents. A useful type of switch is that used for ordinary battery charging and discharging circuits. The number of contacts required will vary with different conditions in the test-room and the various voltages required. The circuits will have to be arranged so that any of the standard instruments can be connected with either the ampere-hour or watt-hour circuits. The resistances to be used in the main circuit must be able to carry the current and vary the same from a fraction of an ampere to several hundred amperes, and must admit of very fine adjustment. For the regulation of current from ·1 to 10 amperes a special adjustable resistance is necessary. The form answering best for this purpose is Lord Kelvin's type, but in cases where the full town voltage is used a bank of lamps is a very useful regulating resistance,

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as are also some kinds of liquid resistances. Some form of testing set will also be required to test the meters for leakage—first, between the main coils and the case, secondly, in the case of wattmeters, from the shunt or pressure coil to the main coil or case.

Now, the instruments required generally will depend upon the quantity and also upon the type of meters to be dealt with. The essential characteristics of the instruments to be used are a clear and well-marked open scale, a sensitive pointer, and an instrument not likely to alter in calibration. Ammeters should be connected on all meter-testing circuits The next and one of the most important instruments for this class of work is the Thomson balance. A set of three of these instruments will be required—that is, the deci-ampere, ·1 to 10 amperes; the deka-ampere, 1 to 100 amperes; and the hekto-ampere, 6 to 600 amperes. These balances should be fixed permanently on the test table. Another instrument which may be used as an auxiliary standard is the well-known Siemens dynamometer. This instrument is very useful and handy, and if periodically checked will give satisfactory results. As regards the high-pressure circuits, all that is necessary is a reliable voltmeter or two having a good open scale. Another instrument which will likely be found necessary is a low-reading voltmeter for obtaining the drop in volts across meters of varying sizes, and under different loads. Then, for taking insulation tests, a Silvertown testing set will be required. The great advantage of this set is that a Wheatstone bridge is combined with it. A certain number of portable ammeters and voltmeters of different ranges will be required for testing meters on consumers' premises. This practically completes the instrument which should be found in a well-equipped meter department, with the addition of one standard instrument for periodically checking all the others—that is, some form of potentiometer, such as the Crompton. J. C. B.

Answer to No. 246 (*awarded* 5*s.*).—The necessary fittings and accessories for a meter-testing room at an electric light station, whether for the calibration of continuous or alternating current instruments, are somewhat numerous, though their manipulation is a matter of great simplicity. In examining the different meters, we find them to consist of two kinds—one being called a coulomb-meter, and the other an energy meter. The duty of the first named is to integrate the varying currents in demand by the consumer, and the time during which these currents extend, without taking notice of the E.M.F. at which they are maintained. The function of the last named, however, is to find the value of all these quantities. Let us take, in the first instance, a station where continuous currents are solely employed. It will be seen that to arrive at the calibration of either a coulomb or energy meter we only require at our disposal a source of current, the means of accurately measuring same and a record of the time during which the current extends. The following apparatus will fulfil every requirement: (1) Crompton potentiometer set, comprising (*a*) potentiometer; (*b*) D'Arsonval galvanometer, with lamp and scale; (*c*) two Clark standard cells; (*d*) two secondary cells; (*e*) three standard resistances for maximum currents of 150, 15, and 1·5 amperes. (2) Secondary battery of, say, 10 cells, having a capacity of 100 ampere-hours, and capable of being discharged at a high rate for short periods. (3) Battery-regulating switch. (4) Resistance frame, with plug switch. (5) Main switch. (6) Double-pole main cut-out. (7) Stop-watch. The cost of this set will not be anything short of £100. With the addition of a ratio-box of high and low resistances, whereby voltages of high value may be compared on the potentiometer, we have a most complete equipment. An examination of Fig. 1 will make clear the mode of connecting up the various pieces of apparatus for the measurement of current.

It is not proposed to enumerate any methods of calibrating meters, as it would be quite apart from the question under consideration. We will, therefore, proceed to examine the requirements of an alternating-current station. The physical nature of an alternating current produces a rate of change in the strength of magnetic field throughout its circuit, inducing a difference of pressure in the circuit, the effect being termed inductance. Owing to inductance and resistance, the current lags in phase behind the waves of E.M.F., and the product of amperes into volts (measured by a Kelvin electrostatic voltmeter) is not a measure of true mean power in a circuit. It will thus be obvious that we require a different set of apparatus to that required for the measurement of direct currents. A set comprising the following

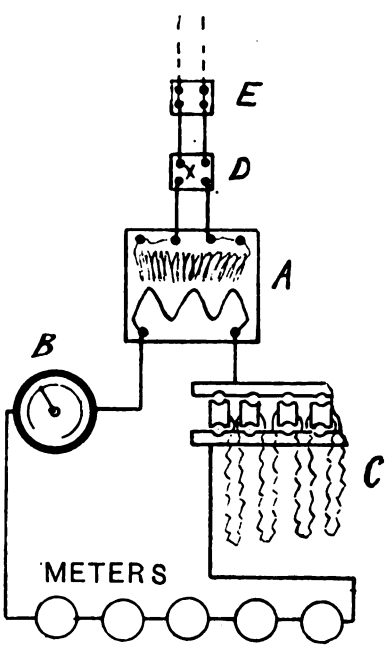

Fig. 1.

instruments and accessories will supply the want: (*a*) one 2-kw. transformer, with ratio for converting down from pressure in distributing mains to about 20 volts; (*b*) electro-dynamometer for current measurements; (*c*) resistance frame, with plug switch, or choking coil; (*d*) main switch; (*e*) double-pole cut-out; (*f*) stop-watch. The plan of connecting up will be as in Fig. 2. Although the pressure is a constant factor in electricity supply from a central station, precaution must be taken when calculating power in alternating-current circuits to apply to the volts a connecting factor dependent upon the function the impressed E.M.F. follows.—W. J. B.

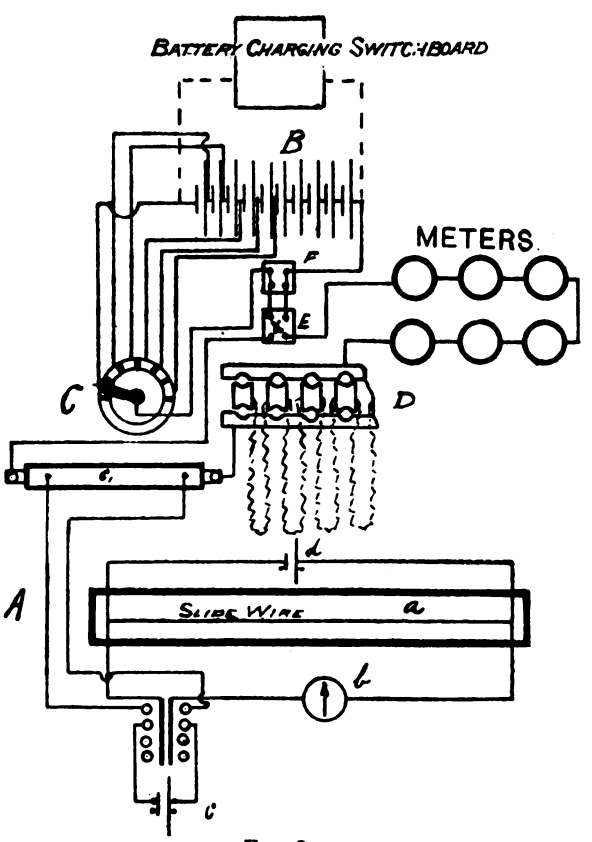

Fig. 2.

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COMPANIES' MEETINGS AND REPORTS.

NOTTING HILL ELECTRIC LIGHTING.

The thirteenth ordinary general meeting of this Company was held on Tuesday last at Notting Hill, Sir William Crookes, F.R.S., presiding.

The **Chairman** said that in the past year all previous records of the Company had been broken. The principal item of the capital expenditure was for new mains. The item of £1,600 for new meters was satisfactory, as new meters meant new customers. There had been a large increase in the number of units sold, and the cost of generating had been brought lower, and was now, he thought, the lowest in London. The number of houses connected at Dec. 31 last was 1,013, against 816 at the close of 1898, and the lamps connected numbered 59,154, against 46,066. The net profit for the past year came to £10,360, as compared with £7,251 for the preceding year, and it was proposed to pay a dividend on the ordinary shares of 7 per cent., being an increase over 1898 of 1 per cent. The Company's Bill had received the Royal assent on July 13. This Act, in addition to conferring power on the Company, in conjunction with the Kensington and Knightsbridge Electric Lighting Company, to erect and work a joint station, gave authority to purchase certain other land which would be required for a distributing station in their own area of supply. The land on which the joint works were to be erected was situated in Wood-lane, Hammersmith, and he hoped that they would be completed this year. The Company's present station was being run to its utmost capacity, and the directors had had to instruct the engineer to refuse all further applications for a supply of current until it was clear when the new works would be available. The other site was in the northern part of the Company's area, and negotiations were now in progress for its purchase. Most of the machinery was on order for this station. A distributing station would also be required near the south-western boundary of their area before they could safely connect new customers in that district. Up to the present time it had been impossible to obtain a suitable site, and if they could not do so in the ordinary course they would not hesitate to apply for an Act giving the Company compulsory powers of purchase. The machinery at these sub-stations would be run by current transmitted at a high pressure through a separate main from the joint works. To complete the whole of these arrangements additional capital would be required, and he expected that their immediate requirements would be, roughly, £30,000. The authorised capital of the Company remaining unissued was only £19,000 debentures, so that it would probably be necessary soon to call the shareholders together again to create new capital. The method of raising the money for the joint works had not yet been decided on. Meanwhile, the bankers had advanced the capital required on the joint and several guarantee of the two companies. To the end of last year £5,000 had been borrowed in that way, and it would, of course, be paid off so soon as the new capital was subscribed. In conclusion, he moved the adoption of the report.

Mr. J. F. Jervis seconded the motion, which was carried unanimously.

CHELSEA ELECTRIC SUPPLY.

The annual meeting of this Company was held on the 7th inst. in the Town Hall, Chelsea, Mr. J. Irving Courtenay presiding.

The **Chairman**, in moving the adoption of the report, said the dividend of 6 per cent. on the ordinary shares had been maintained, although the capital was increased at the end of 1898 by a debenture stock issue of £40 000. At Alpha-place the large generating station had been completed, and would be able to serve a total lamp connection of 150 000.

Major-General Webber, C.B., seconded the motion, which was adopted.

WINDSOR ELECTRIC LIGHT.

At the annual meeting of this Company on Wednesday, the report of the directors stated that the number of lamps and motors installed was equivalent to 13,878 of 8 c.p., 7,914 having been added during the year. Large additions was also made to the mains and machinery during the year, no less than £21,947. 16s. 1d. having been spent on capital account to meet the demands for public and private lighting. The Company have entered into contracts with the towns of both Windsor and Eton for lighting the streets for five years, and although they do not expect to derive much profit from this source, it will encourage a more general use of electricity. Many lights have been added to Windsor Castle, and large additions are in hand. The parish church and town hall have had the light installed, and large additions made at Eton College, whilst experiments have also been made at St. George's Chapel with a view of lighting it with electricity. The net profit for the year was: installation work, £1,577. 16s. 2d.; lighting, £2,552. 0s. 7d.—total, £4,129. 16s. 9d., against a total of £2 539. 12s. 9d. for the previous year. Including £491. 12s. 11d. brought forward, the total amount of profit available for distribution was £4,590. 12s. 3d., and the directors recommended a payment of 8 per cent., which was accepted. This left a balance of £2,298, of which the directors recommended that £750 be added to the reserve fund, £500 to a special fund for equalising dividends, £350 as directors' fees, the remainder to be carried forward as a balance. During the year £10,000 further capital was made, at a premium of 2s. 6d. per share, and the premiums, amounting to £1,272. 0s. 6d., was added to the reserve fund, bringing it up to the substantial total of £2,922. 0s. 6d. An issue of £15,000 capital was also made at a premium of 5s. per share to shareholders only, from which it was stated shareholders derived considerable benefit. In the early part of the year the current was reduced to 6½d. per unit, but the cost of production was heavy owing to the abnormal price of coal. The report was considered highly satisfactory.

AMAZON TELEGRAPH.

The fifth ordinary general meeting was held on March 2 at the offices, Moorgate Station-chambers. **Mr. D. H. Goodsall**, who presided, in the absence through indisposition of Mr. W. S. Andrews, moved the adoption of the report, which showed as the result of the year's working a debit balance of £29,000. He said that the traffic existed, and if the cables could have been kept working the accounts would have presented a very different appearance. They were now being successfully repaired. In three places the lines had been diverted, and he hoped that this change would lead to the permanent maintenance of these parts of the system. The directors had obtained a concession for a land line, which they hoped shortly to be able to erect. Part of the material had already been dispatched. If the undertaking could be kept at work the Company would earn £27,000 a year in subsidies, in addition to which a good traffic existed. The motion was adopted.

OLDHAM, ASHTON, AND HYDE ELECTRIC TRAMWAY.

The report for the year ended Dec. 31 last states that during the year £40,000 4 per cent. debentures have been issued. The premiums received, less expenses, amount to £322, and this sum has been placed to a reserve fund. In order to cope with the traffic it has been found necessary to obtain eight additional motorcars and 12 trailer cars, and to extend the car depôt to provide facilities for storing the extra cars. The total capital expenditure now amounts to £121,462. The total revenue from the date of commencing to work (June 12, 1899) to Dec. 31 last amounted to £12,606 and the expenditure, including debenture interest, to £8,186, leaving a net profit of £4,420, which the directors propose should be applied as follows: dividend at the rate of 5 per cent. per annum on the cumulative preference shares from Aug. 15 to Dec. 31, 1899, £750; amount owing to the guarantors, being advances made by them to meet dividends on the cumulative preference shares from Jan. 18, 1898 (date of allotment of shares) to Aug. 15, 1899, £2,552; amount to be placed to depreciation fund, £500; balance to be carried forward to next account, £618.

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

Abstract of the report of the directors (and accounts) to be submitted to the shareholders at the twelfth ordinary general meeting, to be held at Winchester House, Old Broad street, E.C., on March 15 at 3.30 p.m.:

The revenue account shows a credit balance of £18,180. 16s. 6d., which, with the balance of £159. 8s. 5d. brought forward and £1,237. 5s. 1d. balance of interest received, makes a total of £19.577. 10s. After deducting £2,250 for interest on debenture stock paid and accrued, £2,100 for interim dividend paid on the 7 per cent. cumulative preference shares, and £2,457. 12s. 6d. for interim dividend at the rate of 5 per cent. per annum for the half-year to June 30, 1899, on the ordinary shares, the directors recommend that the sum remaining—viz, £12,769. 17s. 6d.—be dealt with as follows: to credit of depreciation account, £4,500; in reduction of renewals suspense account, £2,500; to payment of the remainder of dividend to Dec. 31, 1899, on the 7 per cent. cumulative preference shares, £2,100; to payment of a dividend on the ordinary shares for the half-year to Dec. 31, 1899, at 7 per cent. per annum, making 6 per cent. for the year, £3,440. 13s. 6d; balance to be carried forward to the next account, £229. 4s. The increase in the number of lamps connected during 1899 was equivalent to 15,002 35-watt (8-c.p.) lamps. The supersedure of plant, to which reference has been made in previous reports, has proceeded so far that the Company's station has now been practically remodelled, the whole of the rope-driven plant having been replaced by high-speed direct-coupled units of the most economical type, and the faulty rubber-covered cable by paper-insulated cable. The result is most satisfactory, and the work is is so far completed that your directors are now in a position to estimate the final cost and to make provision accordingly. The total estimated cost of the plant involved, less receipts from the sale of old material, will not exceed £26,702, of which £23,702 has been incurred to date. To provide for this your directors propose to appropriate £7,000 from the depreciation account and £2,500 from net revenue account, carrying forward the balance of £14,202 to a renewals suspense account, to be written off out of future profits, which the new plant should considerably enhance. The improved position of the Company no longer requiring the special services for which he was appointed managing director, Mr. Page has decided to resign the office. The directors feel sure that the shareholders will join with them in their appreciation of his invaluable services. In accordance with the special resolution passed Aug. 24, the name of the Company has been changed with the approval of the Board of Trade and the Registrar of Joint-Stock Companies. Mr. H. R. Beeton and Mr. W. Page retire from the Board by rotation, and, being eligible, offer themselves for re-election. Messrs. Miall, Wilkins, Randall, and Co., the auditors of the Company, offer themselves for re-election.

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REVENUE ACCOUNT.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel	£3,619 6 2	
Oil, waste, water, and stores	434 7 2	
Proportion of salaries	1,055 4 4	
Wages and gratuities	1,590 2 5	
Repairs and maintenance: buildings, £51. 12s. 1d.; engines and boilers, £317. 10s. 5d.; dynamos, exciters, motors, etc., £26. 7s. 10d.; other machinery, instruments, and tools, £117. 0s. 4d.	512 10 8	
Cartage of ashes	29 5 0	
		7,240 15 9
Distribution of Electricity.		
Proportion of salaries	145 0 0	
Wages	204 1 11	
Repairs and maintenance of mains	38 15 5	
Repairs, maintenance, and renewals of transformers, meters, etc.	60 8 4	
		448 5 8
Rents, Rates, and Taxes.		
Rents payable	357 6 2	
Rates and taxes	1,140 11 0	
		1,497 17 2
Management Expenses.		
Directors' remuneration	1,000 0 0	
Managing directors' special remuneration	200 0 0	
Salaries of secretary and clerks	627 11 0	
Salaries of collectors	160 0 0	
Stationery and printing	131 2 8	
General establishment charges	299 13 4	
Auditors of Company	42 0 0	
Auditors of the Board of Trade	41 0 0	
		2,501 7 0
Law and parliamentary charges		112 6 5
Insurances		212 17 10
Remuneration to trustees of debenture stock holders, etc.		222 7 0
		12,235 16 10
Balance carried to net revenue account		18,180 16 6
		£30,416 13 4

Cr.	£ s. d.
Sale of electricity per meter (less rebates)	28,912 9 8
Rental of meters on consumers' premises	1,491 6 2
Transfer fees	12 17 6
	£30,416 13 4

GENERAL BALANCE-SHEET.

Dr.	£ s. d.
Capital account—amount received	208,305 0 0
Sundry creditors	9,097 1 4
Doubtful debts reserve account	123 10 4
Depreciation account	11,500 0 0
Balance at credit of net revenue account	5,769 17 6
	£234,795 9 2

Cr.	£ s. d.
Capital account—amount expended for works	186,212 0 4
Renewals suspense account	14,202 0 0
Stores on hand: coal, £184. 5s. 2d.; oil, waste, etc., £228. 7s. 10d.; general, £20	432 13 0
Sundry debtors for electricity supplied	12,168 8 8
Other debtors, and prepaid and suspense charges	1,341 13 7
Cash at bankers	20,407 1 6
Cash at office	31 12 1
	£234,795 9 2

NORTHWICH ELECTRIC SUPPLY.

In their second annual report, the directors state that a steady and continuous increase has been made in the number of consumers connected to the mains. On Dec. 31, 1898, there were 88 consumers, with an equivalent of 3,885 8-c.p. lamps; and during the year 1899 64 consumers have been added, with a total of 2,301 8-c.p. lamps, making a total on Dec. 31, 1899, of 152 consumers and 6,186 8-c.p. lamps. In addition seven motors, with an aggregate of 61 h.p., have been connected to the mains during the year. The length of mains laid to the end of the year is as follows: feeder mains, 5,720 yards; distributing mains, 10,560 yards; public lighting mains, 4,250 yards; service mains, 3,000 yards; making a gross total of 23,500 yards, or over 13⅓ miles. The principal extensions during the year are for the public and private lighting of Hartford, where the Company have been accorded a large amount of support, 1,154 lamps having been connected in the parish since the middle of September. The Parish Council of Hartford have adopted electric lighting for the village, the whole of the roads of the village—about 2½ miles—having been lighted since Nov. 14, this being the first village in the kingdom to adopt public electric lighting throughout. Owing to the very encouraging manner in which the demand for electricity has risen, and with a view to obtaining still more consumers along the route of the mains, the directors decided to reduce the price, as from June 30 last, by adopting the Brighton maximum demand system of charging. From that date the charge for current has been 6d. per unit for the first hour's use per day of the maximum current demanded, and 4d. per unit for all consumption over and above that amount. This is equivalent to an all round charge of about 5d. per unit, or a reduction of 15 per cent. With a view to encouraging small consumers, the directors decided to adopt a system of free wiring, with prepayment slot meters, which in practice is proving extremely successful, and the directors anticipate a large extension in this department. The system of mains is now being extended to Winnington, where substantial support has already been secured. It is anticipated that these extensions will be working during the month of March. Owing to the rapid and continued increase of business in the supply department of the Company, the directors decided in December last to relinquish the wiring department, and have entered into an agreement with Messrs. Woods and Co., of 2, Gray's-inn-road, London, whereby they will do all all the wiring previously done by the Company. In consequence of the continued progression of the Company, and the extension of the area of supply, it will be necessary to raise further capital, to obtain which the directors will submit a proposal for the issue of debentures. After writing off £51. 9s. 11d. for the goodwill of the wiring department, the net profit for the year is £529. 18s. 10½d., which, with a balance of £113. 9s. 6½d. brought forward from last account, gives a total of £643. 8s. 5d., from which, after deducting £28 off preliminary expenses account, and setting aside £95 for depreciation, the directors recommend payment of a dividend at the rate of 3 per cent. per annum.

METROPOLITAN ELECTRIC SUPPLY.

Directors: W. Harrison Cripps, Esq. (chairman); Admiral of the Fleet Lord John Hay, G.C.B.; Sir James Pender, Bart., M.P.; Sir Eyre M. Shaw, G.C.B.; Frank Bailey, Esq., M.I.C.E.; F. Leverton Harris, Esq.; the Hon. John Birkbeck Lubbock; James Carr Saunders, Esq.; John Verity, Esq. General manager: J. Conacher, Esq. Secretary: E. Cunliffe Owen, Esq., C.M.G. Consulting engineer: Lord Kelvin, D.C.L., F.R.S. Engineer: Reginald R. Todd, Esq.

Report of directors (with abstract of accounts) to be presented to the shareholders at the thirteenth ordinary general meeting of the Company to be held at Winchester House, Old Broad-street, E.C., on March 13, 1900, at 12 noon:

The capital expenditure, which at the end of 1898 amounted to £993 761. 13s. 9d., has now reached a total of £1,244 254. 1s. 6d., being an increase during the year of £250,492. 7s. 9d., the result being an excess of expenditure over receipts of £18,977. 12s. 7d. The principal item of expenditure was for the new works at Willesden. A portion of this capital expenditure was provided for by the issue of £125,000, being half of a new 3½ per cent. mortgage debenture stock which the directors considered it expedient to create. This issue was offered to the shareholders at 97 per cent., and the whole of it placed at that price. The gross revenue for the year amounted to £179,190. 1s. 10d. against £151,605. 12s. 3d. in 1898, being an increase of £27,584. 9s. 7d. The cost of generation, which in 1898 was £76,736. 8s. 7d., amounted in 1899 to £90,419. 7s. 1d., or an increase of £13,682. 18s. 6d. During the whole of the period under review, the erection of the Company's new generating station at Willesden was proceeded with, but owing to delays in the deliveries of constructional and other ironwork, the completion of the works was seriously hindered, with the result that from early in October to Dec. 15, when they commenced to supply current, the resources of the Manchester-square station were unduly taxed, and it was found necessary to temporarily withdraw the supply from certain of the circuits at hours of maximum demand. The directors have endeavoured to meet the consumers affected in what they regard as a fair and reasonable manner. In consequence of these interruptions, the Company was twice summoned at the Marylebone Police Court under the Electric Lighting Acts. On the first occasion the proceedings were postponed for three months, and on the second, after hearing evidence, nominal fines were imposed, the magistrates in each case considering that the Company, though technically at fault, were not to blame for the unfortunate interruptions which had occurred. Full particulars of the hearings of these summonses were circulated among the shareholders. Since Dec. 15, 1899, the Willesden generating station has been working satisfactorily. During the last session of Parliament, the London County Council introduced a Bill to authorise the construction of a new street from Holborn to the Strand, which involved the compulsory acquisition by them of the Company's works at Sardinia street. The directors are pleased to state that a clause was obtained in this Bill by which the Company's interests are fully protected. A protective clause was also obtained in the Central Electric Company's Bill. The balance to the credit of the revenue account, before providing for depreciation, is £66,392. 17s. The directors have set aside £13,000 as an addition to the depreciation and reserve fund, carrying to the credit of the net revenue account the sum of £53,392. 17s., which, with the balance brought forward from last account and other receipts, makes a total of £57,728. 10s. After deducting debenture and share interest and other charges, there appears a balance of £25,660. 6s. 3d. An interim dividend of 5s. per share on the ordinary share capital was paid on Aug. 14, 1899, amounting to £19,679. 12s. 8d., and the directors recommend that a further dividend of 5s. per share on such shares be now paid, making a total distribution of 10s. per share for the year, or 5 per cent. on the capital. This will absorb a further sum of £21,250, and leave a balance of £4,410. 6s. 3d. to be carried forward to the next account. This result the directors consider to be satisfactory in view of the excep-

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tional circumstances under which the working has been carried on during the year, and having regard also to the large amount of capital which, while entailing additional charges upon revenue, has been unproductive for practically the whole of the year. The number of 8-c.p. lamps supplied by the Company increased during the year 1898 from 430,000 to 500,000. The present number of lamps connected is 509,000 and the applications show no signs of decrease. A report from the Company's engineer is appended, showing that the satisfactory condition of the stations, machinery, and plant has been maintained. The directors have elected Mr. James Carr Saunders and Mr. Frederick Leverton Harris to seats on the Board, and have appointed Mr. W. Harrison Cripps to the office of chairman. The term of Mr. Frank Bailey's appointment as engineering director having expired, he has been elected an ordinary member of the Board. The directors have appointed Mr. J. Conacher to be general manager of the Company. In accordance with the articles of association, the following directors—viz., Frank Bailey, Esq., W. Harrison Cripps, Esq., and F. Leverton Harris, Esq.—retire from the Board, and are eligible for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and are eligible for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£55,584	18	2			
Oil, waste, water, and stores	5 800	4	10			
Salaries	3,021	18	4			
Wages and allowances	8,776	15	2			
Repairs and maintenance: buildings, £1,862. 12s. 10d.; engines and boilers, £9,603. 7s. 7d.; dynamos, etc., £1,528. 13s. 1d.; other machinery, £1,758. 3s. 6d.; accumulators and accessories, £266. 16s. 3d.	15,019	13	3			
Purchase of current	2,215	17	4			
				90,419	7	1
Distribution of Electricity.						
Repairs, maintenance, and renewals of mains	226	13	2			
Repairs, etc., of transformers	1,692	15	8			
Royalties	12	10	0			
				1,931	18	10
Rents, rates, and taxes				3,806	4	8
Management Expenses.						
Directors' and trustees' remuneration	3,550	0	0			
Salaries of management	4,692	1	2			
Wages of meter readers and wiring inspectors	555	8	3			
Stationery and printing	920	4	10			
General establishment charges	3,214	11	0			
Auditors: Board of Trade, £85; Company's auditors, £157. 10s.	242	10	0			
				13,174	15	3
Law and Parliamentary Charges.						
Law expenses	791	2	9			
Parliamentary charges	1,191	14	0			
				1,982	16	9
Special charges—insurances				1,482	2	3
Depreciation—buildings, plant, etc.				13 000	0	0
Total expenditure				125,797	4	10
Balance carried to net revenue account				53,392	17	0
				£179,190	1	10

Cr.	£	s.	d.
Sale of current (8,327,939 B.T. units) less provision for bad and doubtful debts	173.374	9	4
Rental of meters	5,323	14	8
	178 698	4	0
Rents receivable	124	7	7
Work done and goods supplied	51	13	3
Surplus properties	315	17	0
	£179,190	1	10

Dr. GENERAL BALANCE SHEET.	£	s.	d.
Capital account—amount received	1,225,276	8	11
Due from sundry tradesmen and others	72,771	1	9
Sundry creditors on open accounts	7,513	8	8
Depreciation and reserve fund	64,360	16	5
Balance at credit of net revenue account	25,660	6	3
	£1,395,582	2	0

Cr.	£	s.	d.
Capital account—amount expended for works	1,244,254	1	6
Stores on hand: coal, £363. 14s. 8d.; oils, waste, etc., £269. 10s. 10d.; general, £7,978. 11s. 7d.	8,611	17	1
Sundry debtors for amounts paid on account of contracts in course of completion	2,170	19	6
Sundry debtors for current supplied	77,150	11	4
Others debtors	908	19	4
Suspense accounts awaiting adjustment	3,593	19	3
Deposits (provisional orders, vestries, etc.)	665	0	0
Investements at cost	51,353	15	9
Cash at bankers on current account	6,872	18	3
	£1,395,582	2	0

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Walthamstow. — The Corporation invite tenders for cables. Tenders by 23rd inst.

Birkenhead.—The Corporation invite tenders for overhead line equipment. Tenders by 20th inst.

Barrow-in-Furness. — The Corporation invite tenders for boilers, condensers, etc. Tenders by 19th inst.

Wasmes (Belgium).—The Municipality are open to receive tenders for the electric lighting of the district. Tenders by May 31.

Leeds.—The Tramways Committee invite tenders for one, two, or three steam dynamos. Tenders by March 21. Details in our advertisement columns.

Islington.—The Vestry invite tenders for the supply of electrical stores for one year from March 25, 1900. Tenders by March 14. Details in our advertisement columns.

Swansea.—The Corporation invite tenders for the supply and laying of insulated electric mains, conduits, junction boxes, etc. Tenders by 19th inst. Details in our advertisement columns.

Plymouth.—Tenders are invited for 12 months' supply of alternating-current meters, alternating-current transformers, and arc lamp carbons. Tenders by 22nd inst. Details in our advertisement columns.

Dundee.—The Town Council invite tenders for the supply and delivery of feeder mains, joint-boxes, and underground conduits for tramway purposes. Tenders by 21st inst. Details in our advertisement columns.

Mexborough.—Tenders are to be obtained shortly by the Urban District Council for a dust destructor, which is to be utilised for the purpose of creating heat and providing power for the proposed electric lighting installation for the town.

Blackpool.—The Tramway Committee invite tenders for the construction of a double line of tramways in Central Drive from Revol to Waterloo-road. The contract will include the laying of rails, points, etc., excavating, concreting, paving, flagging, etc. The Corporation will provide all the materials. Tenders by 12th inst.

Fulham.—The Vestry invite tenders for the supply, as and when required, of 100 five-ampere meters, 100 10-ampere meters, and 50 20-ampere meters. The meters must be capable of working on an alternating-current circuit having a frequency of 50 periods per second and a pressure of 200 volts. Tenders by 19th inst. Details in our advertisement columns.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and erection of the following: boilers and accessories—viz, six Lancashire and four water-tube boilers and two economisers; polyphase generators—viz., two 1,000 kw. and two 500-kw. low-speed generators. Tenders by April 26. Details in our advertisement columns.

Lancaster.—The Committee of Visitors of the County Asylum, Rainhill, invite tenders for the supply and erection of three Lancashire boilers and superheaters and one Green's economiser; three 175-b.h.p. steam dynamos, with booster, switchboard, feed pumps, piping, tanks, cranes, and other accessories; secondary battery (1,200 ampere-hours capacity) and accessories; feeder mains (solid system); and wiring of buildings. Tenders by March 22. Details in our advertisement columns.

Rainhill (Lancs.).—The Committee of Visitors of the County Asylum, Rainhill, invite tenders for the supply and erection of (1) three Lancashire boilers and superheaters and one Green's economiser; (2) three 175-b.h.p. steam dynamos, with booster, switchboard, feed pumps, piping, tanks, cranes, and other accessories; (3) secondary battery (1,200 ampere-hours capacity) and accessories; (4) feeder mains (solid system); (5) wiring of buildings. Plans, etc., may be obtained from Mr. Thomas L. Miller, M.I.C.E., 7, Tower-buildings, Water-street, Liverpool. Tenders by 12 noon on March 22.

Dartford.—The Urban District Council invite tenders for the supply and erection of the following plant: Lancashire boilers, with fittings, economiser, feed pumps, etc., pipework, etc., in engine and boiler house, surface-condensing plant, two steam dynamos (vertical enclosed high-speed engines) and motor boosters, storage batteries, main switchboard and connections, six-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed type) and posts, station lighting. Tenders by 27th inst. Details in our advertisement columns.

RESULTS OF TENDERS.

Derby.—The Town Council have accepted the tender of Messrs. Browett, Lindley, and Co., at £705, for a 100-h.p. surface condenser.

Southampton.—The Town Council have accepted a tender for erecting street shelters at the Clock Tower, Prospect-place, and Stag Gates by Mr. T. H. Stiles at £295.

Rotherham.—The Town Council have agreed to let the tender for batteries to the Electrical Power Storage Company for £812. 10s. and £70 a year for maintenance.

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Dudley.—The Council have accepted the tender of Messrs. Babcock and Wilcox, Queen Victoria-street, London, for the supply and erection of pump, feed-water heaters, and pipe work.

Crystal Palace District Electric Supply Company, Limited.—An order for two pairs of Hornsby water-tube boilers has been placed with Messrs. Richard Hornsby and Sons, Limited, Queen Victoria-street, E C.

Hastings.—The Town Council have placed with the Wheeler Condenser Company an order for the supply and erection complete of a surface condenser, air and circulating pump, and cooling tower of a size suitable for condensing all the steam from their existing Belliss engine, and from the new engine now on order. The price is £1,534.

Croydon.—Tenders have been accepted for plant for traction purposes and for auxiliary lighting as follows: The British Thomson Houston Company, Limited, two compound steam-engines and dynamos; Messrs. Babcock and Wilcox, three water-tube boilers and pipe work; Messrs. Allen, Son, and Co., condenser; the Wheeler Condensing Company, Limited, cooling tower.

Bedford.—We stated last week that the Council accepted a tender of the Wheeler Condenser and Engineering Company, at £911, for the supply, delivery, and erection of one surface condenser, with air and circulating pumps, and engine for driving same. The following tenders were also received: Worthington Pumping Engine Company, £1,094; W. H. Allen, Son, and Co., £1,160; Clay, Henriques, and Co, £825.

BUSINESS NOTES.

TRACTION.

West Hartlepool.—A commencement has been made with the works of the electric tramways to Seaton.

Warwick.—The Leamington and Warwick tramways order will not be proceeded with so far as it relates to the tramways.

Leeds.—The road under the Wellington-road railway bridge is to be lowered 9in. to allow room for electric overhead tramway wires.

Lytham.—A satisfactory arrangement has now been made by the Council with the Lytham, St. Annes, and Blackpool Tramway Company.

Bolton.—A plan of the proposed improvement in the curves of the tramways at the corner of Deansgate and Oxford-street has been approved of.

Dewsbury.—The Electricity Committee are rapidly getting ready for higher voltage in the lighting department and for the electric traction scheme.

Honley.—A sub-committee has been appointed to approach the gas company upon the purchase of the gasworks, and also to make enquiries about the electric light.

Airdrie.—Notice of opposition to the Airdrie and Coatbridge Tramways Bill has been given in the House of Commons by the North British Railway Company.

Liverpool.—The work of reconstructing the tramways for electric traction in Lime-street, Elliott-street, and Church-street will be commenced early next week.

Warrington.—A clause has been inserted in the Manchester and Liverpool Electric Express Railway Bill with regard to the protection of the Rural District Council.

Litherland.—It is reported that a satisfactory arrangement has been arrived at with the Liverpool authorities in reference to the use of electric traction in Linacre-road.

Greenock.—The Tramways Committee of the Police Board have agreed to accept the offer of the Greenock and Port Glasgow Tramways Company for leasing the tramway.

Rochdale.—The Rochdale and Wardle Councils have not yet come to an agreement respecting the tramways, but from what we gather it appears the terms may yet be arranged.

Barcelona Tramways Co.—The directors announce that at the general meeting to be held on the 21st inst. they will declare a dividend for 1899 of 2 per cent., or 4s. per share.

Suffolk.—The Light Railway Commissioners have decided to recommend an order for a light railway which will connect Long Melford with Hadleigh, a distance of some 12 miles.

Ilkeston.—Application is to be made for a loan of £62,074 to pay the apportioned cost of the generating station for electric lighting and the cost of the construction of tramways.

Portslade.—The Urban District Council's opposition to the Brighton Tramways Bill is to be dropped on insertion of clauses into the Bill giving the Council certain rights and privileges.

Fulham.—The Vestry have decided to object to the introduction of the proposed tramways, as they find that on account of the narrowness of the roads almost insuperable obstacles present themselves.

Burnley.—Petitions have been lodged against the Burnley Corporation Tramways Bill by the Corporation of Nelson, the Urban District Councils of Brierfield and Padiham, and the Parish Council of Reedley Hallows.

Kendal.—With regard to the suggested electric tramways, it was stated at the last meeting of the Town Council that the matter was now ripe for the consideration of the Council meeting as the General Purposes Committee.

British Columbia Electric Railway Co.—In consequence of the continued prosperity and extension of the business the directors have made a reduction in price of 10, 15, and 20 per cent. respectively in the various classes of lighting.

Johnstone.—We understand that much dissatisfaction exists at the decision of the Paisley Town Council to terminate any further negotiation with the Glasgow and district tramways promoters, as by this agreement Johnstone is shut out from the scheme.

Linthwaite.—At a recent meeting of the ratepayers it was resolved that the Huddersfield Corporation Tramways Bill, 1900, be opposed in Parliament for the purpose of obtaining such amendments as the Council consider necessary for the protection of their interests.

Barnsley.—The Light Railway Commissioners have decided to recommend the granting of an order to the British Electric Traction Company, Limited, for the construction of a light railway about half a mile in length, from a junction with a sanctioned light railway from Barnsley to Worsborough Dale.

Portsmouth.—The Town Council have adopted the report of the Tramways Committee recommending that legal steps be taken to obtain possession of the undertaking, which the company should have handed over on Jan. 1. Before proceedings are actually taken a preliminary meeting before the arbitrator is to be arranged.

Reading.—The tramway company have issued a writ with a view to prevent the Town Council from purchasing the tramways. The Town Council have accepted service, and resolved that the valuation or valuations of the tramways undertaking be proceeded with immediately, or as the counsel to the Corporation may advise.

Wealdstone.—With regard to the tramways (Middlesex County Council's Light Railways Order No. 2) the Council have formulated a demand insisting upon a minimum width of 50ft. in the roads over which the line would pass, and asking to be consulted as to the best position for the lines and the standards before they are put down.

Cheltenham.—Application is to be made for £2,100 to cover the cost of changing over the pressure of supply necessitated by the supply to the electric tramway. The charges will be upon the basis of a certain percentage upon such capital outlay as might be exclusively due to the tramway undertaking, plus a charge per unit for energy upon a sliding scale.

Batley.—The Corporation are making a stand against the tramways proposed by the British Electric Traction Company. All the interested local authorities have now received copies of the draft order of the company. They anticipate that the order will be confirmed in June or July, and that the work of constructing the lines will not be proceeded with until the spring or summer of next year.

Wandsworth.—The Wandsworth Board of Works recently received a deputation of ratepayers with reference to the proposed London County (Clapham, Wandsworth, and Kingston road) light railways, asking the Board to oppose the scheme. After some discussion the Chairman thanked the deputation for its attendance, and assured its members that their objections should have every consideration by the Board.

Southampton.—The report on Colonel Marindin's inspection of the Shirley route of the Corporation tramways states that the following are the only limits of speed and compulsory stops which need be required: Maximum speed, eight miles an hour; on Four Posts Hill, six miles an hour on downward journey; on curve between Shirley-road and Four Posts Hill, four miles an hour. Stops: In Commercial road, before crossing Blechynden-street on the descending journey.

Grimsby.—The Tramway Bill has been allowed to proceed by a committee of the House of Lords. Prof. Kennedy in his report estimates that an additional £10,000 will be required if the Council provide power for traction under their provisional order. This will bring the total capital outlay to over £40,000. The Council have decided to reopen negotiations with the company with a view to re-leasing the undertaking to the present company on terms advantageous to the Corporation.

Paisley.—There has been another change of the Council's mind. At the last meeting an amendment was carried to the effect that the Council drop further negotiations with the Glasgow District Tramways Company in the meantime with the view of the Council going in for a similar Bill to that of the Glasgow District Tramways Company in the next session of Parliament. The British Electric Traction Company have withdrawn their proposals to the Town Council in connection with the local tramways schemes.

Impeding the Tram Traffic.—Frank Swift, a painter, from Bolton, was committed to the workhouse for a fortnight as a lunatic. For a few days he had been amusing himself by running in front of the electric cars and jumping on and off them. Thus, said Police-constable Griffith, he had interfered with the traffic to a considerable extent, the drivers being compelled to stop the cars frequently to avoid running over the man. Once he tried to get on a motorcar, and the driver had great difficulty in keeping him off the machine.—*Liverpool Courier.*

Blackpool.—The Town Council have resolved that the Blackpool Corporation tramways to be next constructed be laid along Talbot-square, Talbot-road to Abingdon-street, thence along Abingdon-street, Church street, Raikes-road, Whitegate drive, Waterloo-road (formerly Cow Gap-lane), to Central-drive, thence along Central-drive to Hounds-hill to the Promenade; and that the town clerk be instructed to apply for borrowing powers for the

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amount of the borough surveyor's and borough electrical and tramway engineer's estimates for the execution of the works.

Little Lever.—At the last meeting of the District Council it was reported that the result of the negotiations as to the proposed tramway through Little Lever between Eccles and Whitefield was that the first chance of the construction of the tramway would be given to the United Syndicate, Limited, and that if they failed to get powers in the next session of Parliament for the construction of the line the South Lancashire Tramways Company should have the preference. A copy of the Lancashire Electric Power Company's Bill for the session of 1900 was submitted, and the Council decided to support it, subject to the interests of Little Lever being properly safeguarded.

Eccles.—On March 5 the Town Council agreed to a resolution of the General Purposes Committee that an agreement be entered into with the Salford Corporation for the electrical working of the tramways in the borough. Salford proposes to lease the existing tramways in the borough, and others which it is suggested that Eccles should seek statutory powers to construct for a term of 35 years, subject to the payment of a rent equal to 10 per cent. upon the actual expenditure. Salford will relay the lines, provide the electrical equipment, and purchase the electrical energy from Eccles, but the latter will have to maintain the tramlines and the plant necessary to work them.

St George-the-Martyr.—At the Vestry meeting last week the General Purposes Committee recommended *re* the County Council Tramways Bill now before Parliament, that it be opposed by the Vestry, and if necessary, that the petition be supported by evidence and by means of parliamentary agents and counsel. The Clerk reported that formal consent had been given by the committee on behalf of the Vestry, but that did not prevent the petition being presented. At the conference of representatives of London with the Council's committee the Council had practically conceded nearly all this Vestry had contended for. It was resolved to continue with the petition as far as deemed necessary.

Yorkshire Light Railway Schemes.—The Light Railway Commission held enquiries on Monday relative to two railway enterprises seeking to serve colliery districts in the West Riding. One application had reference to a proposal by the East and West Yorkshire Union Railways Company to construct a line from the flourishing township of Rothwell to Hunslet. The other was by a syndicate who sought permission to construct a line from Hemsworth Station, on the Great Northern and Great Central Branch Railway, to Brackenhill. The first line, being for passengers and goods, was assented to, and the decision upon the second application was postponed. Consent will probably be given upon an undertaking that provision will be made for passenger traffic to Pontefract.

Dublin.—The case of the Corporation against the tramway company is practically shelved till the middle of next month. Judgment was passed on Dec. 9, and a case was to be stated. An application was made to the Court last week by the Corporation in reference to the alleged delay on the part of the tramway company in proceeding with the case stated, which they demanded in reference to the sanding of the streets in December last, when an action was brought by the Corporation to compel the company to carry out the sanding of certain streets. Nothing was done, as counsel were not ready. In the meantime, we understand, the Corporation are sanding the streets under protest. The Dublin United Tramway Company have commenced operations for extending their line in Parkgate-street.

Cheshire Electrical Light Railway.—On Monday evening a conference was held at Winnington between the Parish Councils of Winnington, Anderton, Barnton, and Little Leigh and Mr. R. H. Scotter, C.E., engineer to the Warrington and Northwich Light Railway, at which the engineer agreed to immediately proceed with the western branch of the light railway, and to include the important townships of Whitley, Leigh, Barnton, and Winnington. At the latter place are situate the large chemical works of Messrs. Brunner, Mond, and Co., where some 4,000 men are employed. Workmen's trains at ½d. per mile are to be run on this line, and facilities offered for the workers to reside outside the very congested areas near Warrington and Northwich. A supplementary scheme was also presented which would connect both branches of the railway by a line running through the rapidly-growing districts to the south of Northwich. The engineer promised to introduce on the urban districts of this line an improved system of surface contact if satisfactory financial arrangements can be made for its installation.

LIGHTING AND GENERAL.

Rotherham.—The contracts for the new generating station will be let in a week or two.

Hornby.—The National Telephone Company intend to institute an exchange in this town.

Hastings.—Application is to be made for a loan of £1,584 for a new boiler at the electric light station.

Durham.—Steps are being taken to light by electric light that portion of the district now lighted by gas.

St. Annes.—Application is to be made to the Public Works Loan Commissioners for £18,161 for electric lighting.

Willesden.—The enquiry into the loan of £3,500 for the purchase of land for a municipal electric lighting station has now been held.

Doncaster.—The Guardians have resolved to borrow £22,545 for the purpose of executing the works for lighting by electricity the new workhouse.

Lytham.—The new road through which the tramway is to run will be lighted by electricity.

Whitby.—An enquiry is to be held on the 16th inst. to consider the Urban District Council's application for sanction to borrow £26,000 for electric lighting purposes.

Croydon.—We have already mentioned the dissatisfaction which exists amongst the Corporation's electric light customers, and we now learn that a sub-committee has been appointed to report on the tariff of charges with a view to their modification.

Walker.—A preliminary agreement has been arrived at between the Newcastle-upon-Tyne Electric Supply Company and the Council, and it is expected that very soon the whole scheme as to the electric lighting will be submitted to the Council for confirmation.

Perth.—The generating station to be erected near the River Tay will cost £7,428. The buildings have been designed with a view to facilitate the carrying out of future extensions for lighting and tramway traction; the plant to be erected at present being for lighting purposes alone.

Stock Exchange.—The Stock Exchange Committee have appointed March 13 a special settling day for the St. James's and Pall Mall Electric Light Company's further issue of 8,020 ordinary shares of £5 each, fully paid, Nos. 52,081 to 60,100, and have ordered the same securities to be quoted in the official list.

Spennymoor.—At the last meeting of the Urban District Council the subject of lighting the district by electricity was fully considered and discussed in the presence of Messrs. Fairweather and Brown, of the North of England Electric Supply Company. No definite decision was arrived at. Further meetings will be held to consider the matter.

Manchester.—The City Council have adopted a resolution passed by the special committee dealing with the telephones providing that, with a view to the municipalisation of the telephone service, the National Telephone Company should be approached in order that it might be ascertained whether the undertaking of the company in the Manchester area could be purchased by the Corporation.

Deal and Walmer.—With regard to the question of employing a joint expert to report as to the advisability of adopting the electric light in Deal and Walmer, the Deal Council have resolved not to take any steps at present, as they think the district is too small. When the subject was reported to the Walmer Council this week, it was decided to again approach Deal in the matter.

Lift Accidents.—We understand that at the Great Eastern Hotel a system of interlocking of the doors of the passenger lift is being introduced. The system is the joint invention of Mr. H. C. Amendt, the manager of the hotel, and Mr. Hollins, the company's electrical engineer. It consists in the application to a lift of the interlocking principle governing railway signalling and the working of railway points. The arrangements when completed will ensure that the lift cannot be worked while any one door to it is unlocked.

Parliament.—The following Bills were read a second time during the past week: In the House of Commons—March 2: the Baker-street and Waterloo Railway, South Lancashire Tramways, the Airdrie and Coatbridge Tramways; March 5: Charing Cross, Euston, and Hampstead Railway, City and South London Railway; March 6: Aberdeen Corporation Tramways, Newcastle-upon-Tyne Electric Supply, Wellingborough and District Tramroads. In the House of Lords—March 6: Folkestone, Sandgate, and Hythe Tramroads.

Appointments Vacant.—The Plumstead Vestry require the services of an assistant to the electrical engineer.—Telegraph linesmen are required for the telegraph department of Northern Nigeria, Africa.—A working engineer is required for the Islington new infirmary, Highgate-hill, Upper Holloway, N.—An engineer is also wanted by a firm of electrical engineers in Scotland to take charge of installation department. Full particulars referring to these vacancies, also for a draughtsman and others, appear in our advertisement columns.

London Gazette.—A receiving order has been made out *re* F. Metcalfe, 4, Ashville-terrace, Cardigan-road, Leeds. The first meeting of creditors will be held on March 14, at 12.30 p.m., at the Official Receiver's office, 22, Park-row, Leeds, and the public examination on March 27, at 11 a.m., County Court House, Albion-place, Leeds.—The order for discharge *re* E. M. Winter, Norfolk-street, Strand, has been suspended until Feb. 6, 1902.—The first meeting in the estate of A. R. Earle, Norwich, will be held on March 9, at 3 p.m., at the Official Receiver's office, 8, King-street, Norwich, and the public examination on March 21, at 11 a.m., at the Shirehall, Norwich.

W. T. Glover and Co., Limited.—We have received a copy of the new price-list of this Company, which contains much valuable information, in addition to the usual lists of sizes and prices. Thus under "Details of Conductors" there are given most complete tables of weights, resistances, etc., of practically all the sections of cable used in electric wiring and cable-laying work. Then follow tables of the following types of cables: vulcanised rubber-covered cables, twin cables with the same insulation but lead-covered, concentric cables with vulcanised rubber insulation, armoured cables, diatrine cables for town-lighting mains, pure rubber cables. Then there follows a long list of accessories for electric work, such as of flexible cords, concentric wiring, armature conductors, and jointing apparatus. The booklet is most conveniently arranged for easy access to any particular section.

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Metropolitan Electric Supply Co.—The ordinary general meeting will be held on 13th inst. at noon at Winchester House.

Long Eaton.—Messrs. Hopkinson and Talbot have been appointed to report upon the electric lighting scheme of Mr. Crowther.

Daventry.—The Council are asking the National Telephone Company to extend their Northampton area so as to include Daventry.

Gravesend.—A sub-committee has been appointed to enquire into, and for the purpose of carrying out, electric lighting in the borough of Gravesend.

Otley.—The Urban District Council have decided to form a committee for the purpose of enquiring into the advisability of lighting the town by electricity.

Hackney.—Mr. J. R. J. Bowden, an electrical engineer, has been appointed clerk of the works by the Vestry to inspect the electric mains during the laying.

Derby.—The Council are applying for a loan of £730 for a surface condenser. They are also making an extension of the electric light mains in Whitaker-road.

Ilkeston.—Application is to be made to the Local Government Board for sanction to the borrowing of £18,271 to meet the apportioned cost of the electric lighting generating station.

Worksop.—Mr. Mountain, consulting engineer, of Huddersfield, has expressed the opinion that the proposed electric lighting of the town would be in working order by next Christmas.

Wombwell.—The District Council have granted permission to the National Telephone Company to erect a line of poles from Barnsley-road to the Wombwell Main Colliery by way of Smithly-lane.

Barnard Castle.—The cost of an expert's opinion on the proposed electric lighting is to be obtained. There are already four or five applications which have been made in anticipation of this resolution.

Limerick.—The following resolution has been adopted by the County Council: "That we approve of the Shannon Electric Power Bill, provided all vested rights are properly protected and safeguarded."

Fenton.—The Electric Lighting Committee have met members of the Stoke Corporation and discussed the question of terms, and a similar course has been taken with Longton, but the matter is not ripe for publicity.

Windermere.—A letter from the Bowness Council, asking this Council if they were prepared to consider the appointment of a joint electrical inspector, is before the Highways Committee of the Urban District Council.

Lancaster.—The Electricity Committee have been obliged to refuse to make a reduction in their charges because a large increase in the use of current for lighting purposes especially would necessitate a considerable increase in the plant.

York.—We learn that since the opening of the works on Feb. 20 there have been numerous applications for the supply of the electric light, and that it was more than probable that the Council will be asked shortly for additional funds to extend the works.

Belfast.—The charge for current for lighting purposes for the first hour has been reduced from 7d. to 6d. per unit, and for motor purposes from 4d. to 3d. per unit for the first hour, and from 1½d. to 1¼d. per unit for the subsequent hour charge.

Disclaimer.—We are informed by Mr. Edwin Cooper Wallis, A.I.E.E., of Central Works, Swinegate, Leeds, that for about five years his business has been quite distinct from that of Messrs. Cuttries, Wallis, and Co., Limited, which is now in liquidation.

Brighton.—The second annual social evening of the Brighton telegraph clerks and their friends took place at the Oddfellows' Hall, Queen's-road, last week. A good foundation has been found on the intended site for the new generating station at Portslade.

Scarborough.—The local papers are apparently elated over the fact that although the electric light is making great strides, the gas company's business has not suffered in the least. This is only a repetition of what has happened in most, if not all, similar cases.

King's Lynn.—At the last meeting of the gas company, a resolution was passed empowering the directors to spend a sum not exceeding £5 in joining with other ratepayers in protesting against any further capital expenditure on account of electric lighting.

Kingston (Surrey).—The Lighting Committee have been authorised to give a preliminary order for boilers for the electric light works at the estimated cost of £2,700, subject to the subsequent confirmation of the Local Government Board for the borrowing of the money.

Dover.—The Electricity Supply Company have obtained the Council's permission to break up the footway and lay mains in Priory-road, Norman-street, Saxon-street, and Folkestone-road as far as Beaumont-terrace, the placing of transformer chambers being left over at present.

Liverpool.—It was reported at the last meeting of the Electric Power and Lighting Committee of the Corporation that the accounts for 1899 showed a net balance of £11,206. 13s. 8d. The committee have put £6,000 to the credit of the renewal account and the balance to the reserve account.

Aberdeen.—In view of applications from the Rosemount district for electric lighting, it has been decided to recommend that the cable be extended from Rosemount-viaduct to the top of Esslemont-avenue at an estimated cost of £204. Several increases in salary have been granted in the electrical department.

Criccieth.—A committee has been considering the question of lighting the town, and reported to the last meeting of the Urban District Council that at present they had no recommendation to make as to lighting the town with either gas or electricity.

Hull.—The Chamber of Commerce have appointed a committee whose duty will be to impress upon the National Telephone Company and the Government the necessity of repairing the damage caused by the late storm as speedily as possible, and to obtain information as to the suggested municipal system of telephones.

Contradiction.—We note in the *Chatham News* the following paragraph: "Chatham, Rochester, and District Electric Lighting Company, Limited.—The above company were in no way responsible for the failure of light at the town hall on Tuesday, Feb. 20, the occasion of the Dickens Bazaar, as reported.—Geo. A. Abbott, secretary."

Consequence of an Electric Light Failure.—A Reuter's telegram states that three British officers escaped on Monday from the Model School, Pretoria, during the confusion which followed the cutting off of the electric light. Their names are given by a Transvaal journal as Captain Haldane and Lieutenants Mesurier and Brockie.

Edinburgh Telegraph Messengers.—The twenty-ninth of the entertainments annually given to the Edinburgh telegraph messengers took place on March 2 in Queen-street Hall, which was filled to overflowing with an audience composed of the boys and their friends. Mr. John Newlands, controller of telegraphs in the Edinburgh General Post Office, presided.

Wakefield.—There is considerable grumbling at the charge for electricity here. The Tradesmen's Association have just passed the following resolution: "That the Corporation be approached with the view to obtaining a reduction in the price of electric light, and that it be suggested a reduced maximum charge be made, the rebate abolished, and the charge for meters be reduced."

Airdrie.—At a recent meeting of the Town Council the Town Clerk said the tramway company might buy their provisional order, and under the powers contained in it construct a generating station, say, at Coatdyke, and supply the burgh with electric light. There were numerous other companies eager to get the order as well, and the Council could easily dispose of it at a profit.

Eastbourne.—The Council are considering a recommendation by the Finance Committee as to the borrowing of £116,420 for electric light and other purposes as sanctioned by the Local Government Board, or the raising of stock. Application is to be made for power to borrow £800 for the extensions of the electric light mains now contemplated and for those that will probably occur during the present year.

Buxton.—Most of the plant and lamps have been erected. Tenders are to be advertised for meters. As soon as possible the engines will be started running, so that they may be tested and got into proper working order before the supply from the station is started. The consideration of the National Wiring Company's reply has been deferred for the present, as Mr. Calvert considers that sufficient consumers will be obtained by the time the works are completed.

Lincoln.—With regard to the electricity loan, it has been decided that in the event of the clerk being able to obtain applications for Corporation stock at a minimum price of £97 per £100 stock, he be authorised to accept such applications to the extent required to provide £1,167, the amount authorised to be borrowed to pay for the cost of the site of the proposed infectious diseases hospital, and £6,500, part of £19,000, the authorised sum for electricity works purposes.

Wrexham.—The Town Council have closed with an offer for their loan of £20,000 for electric lighting. The engineers have been requested to supply particulars of the relative cost of a pipe for traction cable, with a distribution main, or a spare way into which it could be drawn if laid at the same time, and the route from the depôt works was taken along Madeira-hill, Talbot-road, Fairy-road, and Belmont-road, to delivery point in Ruabon-road, or an alternative to Poplar-road route.

Torquay.—Application is to be made by the Council for sanction to borrow £10,000 for additional generating and other plant, and £5,000 for extension of mains. At Tuesday's meeting it was stated that two years ago there were 55 private electric light consumers, now there were 214. They had 11,326 8-c.p. lamps connected, and the total capacity of the present plant was 11,500 lamps. Consequently it was absolutely imperative that the plant should be increased. The plant was loaded to a dangerous extent.

Newington.—The Vestry have passed the following resolution at the instance of the Electric Lighting Committee: "That the Vestry concur in the opinion expressed by the Board of Works for the Poplar District that the undertakers of municipal schemes should be empowered to wire consumers' premises upon a hire or easy payment system, and that the London County Council be requested to promote legislation enabling those metropolitan local authorities holding provisional orders to borrow money to carry out such work."

Londonderry.—After discussing Sir Wm. Preece's report last week, the Corporation decided that the private lighting scheme be extended as follows—viz., to the Shipyard in the Strand-road, to St. Columb's College in Bishop street, and Bayer's factory on Foyle-road, and to the Belfast and Northern Counties Railway Railway and the Ebrington Barracks in the Waterside, and that the further consideration of Sir William Preece's report be adjourned pending a full and detailed estimate of the total cost of the whole scheme as now approved of by the committee to be prepared by

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Mr. Macrory, and submit same to the committee at next meeting for inspection and approval.

Wealdstone.—At the last meeting of the District Council it was mentioned that a letter had been received from the secretary to the North Metropolitan Electric Power Supply Syndicate asking to be furnished with the names and addresses of the members of the Council for the purpose of supplying information. The Harrow Electric Light and Power Company have served formal notice upon the Council that after the expiration of three days from the date of the notice they would extend their mains from the corner of Hindes-road to the entrance of Braybrooke Lodge, in Station-road.

Stockton.—At Saturday's fire, which resulted in the destruction of a portion of Messrs. Blair and Co.'s engineering works, an expensive electric lighting installation, consisting of three valuable engines and 16 dynamos, was destroyed. With regard to the electric lighting of the main thoroughfares, the committee reported on Monday that in the case of Leeds, where lighting was done from the top of the tram poles, and Newcastle, where the lamps were placed in the middle of the wide streets, this system of lighting was not very effective, and they recommended, and it was agreed, that the lighting should be done from the street kerbs.

Gorton.—At the last meeting of the District Council it was proposed that arrangements should be made with the Manchester Corporation to supply electric light and power. It was said that the Council's consulting electrician had estimated that the Council would require in a year or two 6,200 lamps and 300 meters, and he stipulated that the charge would be 4½d. per unit. Finally, the motion was withdrawn, it being thought that the Council should at least wait until they had heard the report of the Electric Lighting Committee. The Council decided to apply to the Local Government Board for sanction to borrow £13,111 for the purpose of erecting a refuse destructor near Sunny Brow-road.

Stoke-on-Trent.—The report of the Electric Lighting Committee of the Rural District Council states that at a recent meeting with a committee of the Corporation on the subject of a joint undertaking in the supply of electrical energy for the district, no resolution was arrived at, but it was suggested by the representatives of Stoke that the Rural District Council should inform them what would probably be the minimum and maximum supply which the district would require, and also the minimum number of years which the Rural District Council would accept a supply from Stoke, and the Stoke Town Council would then be enabled to quote a price or to say what other arrangements could be come to between the two authorities.

New Issues.—The following new issues have been made this week: National Telephone Company—100 000 ordinary shares of £5 each at par and £500,000 4 per cent. debenture stock at the price of 98 per cent.; Bournemouth and Poole Electricity Supply Company—£70,000 4½ per cent. debenture stock (offered at the price of £103 per cent.). At a Board meeting of the British Insulated Wire Company, Limited, on Monday last, applications for the new issue of shares were considered, and it was resolved that in view of the fact that both the ordinary and preference shares were largely over applied for the allotment of shares should be adjourned until Wednesday, the 7th inst., when letters of allotment and regret were to be posted.

Electric Launch Service.—Some time ago we referred to trials which were being made at Venice with electric launches, built on the Thames, in order to remove the obnoxious steam-launches now in use. One of the greatest objections to the latter is the damage done by the backwash, not only to passing gondolas, but to the foundations of the houses lining the canals. The trials have proved highly successful, and it has now been decided to institute a regular service of two lines—one is to start from the railway station and will pass along the Canale Grande to the Rialto, the other from the Piazetta to the Lido, where the bathing places are; the latter boats will touch at the public gardens. The fares for the whole distance have been fixed at 1d., and no doubt the boats will prove extremely popular.

Glasgow.—The Telephone Service Committee, who were empowered last week to proceed with the establishment of the municipal telephone system, have fixed the annual subscription for a telephone, including an unrestricted number of calls, at £5. 5s. The rate for the toll system has not been fixed yet, but probably a charge of £3. 10s. per annum will be made, with an additional 1d. for each call by the lessee. These charges will apply in Glasgow, Partick, Govan, Kinning Park, Pollokshaws, and Rutherglen, and in the rural districts included in the area which extends from Cambuslang to Clydebank and from Kilsyth to Eaglesham. Mr. A. R. Bennett recommends the laying down of an exchange for 5,250 lines, which he thinks may be obtained for less than £100 000. The Telephone Committee intend to ask for power to borrow £120,000.

Stirling.—The *Stirling Journal and Advertiser* of March 2 says: "The news of the relief of Ladysmith has expedited the turning on of the electric light in Stirling. For the first time the ancient and royal burgh was last night lighted up by arc lamps. The machinery at the electric lighting station has been running for several days, so as to get it into proper working order, but it was not intended to apply the current to the lamps for some time yet. Buller and Dundonald, however, have upset these calculations. The Lighting Committee thought that it would be a happy circumstance if the inauguration of the electric light could be made to coincide with the date on which intelligence was received of the relief of the beleaguered garrison. The final connections were accordingly made, and the current was applied. The light produced was very brilliant, and was greatly admired."

Electric Light and Trams for Devonport.—According to the *Western Morning News*, the Electric Lighting Committee has approved of plans, estimates, and specifications for the erection and equipment of the power station at Newport Quay, and for mains and works in Devonport and Stonehouse. The committee also recommends the Borough Council to apply to the Local Government Board for sanction to borrow £74,536, including the usual 10 per cent. for contingencies to carry out the work. A sub-committee has been appointed to visit various towns with a view to arranging for the purchase of traction plant for the purposes of the Devonport and District Tramways, and to enter into provisional agreements, subject to the approval of the committee. A drawing and specification of the tramcars to be used on the company's system has been approved by the committee, with the condition that three brakes shall be provided, one of which, in the opinion of the committee, should be a slipper brake.

Eccles.—The price of current has been fixed at 6d. per unit, and the Town Council have resolved that the supervision of the whole of the street-lighting of the borough be transferred from the sanitary inspector to the electrical engineer. The electrical engineer has been instructed to make enquiries and report on the question of the cost of plant sufficient to deal with the light load in place of the motor-generator and accumulator. He is also to report the additional mains which are in his opinion necessary to meet any increase in the demand for the supply of electrical energy, taking into consideration probable requirements for tramway purposes. With a view to the reduction of the working expenses, the electrical engineer will be allowed to take two pupils. The electrical engineer is about to ascertain from 12 Lancashire municipal electric light undertakings the number of hours worked by the employés. Steps are being taken to obtain the sanction of the Local Government Board to the borrowing of the sum necessary to cover £5,000 overspent in respect of the electric light undertaking.

Paddington.—The Electric, Gas, and Water Committee reported to the Vestry last week having consulted Messrs. Preece and Cardew, electrical engineers, as to whether the proposal of the Metropolitan Electric Supply Company to lay extra high-pressure mains between stations in Paddington would be detrimental to the interests of the parish, "is of opinion that so long as the company comply with the Board of Trade regulations, no objection need be raised to the proposal before the Board of Trade. The committee, however, would stipulate that the mains should be laid to the satisfaction of the surveyor, and that the same powers as regards inspection of apparatus, etc., as are given to the Board of Trade, should be conferred on the Vestry." The committee further reported the receipt of a letter from the London County Council, stating that a notice had been given to the Council by the Metropolitan Electric Supply Company to lay mains along Tichborne-row, Tichborne-street, Upper Porchester-street, Sale-street, Grand Junction-road, Cambridge-place, London-place, Talbot-square, Cambridge-square, Somers-place, Southwick-place, Southwick-crescent, Southwick-street, Albion-street, Norfolk-crescent, Edgware-road, Chapel-street, Burwood-mews, Burwood-place, Torrington-mews, Sovereign-mews, Cambridge-street, Porteus-place, Connaught-square, Seymour-street, and Stanhope-place, and recommending that no objection be offered to such application. This report was agreed to.

Southampton.—The Town Council have adopted a report from the Electricity Committee stating that the number of units sold for private lighting during the past month was 58,171, an increase of 77 per cent. over the number sold in January, 1899. The equivalent of 1,539 8 c.p. lamps were connected during the month. Several large institutions had been, or were about to be, connected to the mains—viz., the new isolation hospital, the infirmary, the Ordnance Survey Office, and the Shirley car depôt. Two serious failures of the light had occurred, both due to short-circuits on the mains in the old part of the system, the cause being explained, and it was stated that steps were being taken to minimise the possibility of the recurrence of such a breakdown. In connection with this return the committee made the charge that they failed to see the value of the present return, in which the income received and the liabilities incurred are set forth as identical with the amounts estimated last year, and recommended that Mr. Ramshaw be requested to prepare a return of the actual income, including assets, and the actual expenditure, including liabilities, for the nine months ended Dec. 31. The recommendation of Mr. E. Manville, that the charge for the supply of current to the tramways should be 2d. per Board of Trade unit delivered to the tramway feeders for any amount of energy up to 300,000 Board of Trade units per annum, was adopted, and it was further decided to increase Mr. Chaplin's salary by £25 per annum for his services in connection with the supply of electric energy to the tramways, and a further £25 per annum upon the completion of the reconstruction of the existing tramways. Mr. J. Shepherd is to be engaged as outdoor assistant. A fitter and a lineman are to be appointed when required. The Highways and Lighting Sub-Committee has been invited to submit a report on the lighting of the Shirley route of tramways.

LEGAL INTELLIGENCE.

J. GOLDBERG AND SON v. LIVERPOOL CORPORATION.

At the Chancery Court of the County Palatine of Lancaster, held at St. George's Hall, Liverpool, recently, before Vice-Chancellor Hall, an action was heard at the instance of Messrs. J. Goldberg

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and Son Limited, 41 and 43, Paradise-street, against the Corporation of Liverpool for an injunction to compel them to remove a pole which they had erected at the entrance to the plaintiffs' premises. Mr. Mattinson, Q C., and Mr. W. D. Rotch represented plaintiffs, and Mr. Maberly, with Mr. Rutherford, represented the Corporation.

Mr. Mattinson said the action was really to obtain an order of the nature of an injunction requiring the Corporation to remove a pole which they erected at the entrance to plaintiffs' premises under circumstances which, plaintiffs considered, entitled them to the relief they asked for. Plaintiffs were lessees under the Corporation of the premises in Paradise-street, and in the lease there were the usual qualifying covenants. Upon these premises the plaintiffs carried on the business of importers of tobacco and had done so for a good many years. The main entrance was partly in Paradise-street and partly in a side street called College-lane. The footpath in Paradise-street was 12ft. wide and in College-lane 5ft. wide. In 1898 the Corporation decided to extend the electric tramways, and prepared plans and obtained a provisional order which authorised the Corporation to construct the tramways along Paradise-street and other thoroughfares. At the beginning of 1899 the Corporation proceeded with the construction of the tramway along Paradise-street, and they approached the frontagers to allow them to place supports for the span wires on their premises by means of rosettes or brackets. Plaintiffs declined to allow any interference with their building, and the Corporation subsequently proceeded under the powers given them by their Act to put up the pole, and one question would be whether under this legislation they had any statutory power to act in this way and put the pole upon the footpath as distinguished from the street. If they had the statutory power they could only act upon it if they exercised expedient and necessary care, and he contended that the Corporation put the pole and fuse box at the place they did, not because it was essential they should be put up at that point, but because a plan was submitted to try to compel his clients to accept a rosette on their premises. He then proceeded to quote the correspondence which had taken place between the parties to the action, and said as no result came of this the Corporation put a pole 25ft. high on the footpath a distance of 3ft. 8in. from plaintiffs' doorstep, to the great inconvenience of their customers. Plaintiffs suggested that the pole might be placed where the existing lamp-post now stands, but this did not meet the views of the Corporation. Subsequently the Corporation proceeded to put a fuse box measuring 2ft. 6in. by 1ft. 9in. and 3in. 4in. in height alongside the pole, and he urged there was no reason why the two should be placed so close together, thus causing a double obstruction to plaintiffs' premises. The fuse box was 2ft. 6in. from the bottom of the doorstep, and both obstructions were wholly in College-lane, where the footpath was only 5ft. wide. Throughout the whole of the correspondence there was a complaint from Messrs. Goldberg, and a retort by the Corporation.

Mr. John Alexander Brodie, city engineer, examined by Mr. Maberly, stated that he prepared the scheme for the tramways in Lord-street and Paradise-street. He made trial holes to find which scheme would be most suitable, but owing to the obstruction of gas and water mains he considered that columns along Paradise-street would not have been feasible. He decided that any poles to be put down in Paradise street were to be placed as near as possible to the line of buildings. He considered the pole was placed in the best site for it. The only other site where there was not a window was 30ft. up the street, but the result of that would be that the wire would foul the line of building, and would go right across the windows. The sites for the supporting wire were fixed before any question arose between Messrs. Goldberg and the Corporation, and there was no malice whatever in this case. He did not think the fuse box and pole materially affected the entrance to the premises at all from Paradise-street, and he did not know any other place where they could be put with less inconvenience.

Mr. Walter Leake, electrical engineer, Manchester, said, in his opinion, having regard to the tramway conditions in Paradise-street, it was not necessary for the Corporation to place the pole and fuse box in the exact position in which they were in front of the plaintiffs' premises. It was practicable to put the pole further up College-lane without making any greater obstruction of the footpath than it was at present.

In reply to Mr. Maberly, witness said he had not had experience in the erection of an electric tramway under conditions similar to those in Paradise-street. He thought a less obstructive form of fuse box might be devised.

Mr. William Hesketh, architect and valuer, Dale-street, Liverpool, said there were no footings to interfere with the placing of the pole and box against the wall of the plaintiffs' premises in College-lane. As at present placed, the pole and box, in his opinion, caused considerable depreciation of the value of the premises. In all other cases the Corporation had made efforts to meet the convenience of owners and tenants, but here there was an utter disregard of the requirements of the business of the plaintiffs.

In cross-examination by Mr. Maberly, witness stated that he was not aware that the Corporation had given instructions for all fuse boxes to be brought as near the poles as possible.

Mr. Allen, assistant engineer to the gas company, was then recalled to state the position of the gas-mains in College-lane, but as his Honour was not satisfied with the plan produced, an investigation was made in the presence of a surveyor representing each party in the case.

In summing up, the **Vice-Chancellor** held that the Acts clearly comprehended the whole street as being within the powers of the Corporation, the only restriction being the reasonable and proper use of such powers. As a result of investigation, however, he found that the Corporation were by no means confined to the spot selected, but that the pole and fuse box might have been erected in two other places, without inconvenience to the plaintiffs. He held, therefore, that there was no reasonable ground for selecting the front of the plaintiffs' premises, and that the city engineer's conduct was perverse and vexatious, and not a reasonable exercise of the powers vested in the Corporation. He was of opinion that the plaintiffs were entitled to an injunction, and that the Corporation should pay the costs of the action. His Honour consented to suspend the operation of the order for a fortnight.

PROVISIONAL PATENTS, 1900.

FEB. 26.

3693. Improvements in secondary batteries. Hugo Korten, Yarrow Cottage, Sidney-road, New Southgate, London.

3731. Improvements in the manufacture of electrically-conducting material. Eberhard Sander, 18, Buckingham-street, Strand, London. (Complete specification.)

3753. Improvements in and relating to electrical secondary batteries. Edmond Napoléon Commelin and René Alfred Viau, 1, Queen Victoria-street, London. (Complete specification.)

FEB. 27.

3762. The application of steatite to electrical purposes as an insulating material. Frédéric de Mare and Emile Frémy, 100, Wellington-street, Glasgow.

3789. Improvements in telephone transmitters. Ernest Benjamin Fahnestock, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3834. Improvements in and relating to electric generators and motors. Norman Wilson Storer, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, July 28, 1899, being date of application in United States.)

FEB. 28.

3854. Recording and indicating pyrometer galvanometer. Alexander Hill and John Tatlock, 40, Renfrew-street, Glasgow.

3878. Improvements in alarm apparatus for engine-room telegraphs or the like. Thomas Bell, 34, Castle-street, Liverpool.

3913. Improvements in or connected with the metering of electricity. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

3917. Improvements in electricity meters. Jean Lorwa, 4, South-street, Finsbury, London.

3922. Improvements in holders for electric glow lamps. Johann Heinrich Friedrich Krull, 45, Southampton-buildings, Chancery-lane, London.

MARCH 1.

3923. Improvements in the method of and apparatus for reversing the trolley in electric tramcars and other like vehicles. James William Oldfield, 2, Market-street, Bradford.

3937. Electric feeder log. William Thomson, Baron Kelvin, 154, St. Vincent-street, Glasgow.

3949. An improved electrical speed indicator. Robert Foster Collinge and Rupert John Collard, 54, Jolliffe-street, Liverpool.

3961. Improvements in and relating to electric traction. Francis Alan Wilkinson, 39, Eccles Old-road, Pendleton, Manchester.

3968. Improvements in recording instruments for electric telegraphs. Alexander Muirhead and Robert Henry Edgar, 323, High Holborn, London.

3969. Improvements in electric switches. Walter Frederick Jones, Albert Works, Hammersmith, London.

3981. Improvements in apparatus for switching on and off lamps in electrical illumination, particularly in advertising. Alfred Frank Biddle, 11, Burlington-chambers, New-street, Birmingham.

3992. Improvements in voltmeters. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Actien Gesellschaft Electricitätswerke (vorm. O. L. Kummer und Co.), Germany.)

3993. Improvements in electricity measuring instruments. William Morris Mordey, 46, Lincoln's-inn-fields, London.

MARCH 2.

4002. Improvements in or connected with electrical switches. William Smith Brentnall and Ensor Brentnall, 5, John Dalton street, Manchester.

4022. Improved means for use in the distribution of electric current in electric road traction. Eduard Baron von Mairhofen, 47, Lincoln's-inn fields, London.

4026. Improvements in electricity meters. John Lee, 2, Selborne-road, Tottenham, London.

4038. Improvements in electrical resistances. Bertram Hopkinson, 26, Victoria-street, Westminster, London.

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4046. Improvements in or connected with fusible cut-outs for electric installations. Charles Arthur Hemingway and Robert James Coley, 33, Chancery-lane, London.

MARCH 3.

4105. Improvements in electric tramways. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Edouard Bonnet, Jules Paufique, and Georges Linière, France.)

4109. An improved electric clock. Frederick William Golby, 36, Chancery-lane, London. (Heinrich Hansen, Germany.) (Complete specification.)

4122. Improvements in switch contacts for use in electrical ignition devices for multi-cylinder explosion motors. Ernst Khülstein and Joseph Vollmer, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published March 24.

1898.

24982. Appliances for overhead electric traction. Smith.

1899.

4801. Resistance switches for electric circuits. Holmes and Broadbent.

5250. Electric brake. Hill.

5398. Electric traction on the conduit system. Bede.

6229. Column printing telegraph instruments. Higgins.

6819. Electric switches. Jones.

6947. Method of and apparatus for transforming continuous electric currents into continuous or alternating currents of different voltage. Wydts and Weissmann.

6982. Apparatus employed in wireless telegraphy. Marconi and Wireless Telegraph and Signal Company, Limited.

8728. Switches for electrical purposes. Watson.

8949. Starting mechanism for electric motors. Belfield. (Perkins.)

9278. Dynamo electric or electro-dynamic machines. Statter.

9522. Distribution of electric currents. Lamme. (Date applied for under International Convention, Oct. 6, 1898.)

16163. Electric circuit-breakers. Lake. (Scott.)

15919. Telephone switches and switchboards. Gillmore.

16494. Automatic cut-off devices principally designed for controlling the flow of fluids and of electric currents. Groome.

21777. Electric conducting sheaths or coverings for articles of ceramic or pulverulent materials. Szanka and Ganz und Co., Eisengiesserei und Maschinen-Fabriks Actien Gesellschaft.

23219. Electric signal alarm and safety devices for railways. Boult. (Cumont.)

1900.

489. Devices for locating earth contacts on electric circuits. Myers.

729. Electrical switches and cut-outs. Dorman, Smith, and Bagge.

1167. Adjustable suspension device for electric lamps. Fabre.

1694. Treatment of carbon electrodes for electric arc lights. Robinson and Ferguson.

1863. Coils or helices for electrical purposes. Heys. (Scott, Varley, and Anderson.)

1864. Method of winding coils or helices for electrical purposes. Heys. (Scott, Varley, and Anderson.)

2120. Electric switches. Waterhouse and Simplex Steel Conduit Company, Limited.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Mar. 3	4,127	3,742	+ 385	35,223	33,771
Blackpool-Fleetwood	,, 3	177	196	- 19	1,290	1,463
Bradford City Trams	,, 4	385	265	+ 120	27,018*c*	—
Bristol Tramways Co.	,, 2	2,743	2 498	+ 244	—	—
City & South London	,, 4	1,459	1,111	+ 348	10,473	10,071
Dover Tramways ...	,, 3	139	139	—	1,309	1,282
Dublin U.T., elec. cars	,, 2	2,938	950	+1,088	—	—
Dublin S.D. Electric	,, 2	639	656	- 17	—	—
Halifax Corporation	,, 4	573	301	+ 272	28,060*a*	9,729*b*
Hull Corporat'n E.S.	Jan. 13	682	—	—	—	17,711*e*
Liverpool Corporat'n	Feb. 24*d*	6,882	5,723	+1,159	52.098	46,118
Liverpool Overhead	Mar. 4	1,432	1,285	+ 147	12,932	11,638
Sheffield Corporation	,, 4	1,866	—	—	—	—
South Staffordshire	—	—	—	—	—	—

a Since April 1, 1899. *b* Since June 29, 1898.

c Total receipts. *d* Partly electrical. *e* Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	..	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	5⅞-6⅛
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	15/16-1 1/16
—— 6 per cent. Cum. Pref., 1-50,000	1	..	¾-1
—— 4½ per cent. First Mortgage Debentures	108	..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	4⅞-5⅛
Brush Electrical Engineering, Ordinary	2	—	1⅞-2⅛
—— Non. Cum., 6 per cent. Pref.	2	..	2⅛-2⅜
—— 4½ per cent. Debenture Stock	100	..	108-113 xd
—— 4½ per cent. 2nd Debenture Stock	100	..	102-106
Callender's Cable, Debentures	100	—	111-115
—— Ordinary	5	..	14-15
—— 5 per cent. Pref.	5	..	5⅛-6
Crompton and Co.	2	—	3⅛ 4
—— 5 per cent. Debentures	—	..	99-101
Edison and Swan United, Ordinary	2	..	2-2⅛ xd
—— 5 per cent. Debentures	5	..	3¼-4¼ xd
—— 4 per cent. Deb. Stock, Red.	100	..	93-95
Electric Construction	2	..	2⅛-2⅜
—— 7 per cent. Cumulative Pref.	2	..	2⅜-2⅝
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	104-107
Giffre Electro-Chemical and Power, Ordinary	1	—	¾-1
W. T. Henley's Telegraph Works, Ordinary	5	—	14-15
—— 4½ per cent. Preference	5	—	5⅛-6
—— 4½ per cent. Debentures	100	..	110-114 xd
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	..	100-104
Telegraph Construction and Maintenance	13	..	37-41
—— 5 per cent. Bonds	100	—	102-105
Telegraph Manufacturing, Ordinary	5	—	9-10
—— 5 per cent. Cum. Pref.	5	..	5⅛-6
Willans and Robinson, Ordinary, 1-80,000	5	..	10½-11½
—— 6 per cent. Cum. Pref., 80,001-60,000	5	..	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-⅞
Bournemouth and Poole, Ordinary	10	..	12-13
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8⅞-9⅛
Charing Cross and Strand	5	..	9⅛-10⅛
—— 30,001-50,000	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5⅛-6 xd
Chelsea Electricity Supply	5	—	7⅞-8⅛
—— 4½ per cent. Debentures	100	—	110-112
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9½-10⅛
—— 6 per cent. Cum. Pref.	10	..	12⅛-13⅛
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	100-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4⅞-5⅛
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	8	—	8-8½
London Electric, Ordinary	3	—	1⅞-2⅛
—— 6 per cent. Pref.	5	..	4⅛-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	101-103
Metropolitan, Ordinary	10	..	14-15
—— 62,501-85,000	10	..	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	—	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	..	95-97
Notting Hill Electric Lighting	10	..	16-17
Oriental, 1879	1	..	1⅛-1⅜
—— £5 Shares	5	..	7-7⅛
—— £4½ Shares, New	4½	..	6⅛-6⅜
Orford Electric, Ordinary, 1-96 and 407-10,310	5	..	6¾-7⅛
River Plate Electric Light and Traction, Deb.	100	—	78-85
Royal Electrical Company of Montreal	1½	..	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100	..	104-106
South London, Ordinary	3	..	3⅞-4⅛
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14⅛-15⅛
—— 40,081-52,080	5	..	14⅛-15⅛
—— 7 per cent. Pref.	5	..	8⅛-9⅛ xd
Westminster, Ordinary	5	—	13⅞-14⅛ xd
Electric Railways.—			
Central London, Ordinary	10	..	9⅜-10½
—— Pref. Half-Shares	5	..	4⅜-5⅛
—— ,, ,, deferred	5	..	4⅜-5⅛
City and South London, Consolidated Ordinary	100	..	61-64
—— ,,	5½	—	4-5
—— 4 per cent. Debenture Stock	100	—	125-130
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	—	12¾-13
Waterloo and City, Ordinary	100	—	101-104
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	—	17-18 xd
Brisbane Tramway	100	..	104-106
British Electric Traction, Ordinary, 1-30,000	10	..	17-18
—— 60,001-75,000	10	..	16⅛-17⅛
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	13½-13⅝
—— 5 per cent. Perpetual Debenture Stock	100	..	126-129
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	4⅛-5⅛
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4⅛
—— 5 per cent. Deb. Stock, Red.	100	..	105-108
Costa Rica Electric Light and Traction, 5 per cent. First Deb., 1-1,000 of £100 and 1,001-1,680 of £50 each	—	..	75-85
Isle of Man Electric Power, 1-95,000	1	..	15/16-1 1/16
—— 6 per cent. Preference, 100,001-170,000	1	..	15/16-1 1/16
Kidderminster and District Lighting and Traction, Pref.	8	..	8-8½
New General Traction, Ordinary	5	—	3¾-4
—— 6 per cent. Cum. Pref.	5	..	4⅛-5⅛
North Staffordshire Trams	6	..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	18-19
—— Preference	10	..	10⅜-10⅝
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11⅛-12⅛
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	⅛-¼
National Telephone, Ordinary	5	..	5-5⅛ xd
—— 6 per cent. Cum. First Pref.	10	—	14-15 xd
—— 6 per cent. Cum. Second Pref.	10	—	14-15 xd
—— 5 per cent. Non. Cum. Third Pref.	5	..	5⅛-5⅜ xd
—— 3½ per cent. Deb. Stock, Red.	100	..	97-100
Oriental Telephone and Electric Company	1	—	¾-1

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NOTES.

Mica Mining.—The price of the mica mines in India seems to be steadily on the increase. We learn from *Indian Engineering* that five of the well-known mica mines in the Hazarilagh district were recently put up for auction, and the renewed leases fetched a much higher value than those now lapsed.

Electrical Tramways in Europe.—We notice in *L'Electricien* a very interesting table setting forth the extensions of the electric tramways which have taken place in the various countries in Europe during the last four years. Thus Germany comes at the top of the list with a length of 250 miles of electric tramways in 1896, which in 1899 had increased to 2,160 miles. Austria-Hungary comes next with a length of 45 miles in 1896 and 600 miles in 1899. The third place is taken by the United Kingdom, the figures being 67 miles in 1896 and 600 miles in 1899. The next countries in order are Italy, France, Switzerland, Russia, Belgium, etc.

Telegraphy.—It is difficult to realise the comparatively short life of the telegraphic system of the various countries, but the passing away of those who assisted in the first experiments in telegraphy remind us that this is the case. We had recently to record the death of a telegraph engineer in England whose experience extended right back to the first practical application of telegraphy. Now we hear from America that the lady who sent the first practical message on the Morse system is dead. This lady, whose father was a friend of Morse, was only 72 at the time of her death. In her lifetime the whole art of telegraphy has been developed up to the perfection which is enjoyed to-day.

Conference.—We notice that the Islington Vestry has issued a circular letter to the other London vestries forwarding copy of a report by its Electric Lighting Committee on the procedure of the London County Council in connection with sanctions to loans for electric lighting purposes, and stating that as the delay resulting from the Council's procedure is seriously interfering with the extension of the electric lighting undertaking in Islington, and as it is known that considerable inconvenience is caused in other parishes by the action of the Council, it has been decided to hold a conference of local authorities concerned. This conference is, we understand, to be held at the Vestry Hall, Islington, at 4 p.m. on March 22.

Advertising.—The latest device for advertising which has been brought to our notice, and which is sure of a prompt condemnation by the London County Council, consists in replacing a flagstone in the footpath by a semi-transparent block, on which the article to be advertised is described in glowing terms. A strong light underneath this makes the advertisement readable at night, so that the passer-by who refuses to gaze at the dazzling sky-signs finds himself walking on somebody's soap or trying to avoid some other advertisement in the footway. The idea is exceedingly good from an advertiser's point of view, but the public surely have a right to object to such a use being made of the footpaths.

Prof. Hughes's Bequests.—More details of the provisions of the will of the late Prof. D. E. Hughes are now published, which show that he has remembered those countries in which his inventions were first taken up. Thus £4,000 is set aside to found a prize to be awarded by the Academie des Sciences of Paris for an important discovery in science. In awarding this prize, which, we presume, will be taken from the interest of the sum left, preference will be given to discoveries in electricity and magnetism. The National Society of Electricians in Paris also receives £2,000 in the provisions of the will. It will be remembered that the French were the first to take up Prof. Hughes's printing telegraph, and thus the French nation gave encouragement to the inventor which was not accorded him by his own country. The provisions made in this way are a fitting recognition of the assistance given to Prof. Hughes in the early days of his professional career.

Swiss Industries.—A consular report states that under the influence of new water power all industries in the Romanist Switzerland are progressing considerably. Recently-made returns show that the interest earned by commercial industries is well on the increase. The same report comments on the increased use of electricity for working machinery as well as for traction and lighting purposes. The transmission and distribution of electrical energy have proved to be of great service in developing small industrial districts such as are common in Switzerland. In these cases it is the taking of the power to the population, rather than the moving of the population to the source of the power, which is being effected. In England the reverse operation has always taken place, but it remains to be seen whether the distribution of power from central stations equipped with steam plant, and on the coalfields, will also revolutionise some of our country districts. In these districts wages can be considerably below those which now obtain owing to the decreased cost of living.

Institution of Mechanical Engineers.—At the ordinary general meeting of this institution to be held next Thursday evening, at 8 p.m., the discussion on two papers already read will be resumed. The first of these is on the "Improvements in the Longworth Power Hammer," by Mr. Ernest Samuelson, and the second on "Portable Pneumatic Tools," by Mr. Ewart C. Amos. In this last discussion some interesting comparisons should be forthcoming as to the relative advantages of compressed air and electricity for driving portable tools. Time permitting, a paper will then be read by Mr. Bryan Donkin on "Some Observations on an Improved Glass Revealer for Studying Condensation in Steam-Engine Cylinders and Rendering the Effects Visible." We understand that the author has made some most interesting experiments on initial condensation in steam-engines, and his paper is worthy of careful attention by all engineers having to do with the working of steam-engines. It is further announced that the annual dinner of the institution, which was to take place on April 25, has been postponed.

International Tramways Exhibition.—We are informed that the International Tramways and Light Railways Exhibition will be held from June 23 to July 4 of this year. The promoters of the exhibition have decided, in accordance with numerous sugestions, to offer certain prizes to exhibitors. The prizes will consist of one of £25 for the best invention for securing a dry seat on the tops of tramcars and omnibuses in all weathers, and another of £25 for the most practical and efficient life-saving guard or fender for tramways. The conditions imposed upon the competitors are that they must exhibit a full-sized apparatus and pay an admission fee of £1, and each must send a statement of his intention to exhibit to the offices of the *Tramway and Railway World* by June 1. We certainly think the objects to be obtained in this way are desirable. For instance, the tarpaulin apron now provided on tramways is a "delusion and a snare," as a protection from the weather. An efficient means of picking up stray passengers from the tramway tracks without damage is also a much-needed apparatus.

The Erie Telephone System.—We are surprised to hear that this important telephone company in the United States, which has on its lines some 155,000 sub-

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scribers, has been acquired by the Telephone, Telegraph, and Cable Company. The Erie Telephone Company, which has progressed so fast under the control of Mr. C. J. Glidden, is practically the only company in the United States working under the Bell telephone license which is not controlled financially by the Bell Company. In consequence of this, it will still be able to use the instruments and patents of the Bell Company, although owned by an independent telephone company. It is not quite easy to see in what direction this amalgamation tends, but it seems rather probable that the whole of the telephone business in the States will get into the hands of two rival concerns, and in the natural order of things the competition between these two large companies will not be very keen. A large number of important directors have been added to the number of the Erie Company's Board, but with these and the terms of purchase our readers are hardly concerned.

A Small Water-Power Scheme.—The small town of Muscoda, in South-West Wisconsin, commences its electric lighting history this year. The power is obtained from a waterfall three miles from the town, and the streets are being lighted with arc lamps. We understand from the *Western Electrician* that local enterprise practically started the undertaking, and that there are some novel features in the line between the small power station and the town. The Wisconsin River has to be crossed, and the span at the point of crossing is no less than 1,100ft. The two line wires are supported on independent poles about 20ft. apart on the banks of the river. The conductor used is a stranded wire $\frac{5}{16}$in. in diameter. When the river has been crossed, the line is continued on ordinary poles through the woods to Muscoda. This small plant is a practical example of what can be done by water power in the way of village lighting where there are no legal formalities to go through. We are sure there are a number of villages in Scotland and Ireland which could be equally well equipped if only overhead wires for the transmission of power were used.

An Automobile Ambulance.—A much-needed reform has just been made in New York. This takes the form of an ambulance which is driven by electricity. By the use of this vehicle the wounding of horses in battle when used for ambulance purposes could be avoided, and a greater rapidity of movement made possible, of course allowing that it was possible to obtain within a fair distance a recharge in the batteries. The vehicle in question is owned by the St. Vincent Hospital, and is understood to have cost approximately £600. It weighs, with batteries, 4,000lb., and is estimated to be able to run over 140 miles, at an average speed of nine miles per hour, at a cost of 1d. per mile. The tyres of the ambulance are of solid rubber. The cells of the battery are grouped in four sets, and in addition to the supply to the motor, current is supplied to light three lamps. The ambulance is built so as to satisfy the demands of either winter or summer, the doors being removable and the windows of the disappearing type. A very successful trial of the car has been made, and further advances in the same direction are to be expected.

Telephones in Japan.—Some interesting photographs, forwarded by Mr. W. J. Johnson to the *Electrical World*, give one a good idea of the telephone work which is being carried out in Japan. Thus in the town of Tokio there are already some 5,000 subscribers connected, while applications for 4,000 more are in hand. A new central exchange is being built, designed for an ultimate capacity of 6,000 subscribers. Other towns in Japan have also taken up the telephones somewhat readily, Yokohama having over 1,000 subscribers, while Osaka has 1,600. The charge made for connection at Tokio is £6. 12s. per annum, and last year the number of local messages transmitted exceeded 15,000,000. Practically the whole of these exchanges are equipped with American instruments. The large towns in Japan are also being connected with trunk lines, which have been found to do good service already. It is stated in our contemporary that the Japanese Government is spending no less than £500,000 on new telephone work this year, which amount is not far short of what our own Government will spend on the telephone system in London during the same period out of the £2,000,000 authorised.

A Big Blast.—The *Western Electrician* describes the explosion by electricity of an enormous amount of powder in a conical hill near the site of a dam to be erected for the Pikes Peak Power Company. In developing the water power on the south-west slope of Pikes Peak, the company decided to build a dam some 69ft. high, with a width at the base of 125ft. In order to get the material to build this dam it was decided to blow up a small conical hill which consisted mostly of granite. A tunnel was accordingly driven into the heart of the hill for a distance of 135ft. In a cross heading at the end of the tunnel 144lb. of dynamite and 32,000lb. of black powder were placed. The charge was fired in 36 places by means of electric exploders. No less than three exploders were arranged in each firing charge, so that in the event of one of the circuits failing to act, the current could be switched on to one of the remaining lines. When the word was given, a lady depressed the lever of an electric firing-box and the conical hill was converted into a cup-shaped hollow. It was estimated that 110,000 cubic yards of rock was broken up. We need hardly remind our readers that without electric firing the handling of such big charges would be impossible.

The Paris Exhibition.—The Paris correspondent of the *Daily Telegraph* states that during the first few weeks of the Paris Exhibition visitors will not be able to use the new electric railway owing to the delay in completing the same. The trials were originally fixed to take place at the beginning of April, but the date now given is May 15. The railway will, however, be a great relief to the traffic when it does begin running, as it is to be a very commodious line. The carriages are to be of the corridor pattern, carrying some 50 passengers, and will each be lit by 10 electric lamps. Separate doors for the entrance and egress of passengers are to be provided, thus avoiding confusion and crush on the platforms. The trains are to run at very frequent intervals, and the run of nine miles from Vincennes to the Bois de Boulogne is to be accomplished in 27 minutes, including stoppages. The question of the ventilation of the tunnels has now arisen, and it is stated that, in default of shafts, it will be absolutely necessary for the public safety to place pumps worked by electricity on the line between the stations to ventilate the tunnels. This will probably be done, and we gather that plans are now being drawn up for the installation of the machinery in question.

The General Electric Company. — The *Street Railway Journal* has in one of its weekly issues a few notes as to the organisation of the General Electric Company's works at Schenectady. Some 6,000 men are now employed at these works, and it is interesting to note that the organisation of the pay office is such that this number all receive their weekly wages in less than 15 minutes. The major portion of the work of the company is now carried out on the piecework system, but we are told that the average time wage per man is 10d. per hour. About 16,000 tons of steel and iron are used per annum in the framework, spindles, etc., of the machinery turned out, while about 1,000 tons of copper and the same amount of sheet iron and steel is also

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employed. The restaurant at the works is equipped throughout with electric cooking apparatus, the necessary power being obtained from the central station. As regards the nationality of the employés, naturally the majority are Americans, but it is stated that the number of Germans entering the works is steadily increasing. We are pleased to note that, out of the total number of 6,000 employés, 1,600 are stated to be attending classes in electrical engineering so as to improve their positions.

A Portable Rontgen-Ray Apparatus.—We have received from Messrs. Parsons and Eachus, of Queen Victoria-street, an extremely interesting little booklet dealing with a special portable apparatus for X-ray work now being manufactured by the firm. The advantages claimed for this set are compactness, light weight, and the ease with which it can be manipulated. The case containing the apparatus is of polished oak, and weighs complete only 27lb. Inside the case is an 8in. spark coil, this being insulated in a special manner so as to withstand climatic changes. The coil is wound in sections in order to obtain the greatest possible efficiency, and gives an 8in. spark. The contact-breaker supplied consists of an horizontal brass spring, with the usual means of adjustment. The Crookes tube is held in a holder, which slides in and out of the case. It can, however, if desired, be detached from the holder and used in another holder. A fluorescent screen is provided, which is composed of vellum on a mahogany frame and double coated with platino-cyanide of barium. The case containing this apparatus is very small considering the amount it contains, and measures 13in. in height, 12in. in length, and 7in. in width. The firm manufacture these very useful X-ray sets entirely at their own works.

An Electric Motor Wheel.—Messrs. C. Richter and R. T. Eschler patented in May last the construction of an electric motor inside the wheel of a car. A drawing given with the patent is specially arranged to illustrate the details which are claimed by the inventors. We are more concerned at present with the broad idea of the patent, which is somewhat as follows: The wheel rim is made considerably broader than is at present necessary, and the laminated core of the armature is built up on the inside of this rim. The windings are shown sunk in this laminated core with the connections of the commutator brought down to radial sections placed near the hub. The commutator thus has its surface in a plane at right angles to the axis of the motor. The field-magnet system is built up on the fixed part of the axle, and is, of course, of the multipolar type. The brush gear is contained in the base of the field-magnet system, where, it seems to us, it could not be readily inspected. Two bearings are required at each wheel with this system, which necessarily complicates the construction. The whole question, however, is that of whether the system is at all practicable, and we see nothing in the drawing before us to lead us to conclude that it would be successful commercially, or that reasonable powers could be obtained from these wheel motors.

Society of Model Engineers.—At the ordinary monthly meeting of this society held at the Memorial Hall, Farringdon-street, London, E.C., on the 8th inst., the engineering models entered for the society's competition were on view, and formed a most interesting collection. At the request of the society Mr. J. W. Restler, M.I.C.E. (engineer to the Southwark and Vauxhall Waterworks), Mr. W. I. Last, A.M.I.C.E. (South Kensington Museum), and Mr. L. M. G. Ferreira (late chief electrician to the North London Railway) acted as judges, and the following awards were made: the society's gold medal for the best model went to Mr. W. H. Dearden for a model horizontal type gas-engine; the society's silver medal for the best model locomotive was awarded to Mr. W. Bashford for a model Great Northern locomotive; the silver medal for the best stationary engine was given to Mr. E. W. Payne, A.M.I.C.E., for a model of a compound under-type semi-portable engine; the silver medal for the best electrical model was awarded to Mr. A. M. H. Solomon for his Wimshurst machine; and a special silver medal for the best model exhibited by a provincial member was awarded to Mr. Wilson, of Bradford, for his model of a two-cylinder vertical launch engine. Several other models were awarded diplomas setting forth their respective features of merit.

The Removal of Snow.—Heavy snowstorms such as we have experienced this winter throw on the engineers of our large towns a tremendous amount of work. Large staffs of men have immediately to be organised to remove the snow from the streets, and the question of transporting the snow becomes even more difficult than obtaining the labour. We note that a new experiment has been tried in the city of Brooklyn, New York, by which the Brooklyn Rapid Transit Company undertakes to remove the snow from certain streets at its own expense. Previous to this agreement, the company was responsible for the cost of removing the snow from the roadway occupied by its tracks. This cost was estimated on a *pro rata* share of the total cost of cleaning the streets. Under the new arrangement, the street cleansing department has handed over certain streets to be cleaned entirely by the transit company. After the recent snowstorm the new arrangements were tested, and the company employed some 1,500 men to place the snow on flat-bottomed trolley cars running on the ordinary tracks of the street railways. Fifty of these cars were employed, and they were found to be eminently satisfactory. Each car was constructed to hold some 18 cubic yards of snow. The arrangements were found to be satisfactory to the company, in that the regular schedule of passenger cars was not interfered with for any length of time.

Underground Condnits.—We notice in the *Journal* of the Western Society of Engineers of America a paper by Mr. G. B. Springer on "Electrical Underground Construction." The paper gives a lot of useful information as to the cost of laying the conduits in various kinds of roads. Thus, to lay one length 20ft. 6in. long and 500,000 circular mils diameter in a road with no particular paving costs about 31s., to do the same in macadam costs nearly 40s., in granite the cost rises to about 48s., while with asphalte this is nearly doubled. Tables are then given illustrating the cost of making manholes and relaying the various pavings. Illustrations are given in the various portions of the paper, a very interesting one showing the method used by the author for the connecting lengths of feeder cables. Figures are given for the construction of a six-duct lithocite conduit in certain streets in New York, the cost of the brick and concrete work and conduit itself amounting to about £586 for a conduit 10,000 odd feet long. This the author considers a fair average for such work. The rest of the paper mainly consists of illustrations and descriptions of work in various streets. The author concludes that the investment in underground work of lighting companies in large cities is at present a considerable portion of their total assets, and with the rapid growth of the business underground construction seems likely to come into general use in all the large American cities and in many smaller ones.

Institution of Junior Engineers.—We have received the ninth volume of the *Transactions* of the above institution. The book contains the papers, etc., which have been read at the meetings, together with accounts of the visits paid by the members to various works, central

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stations, dockyards, etc. Amongst the papers we notice one read in March last year on "Carbon-Consuming Batteries and their Possibilities," in which the author, Mr. W. R. Cooper, comes to the conclusion that there is a good opening for a carbon-consuming battery, provided it can be made on the same lines as have been employed in making ordinary voltaic electricity of good efficiency. This, he thinks, however, does not at present appear as though it was possible. In the visits to the works, etc., we notice that amongst the places visited electricity stations figure very largely, amongst these being the works of the City of London Company, the Ealing electricity works, Portsmouth electricity works, the Central London Railway generating station, and others. The effect of the summer meeting at Portsmouth and Southampton in August, 1899, can be traced by the visits then paid to the dockyard at Portsmouth and to the Southampton docks. There are numerous plates to illustrate the various papers and visits, and also a very well executed portrait of the president for the year 1898-9—viz., Sir W. H. White, K.C.B. The volume, which is neatly bound in blue cloth, contains a large amount of very useful information, and should be of great interest to engineers in general.

The Suez Canal.—At the meeting of the Institution of Civil Engineers last week, Sir C. A. Hartley, K.C.M.G., M.I.C.E., read a paper giving a short history of the engineering works of the Suez Canal. The last paper read before the institution on the same subject was in 1867, and the author confines himself chiefly to the improvements made in the canal since that date. These improvements were necessitated by the great increase in the size of vessels using the canal, and also by the number of vessels to be provided for. The whole question of extensions was first taken up in 1881 by an international consultative commission consisting of eight Frenchmen, eight Englishmen, and six members of other nationalities. The author describes the improvements then advocated, most of which have since been carried out. He describes the curious fact that a large steamship experimented with when travelling in the canal only made five knots per hour with the engines revolving 45 times per minute, while in the open sea the same number of revolutions gave a speed of 11 knots per hour. The author gave some interesting figures as to the increase of traffic rendered possible by the use of search-lights on the vessels. By this means they are enabled to travel at night, and without this facility the canal could not accommodate the traffic it does at present. An interesting financial fact was brought forward with respect to the purchase in 1875 by the British Government of the Khedive's share in the undertaking. The price paid for the same was £4,000,000, and the shares at the present market value are worth £26,500,000.

The Nernst Lamp.—Mr. W. McA. Johnson states in an article in the *Electrical World* that the Nernst lamp is being used commercially to a small extent in Germany. Thus, when Prince Albert of Prussia came to celebrate the opening of the "Twentieth Century" at the University of Göttingen, his apartments were lighted with Nernst lamps. Now the lamp is being advertised in Göttingen for house and store lighting. The lamps are rented for 6d. a month, and will remain the property of the company. The lamps are to be used on the regular commercial 110-volt circuit, and require about 0·3 ampere for 25 c.p. The company supplies an alcohol heater, and expressly forbids the use of matches. The author points out the need for a quick-acting and reliable automatic heater for use with these lamps, and gives a few diagrams of heaters which have actually been tried. As regards the life of the lamp, he states that it is about equal to the 8-c.p. carbon-filament incandescent lamp, but adds that the cost of a new staff of oxide in the new lamp is small as compared with the cost of renewing the ordinary incandescent lamp. He also alludes to the fact that when the Nernst lamp is used on a direct current, the magnesium disassociates on the negative pole and is at once oxidised by the air, while the oxygen at the positive pole is given off. This results in a heaping up of the oxide on the negative pole. The article is a concise *résumé* of past knowledge, but we should like to have more information as to the experience obtained with the lamps in commercial practice. The claim made for the lamp is that it consumes from 1 to 1·75 watts per candle-power.

Electric Haulage in Mines.—Mr. D. C. Thomas, in a paper read before the Ohio Institute of Mining Engineers, drew attention to some practical points connected with the use of electricity for haulage purposes in mines. Amongst these, he carefully considers the weight of the locomotive to be used, which, as he points out, is intimately connected with the maximum grade and the weight of the load to be transported. He says that practical trials have demonstrated that a 10-ton locomotive going at six or eight miles per hour hauls 18 loaded trucks up a 2 per cent. grade. The trucks in this instance were said to weigh 1,300lb., and to hold 4,000lb. of coal. Mr. Thomas advocates the use of a 30lb. rail with this size of locomotive, and states that the smallest radius of a curve should not exceed 25ft. A good rule for ascertaining that this radius is not being exceeded is said to be the use of a straight-edge 10ft. long laid against the inner side of the rail. The distance between the middle mark of the straight-edge and the inner side of the rail should not exceed 6in. The outer rail should be placed above the inner rail on curves. The author states that the extra height should be equal to one-third of the distance between the middle mark of the straight-edge when placed as above on the rail. The author advises the use of 250 volts as the maximum in mines where there is no firedamp. Finally, Mr. Thomas expresses his preference for electrical haulage over steam locomotives or rope haulage, both on account of improved convenience and also that extensions can be more readily made than by either of the latter methods.

Telephone Standardisation.—The manufacturing of telephone plant is at present confined to a very few firms in Great Britain, but there will naturally be a great increase in the quantity of orders to be given out in consequence of the granting of telephone licenses. We hear rumours, however, that a fair proportion of these orders are at present going abroad to manufacturing firms in countries where the telephone industry has had more freedom. This is, of course, to be regretted, but we do not think British manufacturers need despair if only they are prepared to compete with these firms on the ground of quality. In telephone manufacture the standardisation of parts is most important, but it tends somewhat to stagnation. It can readily be seen that when an exchange has been partially equipped with a given type of apparatus, it is highly essential that any additions should also be of the same type. In consequence of this a large telephone manufacturer has a certain objection to making changes, although the same may be advisable. The new comer in the field, as long as he obtains the requisite experience, is thus able to standardise improved types, which will have a distinct advantage over their older rivals in the field. An attempt has been made in the States towards compelling the independent telephone companies to buy their materials practically from one firm only. We are glad to note that this has not been successful up to

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the present, and that the majority of these companies are leaving themselves free to purchase their materials where they think best. In this way they retain their right to select apparatus according to the latest type.

The Electric Wiring of Buildings.—We have recently had the opportunity of perusing a paper by Mr. W. A. Chamen, read before the Institution of Engineers and Shipbuilders in Scotland, on the "Electrical Wiring of Buildings." The information given in this paper as to the precautions which should be adopted in wiring buildings for electric lighting are worthy of most careful attention. The author discusses in a most reasonable way the various systems which have been brought forward for improvement in wiring. With respect to wood casing, Mr. Chamen points out that in a dry building bare wires might be laid in wood casing, which would test fairly well, and which would give little or no trouble in working. This fact shows how wood casing can be made to cover up defective work, and the author condemns its use for any place subjected to dampness. He advocates, in the interest of safety, the use of some system in which a breakdown will immediately, and without chance of fire, put the lights out, rather than going on leaking in some hidden corner, which leakage may develop into a fire at some time or other. In this respect Mr. Chamen evidently leans towards an iron conduit into which wires are drawn, and he advocates the standardisation of the various connecting boxes, fuses, and switches which are required in connection with the same. The system of wiring buildings from a number of distributing boards is strongly advocated by the author rather than the scattering of fuses throughout a building in an indiscriminate manner, as is often done. The whole paper is worthy of careful studying on the part of the wiring contractors who aim at perfection in their work.

Surface in Accumulator Plates.—The following abstract of a paper by Mr. Norden in the *Zeitschrift fuer Electrochemie* on the "Real Surface of Accumulator Plates" is taken from Mr. Carl Hering's digest in the *Electrical World*. The article in question calls attention to the importance of the ratio of the real surface of an accumulator plate to its apparent surface, which is the product of length and breadth. This ratio should be made as great as possible. For regularly formed surfaces the real surface can be easily measured; in this way Wilke found that ratio to be 8 to 9 for the Tudor type and 14 for the Majert type. For plates of irregular surfaces or for porous plates the real surface cannot thus be measured. He describes an interesting exact method which can be used in such cases, and which is based upon the following considerations: Any primary electrochemical effect is, according to Faraday's law, dependent upon the current. A part of the primary products of the work of the current may, however, form a secondary combination either with the electrodes or with the electrolyte, the effect depending upon the current density—*i.e.*, the current per unit of real surface, not apparent surface. If the relation between current density and secondary effect is known, the measurement of the secondary effect can be used to find the current density, and therefrom the real surface. For practical application such a secondary effect may be used to advantage, in which the quantitative and not the qualitative properties of the reaction vary with the current density, and in such a way that for decreasing current density that part of the whole effect which appears as secondary effect increases, as in the electrolysis of oxalic acid or acetic acid and their salts, when gases are developed at the anode, the quantities being dependent upon the current density. He describes a series of experiments with oxalic acid which prove the correctness of the method, and promises an article on its practical application to the measurement of the real surface of accumulator plates.

Gas-Engine Sub-Stations.—Under the title of the "Future of Electrical Supply," Mr. Alton D. Adams, in an article in the March number of the *Engineering Magazine*, discusses the various possibilities of the future of electric distribution. In the commencement he sums up the losses in the system of distribution using high-potential three-phase currents on the transmission mains and transformers and rotary converters between the transmission main and the distributors. The difficulty in such comparisons lies in the fact that the efficiency of distribution varies so much with the load being distributed. We do not see in Mr. Adams's article a clear statement as to the load he is presuming, but it seems that his figures are intended to represent full-load conditions. He shows that with the above system 80 per cent. over-all efficiency or ratio between the kilowatts actually sold and the kilowatts dispatched from the central station is to be expected with a 5 per cent. line loss. Also reckoning the rotary converter, the transformers, and the generators, plant of 3·34 kw. capacity has to be used in order to supply 1 kw. In looking for some means of improving these conditions, Mr. Adams comes to the gas-engine driven by producer gas. He quotes the well-known tests as to the low consumption of anthracite coal per indicated horse-power with such plants, and estimates that 50 per cent. more fuel is required with the best steam plant than with the best gas-engine plant working with power gas. He goes on to consider how far it is possible to replace steam plant by plant driven by power gas, and comes to the conclusion that it is more economical to group the whole of the generating machinery into one building, even if gas is used. There is, however, the possibility of transmitting the power in the form of gas rather than by steam. Mr. Adams gives items of cost, which we do not propose to dispute, and finds that with a 400-h.p. sub-station five miles away from the generating station it costs about £8. 6s. per horse-power for the machinery to deliver this power electrically, including generating plant, transformers, and rotary converters, while a further £5 per horse-power will be required for the mains. With a distribution by means of gas-driven engines in sub-stations, and allowing 100 cubic feet of producer gas per brake horse-power hour, the author estimates that the cost of the pipe and the machinery in the sub-station, including gas-engines and dynamos, would come out at £13. 4s. per horse-power delivered for distribution. This is as against a total cost of £13. 6s. by the all-electric system, so that the first costs are practically the same. The author claims that while this is so, the combined efficiency of the system using the gas machine and dynamos at the sub-stations would be higher than that in the all-electric system. Figures are given to show that 1·16 times as much of the generated output would be available for distribution. The article itself is most interesting reading, but it is faulty in that it only reviews the matter from one point of view. The economies of plants driven by gas-engines are exceedingly apparent on paper, particularly if no reference is made as to the cost of upkeep and of running machinery. Experience in England and also in Ireland is quite opposed to gas-engines for such work. The fault may certainly lie with the type of gas-engine used, but another point which has been brought up against the system is the difficulty of obtaining large-power gas-engines which will work with a reasonable expenditure per annum for upkeep. The question of wages is also to be considered in any system of distribution by gas such as is proposed by Mr. Adams.

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THE WILLESDEN WORKS OF THE METROPOLITAN ELECTRIC SUPPLY COMPANY.

(Concluded from page 335.)

All the high-tension switch gear in the transformer-house was designed by Mr. G. W. Partridge and manufactured by the Silvertown Company. The mains from the engine-room switchboard convey the current at a pressure of 500 volts to the basement, where a single-pole automatic circuit-breaker is placed in the branch to each transformer. The leads to the low-tension winding then pass up through the floor to the transformers. The high-tension connections (10,500 volts) from the transformers are made at the top of the transformers, so that the whole of the switches and fuses are high up out of reach of the operators. The switches seen in Fig. 13 are worked by levers of the railway-signal type on the floor level. On entering the transformer-house by the door in the centre, the whole of the transformers and gear for what is termed the "red phase" is placed on the right-hand side, and that for the "blue phase" on the

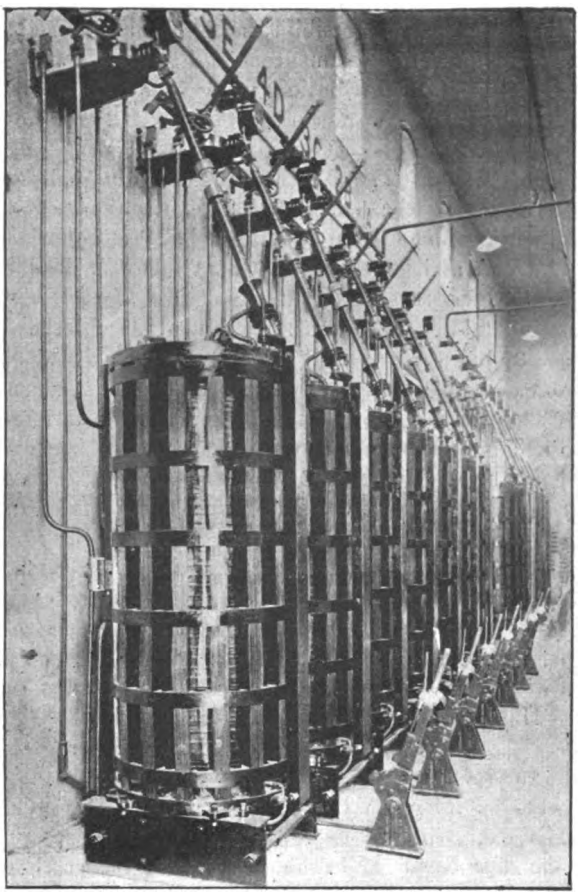

FIG. 13.—The High-Tension Switch Gear and Battery of Berry Transformers.

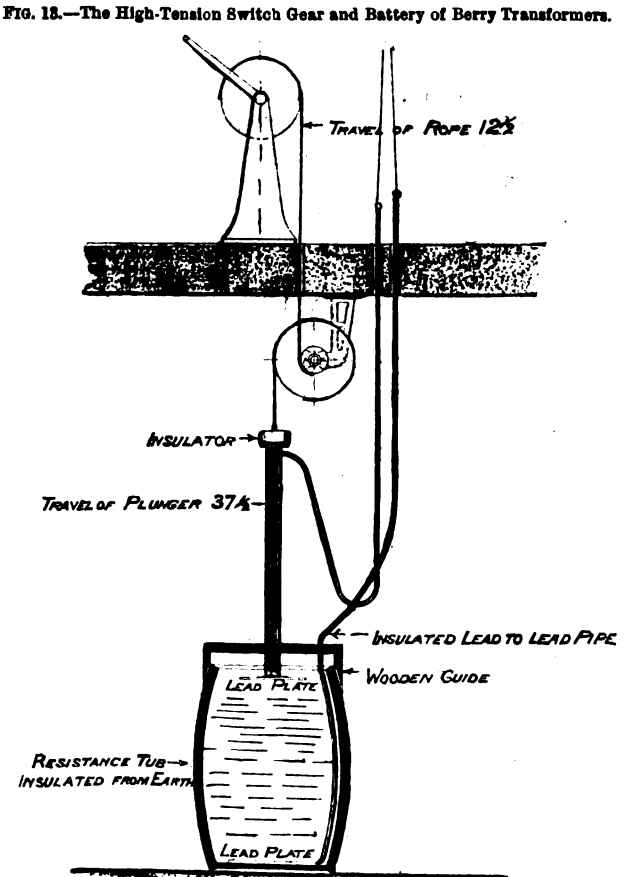

FIG. 15.—Section of the Resistance and Switch Gear for the Main Charging Apparatus.

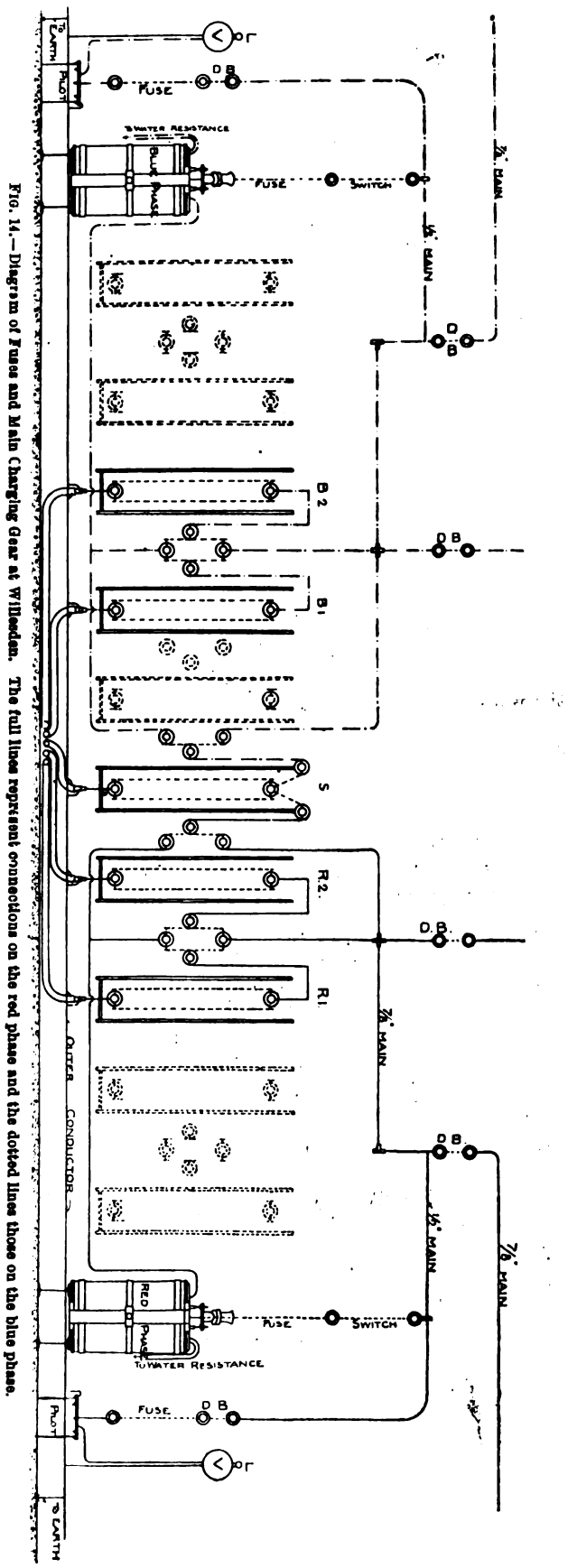

FIG. 14.—Diagram of Fuses and Main Charging Gear at Willesden. The full lines represent connections on the red phase and the dotted lines those on the blue phase.

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left-hand side. The high-tension omnibus bars for each phase are supported on insulators, and are carried round the walls at a considerable height from the floor level. On the wall facing the doorway is all the switch gear for connecting the mains to these 'bus bars. This is shown more or less diagrammatically in Fig. 14. Of the five cables now laid to town, two are permanently used for the blue phase (B_1 and B_2), and two for the red phase (R_1 and R_2). The fifth cable, marked S, is spare, and the connections at the side enables this to serve either phase. With such high voltages it is important that any cable shall not be suddenly switched on to or off from the 'bus bars. If this is done reactions sometimes take place, which have been found to break down the insulation of the cables. The method devised by Mr. Partridge for bringing the voltage on to the cable slowly

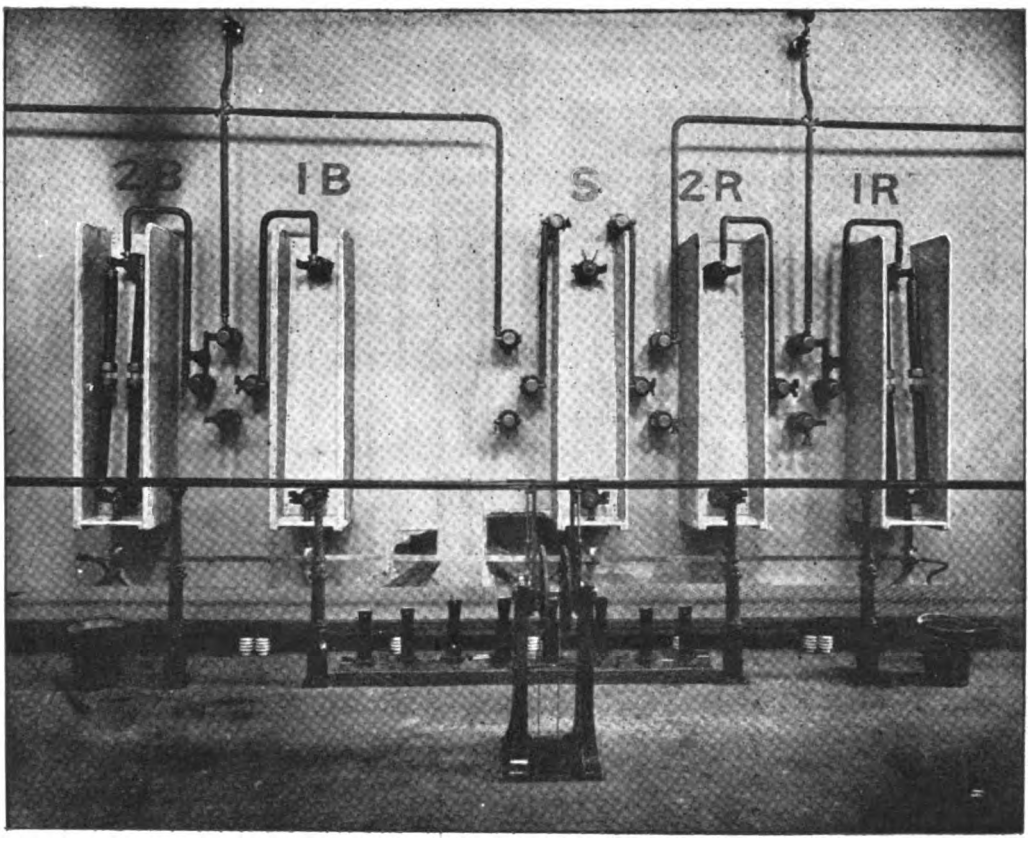

FIG. 16.—View of the Main 10,500-volt Fuses and Levers for the Resistances of the Main Charging Apparatus.

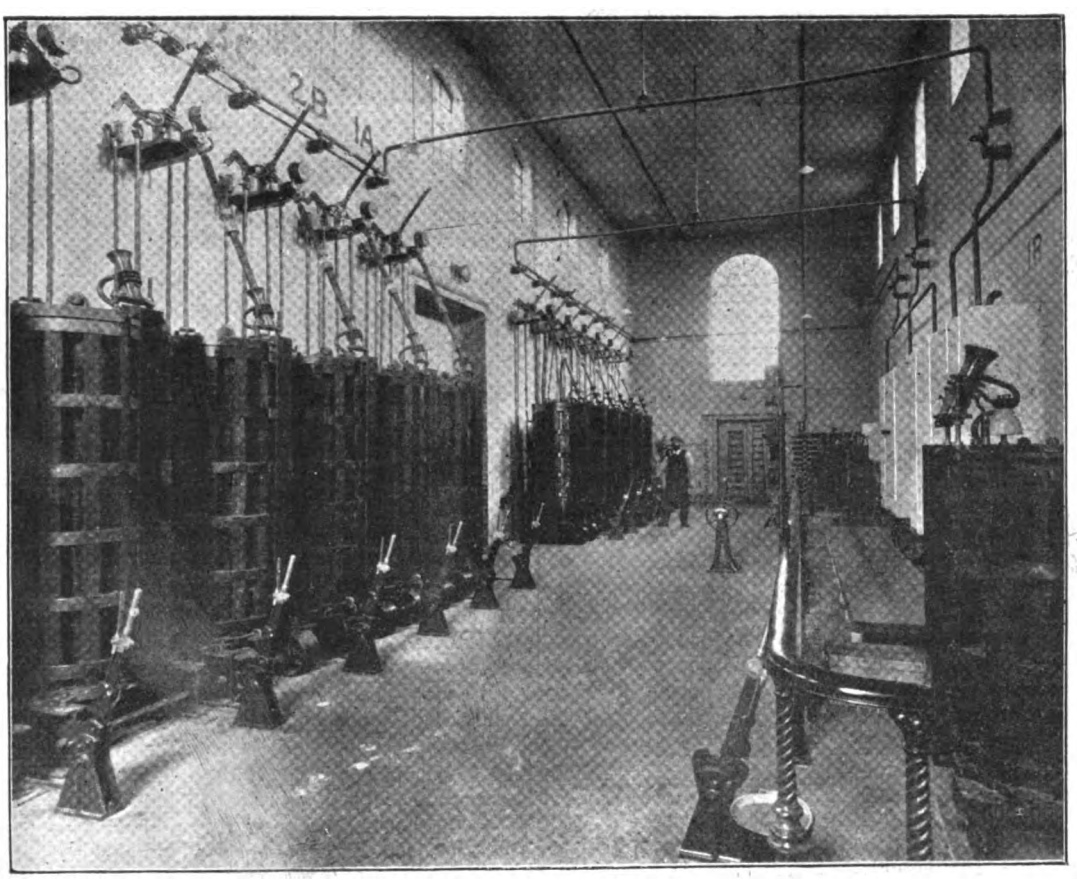

FIG. 17.—General View of the Transformer-House showing the Berry Transformers.

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consists in the use of two auxiliary 150-kw. transformers, seen in Fig. 14. One terminal of the high-voltage winding of one of these transformers is connected to the main to be charged up, and the switch above the transformer then is closed, connecting the other terminal of the high-voltage winding to the 10,500-volt 'bus bar. The low-tension circuit of the charging transformer

FIG. 18.—Map of the Metropolitan Electric Supply Company's District showing the route of the 10,500-volt Feeders and the positions of the Sub-Stations.

is left open, so that a large impedance is in this way introduced between the 10,500-volt 'bus bar and the cable. By means of a water resistance (Fig. 15) the low-tension circuit of the transformer is then gradually short-circuited, which thus raises the voltage on the cable up to practically its working value. The direct connection is then made at the connecting blocks by the side of the main fuses. The reverse procedure takes place if a main has to be cut out of service. Fig. 16 shows the general appearance of this switch gear. The fuses used in these high-tension circuits consist of long, thin fuse wire stretched in glass tubes, which are strengthened at either end by earthenware pipes placed over the glass. The lower portion of the fuse wire is surrounded by sand, which effectually damps out the arc when the fuse goes. It will also be seen that the position of the fuses and switch gear for the transformer is so placed that the attendants are always clear if the arc fuses at the instant of break. The dark patch on the wall above the main fuse, 2 B in Fig. 16, was caused by a fuse going, and shows a considerable flash does take place at such times.

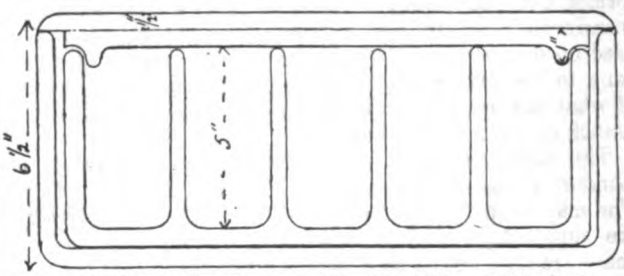

FIG. 19.—Cast-Iron Troughs for Cables. The width over all is 1ft. 4in.

The whole of the step-up and step-down transformers on the Willesden supply have been made by the British Electric Transformer Manufacturing Company, Limited, at their Woodfield-road works. They are of the Berry type, the step-up battery (Fig. 17) consisting of 14 transformers of 250 kw. capacity each, equivalent to 500 kw. more than the full load of two of the large sets. Each transformer is 2ft. 9in. in diameter by 6ft. 3in. high, and weighs about four tons. Substantial undercarriages of steel joists, with massive rollers, are fitted to all the transformers so that they can be moved with facility. For transport purposes a pair of steel joists are attached to each transformer, and to these trunnions are fixed. The transformer is then handled in the same way as a big gun. The step-down transformers in the station in London are of 100 kw. capacity, and transform from 10,000 to 1,000 volts each.

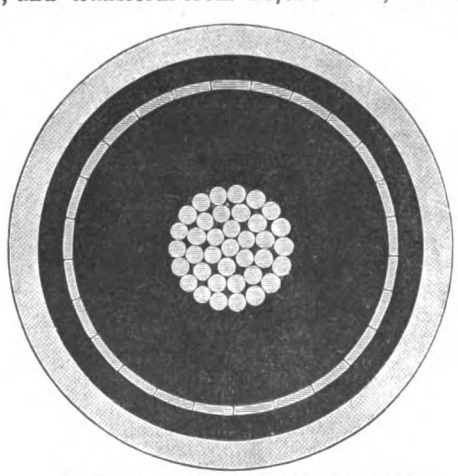

FIG. 20.—Cross-Section of High-Tension Cable.

They are 2ft. 2in. in diameter by 4ft. in height, and weigh about 25cwt. Each is mounted on an undercarriage similar to the 250-kw. units. One end of the extra high-tension winding of the step-up transformers is earthed at Willesden. On the step-down the middle of the secondary 1,000 volts winding is earthed. There are no earth shields or Cardew devices used. The high-tension (1,000-volt) winding of the step-down transformers is taken through a regulating switch, which varies the number of turns so as to give a range of 120 volts in 12 steps of 10 volts each. Intermediate points are arranged to supply through a choking coil when passing from one step to another, so as to avoid short-circuiting the transformer coils. Every transformer has been subjected to the following tests: 15,000 volts for half an hour across the primary coil, one pole being connected to the secondary winding and frame of the transformer, and a pressure of 2,000 volts between secondary and case for half an hour. None

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of the transformers are in cases, and to this arrangement, and the thorough ventilation provided, not only in the iron, but also in the winding, the remarkably cool running is due. A temperature test shows the rise after a 12 hours' run on full load to be only 40deg. C. on the 250-kw. size. This is attained without the use of air blast, oil, or any device other than the free circulation of atmospheric air which the construction of the transformer provides. The drop on these 250-kw. transformers from no load to full load is less than 1½ per cent., and the power factor at no load is about ·72. That the Metropolitan Company are satisfied with the above plant may be inferred from the fact that the British Electric Transformer Company have at present in hand 34 additional transformers of 100 kw. each and 20 of 50 kw. each to be used on new works. The transformers made by this company to the design of Mr. A. F. Berry are a good example of what can be done by a firm specialising in one particular branch of electrical engineering.

The mains from the Willesden works are laid up to London along the banks of the Grand Junction Canal. The map (Fig. 18) shows the whole of the districts which are supplied by the Metropolitan Company; in the map these are surrounded by a dotted line. The first point in London at which the mains are tapped is the Amberley-road station of the company, which is also situated on the banks of the Grand Junction Canal. Five concentric cables, each conductor of which has a sectional area of 0·2516 square inch, are laid from the Willesden works through to the Amberley-road station.

These cables are laid in cast-iron troughs, as shown in Fig. 19, one cable being laid in each division of the trough. The depth of each division is sufficient to allow of another cable of the same section as the present one being laid on the top. The iron troughs along the canal are filled in solid with a special composition of pitch. The continuation of the mains from Amberley-road is carried on to a sub-station in Burwood-mews, between which places the section of the cables is 0·1909 square inch. The whole of the high-tension trunk mains from Burwood-mews to the other sub-station showing on the map have sectional areas of each conductor equal to 0·0973 square inch. We understand that the whole of these cables are laid in iron troughs, but they are not all filled in on the solid system. Instead of this, sawdust is placed round the cables to prevent an accumulation of gas. The cables are insulated with paper impregnated with a special insulating compound, and are lead covered. The cables are jointed up solid from sub-station to sub-station, there being no disconnecting boxes of any kind; all joints are enclosed in lead sleeves, carefully wiped to the lead of the cable. Four twin telephone wires accompany the feeders from Willesden to Amberley-road, and thence two only to the other sub-stations. Each wire consists of two ·0025 square inch twin conductors, insulated with impregnated paper and lead covered. The cables were manufactured by the British Insulated Wire Company, Limited, of Prescot, and the trunk main from Willesden to Amberley-road was also laid by them. The rest of the cables were jointed by them only, the laying having been done by the Metropolitan Electric Supply Company. After the cables were laid and jointed they were subjected to a pressure test of 20,000 volts for half an hour, and they have been in continuous use during the time the Willesden station has been running, working at a pressure of 10,000 volts, without mishap of any kind. The total length of extra high-tension cables amounts to about 40 miles. Fig. 20 shows a full size cross-section of the high-tension cable used for connecting the Willesden works to the Amberley-road station.

The whole of the different works were constructed under the supervision of Mr. R. R. Todd, now the engineer to the company, who was ably assisted by Mr. C. A. Holbrow. The plans were prepared to designs and the plant was constructed to specifications prepared by Mr. Frank Bailey, M.I.C.E., who when the scheme was first brought forward was the engineering director of the company. These three gentlemen are to be congratulated on the results of their labour, and especially on the fact that the present works provide ample facilities for extensions, so that the company will not have to reorganise its system of generation for many years to come.

PERPETUAL MOTION.

The description we printed last week of the two arrangements designed by Mr. A. E. Gilbert has been the subject of several criticising letters, some of which we print below. The illustration of the second arrangement should have been turned round through 90deg. in order to show what Mr. Gilbert intended. To make the device clear we are reproducing the illustrations this week. The following are the letters in question:

Dear Sir,—The designs by Mr. A. E. Gilbert of arrangements from which he expects to obtain energy without putting any into them, are doubtless interesting to every engineer who has had leisure in which to allow his imagination an occasional fling into those seductive realms where principles, laws, and rules may not hold sway. In this criticism the figures which appeared with the description in the *Electrical Engineer*, March 9, 1900, are referred to.

Taking Fig. 1 into consideration, at first sight, seemingly, if the weights are all fixed in the positions shown, the wheels would begin and continue to revolve in a clockwise direction, without having any impetus imparted to them; but a brief examination of some of the conditions will effectually demonstrate the fallacy of this idea. So far from the success of the apparatus being apparent, a little thought shows that the absence of certain features would enhance the "efficiency" of the apparatus. Among these are the two inclines. Let us first consider that in the lower half of the figure; it is intended to guide the weights close up to the circumference of the wheel F, possibly in order to reduce the apparent leverage on the ascending half of the wheel. But it is obvious that either with or without the incline each weight in its movement from the lowest point to where it would naturally touch the ring F, is raised through the same vertical height; also, the length of the arms supporting the weights means no addition to the leverage so long as the weights hang vertically and are free to swing either way during their motion. There is a loss of energy due to the compression of the rubber tyres and the friction of the weights running on their bearings. The only practical use of this incline is to guide the weights gently to F instead of allowing them to fall suddenly. The switchback, H, is better eliminated, as it necessitates the raising of each weight through a distance equal to the fall in H twice instead of once in each revolution. The energy of the impetus claimed, due to the elasticity of the rubber tyres, must be less than the work done on them by the weight in its descent down H, for the same reason that no piece of rubber will rebound to the height from which it may be dropped. The spring C, while it ensures the early throwing over of the weights, also exerts a considerable retarding force. But the most vital point of all seems to have escaped Mr. Gilbert's notice—viz., the number of weights tending to produce motion (in a clockwise direction) as compared with those in opposition. The former number six (the lowest weight is for the moment inactive), and the latter, including those at H and C, for the reasons stated above, amount to nine. The leverage of the descending weights equals approximately 33ft. and those ascending 25½ft. It is probably accurate enough to consider the weights as concentrated at points on a horizontal line drawn through the shaft centre at right angles to its axis. Now, expressing the above conditions in the form of a ratio, we have

$$\frac{\text{No. of weights tending to produce clockwise motion} \times \text{their leverage}}{\text{No. of weights tending to oppose clockwise motion} \times \text{their leverage}} = \frac{6 \times 33}{9 \times 25{\cdot}5} = \frac{1}{1{\cdot}16}$$

approximately, or the state of equilibrium of the apparatus is such that it actually tends to move backwards, which, from the appearance of the figure, it probably would do, through an angle not greater than that subtended by two contiguous spokes of the wheel G, when an even balance would be obtained.

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Fig. 2 has been printed with its vertical centre line in a horizontal position; it must, therefore, be looked at with the page heading to the left, and is here so considered. In this design, as represented, there are 13 weights tending to produce clockwise motion. The weight at the lower end of the vertical centre line is in opposition as shown by the angle which its support makes with the vertical; that next to the right, hanging perpendicularly, is inactive. Consequently the number of opposing weights is 18. With reference to Fig. 3, Mr. Gilbert is not justified in adding to his driving leverage the distance (8ft.) between weight and roller on the ascending side, because the lessened retarding action due to the weight acting at a point within the outer circumference of the wheel is balanced by the corresponding extra leverage gained by the overhanging of the weight. So we have really according to Fig. 3 an effective leverage of 38′ as opposed to 31′, and taking the respective numbers of weights and again expressing as a ratio we have $\frac{13 \times 38'}{18 \times 31'} = \frac{1}{1{\cdot}13}$ approximately, again a slight balance on the wrong side. Of course, the simple formulæ used do not accurately represent all the conditions existing, but come near enough to suggest the inference that if the apparatus can be put into any position from which it will of itself move, it must, like every unbalanced body free to turn on an axis, find a place of rest within the space of one revolution. It seems very probable that the arrangement shown in Fig. 2 would require quite a respectable amount of power to overcome friction.

Mr. Gilbert seems to have lost sight of the point that in any such arrangement as his designs represent, the mechanical advantage of the weight which has the greater leverage is a measure of the greater distance through which it has to fall, as compared with that possessing less leverage. In both his designs the rise and fall are equal. Part of the lift has to be accomplished by methods involving friction, and it is not possible to have the falling weights as great in number as those rising. A perfectly-balanced flywheel has the advantage of being without the two latter objections. It would be interesting to know if any of Mr. Gilbert's models *have* worked continuously without external aid. In the writer's opinion the only class of perpetual-motion device possible must depend upon such natural forces as are due to wind, tides, or variation of temperature for energy to keep them going. Still, he believes there is at least one field in which inventive energy of the kind exhibited by Mr. Gilbert may be put to a useful purpose.—G. Evans.

Dear Sir,—Respecting the two perpetual-motion machines described in your last issue as designed by Mr. Gilbert, I think that a brief reference to first principles is all that is necessary to show the fallacy of the designer's hopes. Perpetual motion is hardly all that is claimed for the machines, as Mr. Gilbert hopes to get "a pretty good horse-power" out of them. Now, this horse-power can only be obtained by the action of gravity on the parts of the machines, and as the laws of gravity are well known, it should be comparatively easy to test the truth of the inventor's claim. The work obtainable from a falling body is measured by the weight of the body multiplied by the distance it falls in feet. It is quite immaterial, as far as this work is concerned, if frictional losses can be neglected, what path is taken by the body in approaching nearer to the centre of the earth. Thus in Mr. Gilbert's first machine, if one weight only is considered, the work which it can do in that portion of the revolution in which it is descending is quite independent of the leverage. The vertical distance from the highest to the lowest part of the path of motion of the weight is only concerned. This, from the drawing, appears to be about 63ft. If each weight is 2,000lb., the work available in descending will be 126,000 foot-pounds. The next portion of the path of the weight is in an upward direction, and unless the vertical height the weight is raised is less than 63ft., an expenditure of work equal to the above will be required. It will be seen that Mr. Gilbert endeavours to reduce the work required on the return path by placing guides to keep the weights nearer the centre of the wheel. Any such expedient is quite useless, as vertical

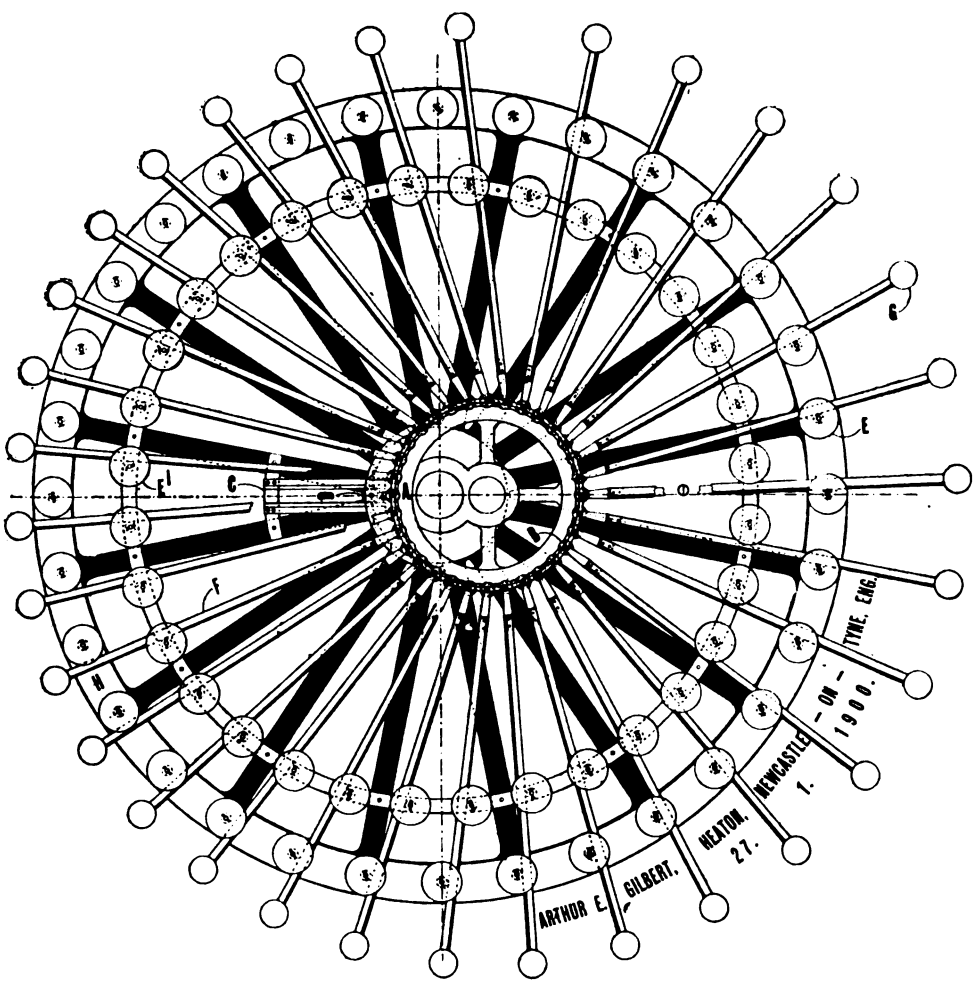

Fig. 2.—Gilbert's Proposed Perpetual-Motion Machine.

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displacement, and not the distance of the weight from the centre, determines the work required. The hinged weight is gradually raised until it rests in the hollow of the guide, H. Its vertical height above the lowest portion of its path is then about 59ft. The remaining 4ft. in the vertical direction is then accomplished, and if Mr. Gilbert could do this, as he suggests, by the action of the rubber tyres or by a spring, without doing any work, the machine would be a success. Unfortunately, the laws of Nature step in, and demand the provision of $4 \times 2{,}000 = 8{,}000$ foot-pounds before the weight can be allowed to reach its final position. This amount wipes out the balance of the work done by the weight in descending, and as there is friction, each individual weight requires the provision of some external power to keep it rotating. The same reasoning applies to the second machine. It may, however, be well to look at the matter from another point of view. Mr. Gilbert hopes, by altering the leverage at which the weights act, to throw the wheel out of balance, and to keep it always unbalanced. This he thinks he does by confining his consideration to two weights at the extremities of a horizontal diameter of the wheel. The very means, however, by which he obtains this result for these two weights increases the number travelling in the upward direction; thus in the position shown there are six weights shown which tend to make the wheel revolve in one direction, and nine weights which have an opposite tendency. This prevents Mr. Gilbert realising the advantage hoped for. As regards Fig. 2, there are several details which require to be explained before the design can be analysed, but it is condemned on the general statement that no body moving regularly in a closed path can, by the action of gravity, do external work. The nearest Mr. Gilbert will get to perpetual motion in the direction he is seeking is by designing a well-balanced flywheel with frictionless bearing and placing the same when running *in vacuo*.—P. T.

Dear Sir,—The arrangement of mechanism by means of which Mr. Gilbert is going to get something out of nothing may be a little different in detail, but is based on the same principle that has been tried by many inventors for years past. Mr. Gilbert, like other inventors of such machines, makes the same mistake in considering leverage only. He certainly has a mechanical advantage with two or three longer levers on one side while the machine is stationary; but, even looking at it from this point of view, he has not

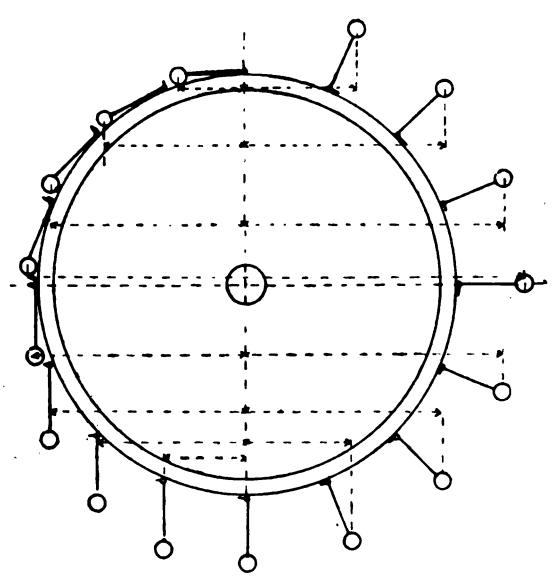

FIG. 4.

the advantage that might at first be supposed, because the weights in each position act vertically downwards, and the sum of the moments on the right side will exceed very little the sum of those on the left side (see Fig. 4). As soon as the wheel starts moving, the conditions change completely, for it is now not a question of leverage, but conservation of energy. We will suppose any one of the weights, W, just starting from position A (shown by Fig. 5). In moving from A to B the weight gives out kinetic energy equal to $\frac{2\pi^2 n^2 W K^2}{g}$; when K = radius or gyration in feet, n = number of revolutions in unit time, W = weight of ball. When the bottom position, B, has been reached the weight can no longer give out energy, and must be again raised to A before being of any use. In being raised to A, potential energy W × A B must be given in. But the principle of the conservation of energy, neglecting friction, is that the gain of kinetic energy = the loss of potential energy.

$$\frac{2\pi^2 n^2 W K^2}{g} = W h.$$

Therefore this proves that unless Mr. Gilbert has a perfect frictionless bearing the machine has not even the power to move its own weight, let alone drive dynamos or other machines. This argument applies to both 1 and 2 machines shown by Mr. Gilbert's drawings in the *Electrical Engineer*.

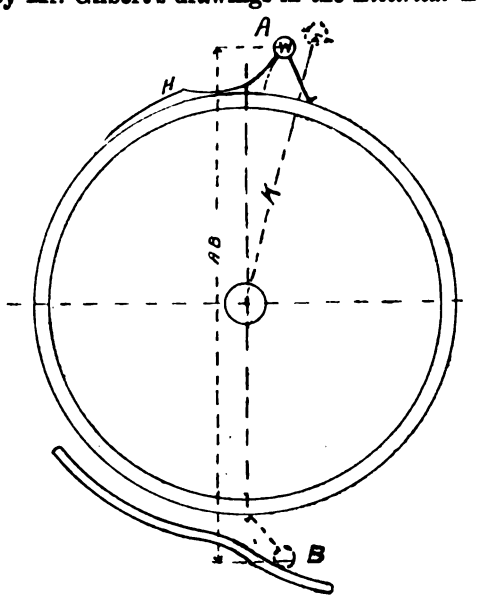

FIG. 5.

Without taking into account the friction of the bearing, which will be something very considerable in a bearing of the size shown and would take a lot of energy to overcome it, there is also the friction of each lever and pin. Then the switchback arrangement, H, would not give an impetus as stated, but would only retard the motion, because you are compelling each weight to move from the path in which it wishes to travel, and this means, again, a waste of energy. Also, with reference to the arrangement shown by Fig. 5 for bringing each weight back to rim of wheel, this would be more than useless, for the force at this point would partially destroy the momentum of each ball, again retarding the machine. As to the spring-push arrangement at the top, I can only say this—that whatever energy it is equal to in the way of a kick it must first have received from some outside source.

I have no doubt that any model Mr. Gilbert has made may have been made to run for a short time, because he has balanced it as much as possible, and eliminated with ball bearings, etc., some of the friction—in fact, I may state that I have seen a similar wheel, arranged with sliding weights, and well balanced, run for about 10 minutes after receiving a considerable impulse at the start.—E. M. HOLLINGSWORTH.

[N.B.—Mr. Hollingsworth is wrong in his statement as to the kinetic energy given out in half a revolution. His formula gives the energy stored in one weight at the normal speed, but there can be no kinetic energy given out unless there is a change of speed.—ED. *E. E.*]

PORTABLE ACCUMULATORS.

In the description given in our last week's issue of the portable accumulators manufactured by Messrs. Niblett, Sutherland, and Marcuson the address of the firm was wrongly given as 16, Chandos-street, whereas the correct address is 61, Chandos-street. We find also that we have exaggerated the capacity of the set of testing accumulators, which will not maintain a 16-c.p. lamp burning the time we stated. The set will, however, incandesce an 8-c.p. lamp for quite sufficient time to enable a large installation to be tested for continuity.

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INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on the 8th inst., before the reading of Dr. Jones's paper, the PRESIDENT announced that the Council had received from the secretary of the Northern Society of Electrical Engineers a formal request for the incorporation of that society as a section of the Institution for the district of Manchester. The Council had approved of the application, and in making the announcement he must say that the society had fought well to be able to throw in its lot with the Institution. This incorporation would be the means of transferring some 90 members who were not members of the Institution to the roll of the different classes. There were some others also in the district who were associated with them. He hoped that the hands of both sections would be strengthened, and they acknowledged that they were distinctly the gainers from the action of the Northern Society in this matter.

The following paper was then read:

On the Applications of Electricity in Medical and Surgical Practice.

BY H. LEWIS JONES, M.D., MEDICAL OFFICER IN CHARGE OF THE ELECTRICAL DEPARTMENT IN ST. BARTHOLOMEW'S HOSPITAL.

It was with very great pleasure that I received a communication from your president last autumn asking me to write you a paper on medical electricity. And it is a pleasure to me for several reasons: first, because it is a recognition by the Institution of Electrical Engineers of the existence of their somewhat humble sister medical electricity; secondly, because it gives me an opportunity of putting on record the position which medical electricity holds at the end of the nineteenth century; and thirdly, because I hope to be able to give you some information which may be new to you.

To a certain extent there is a correspondence between the work of an engineer in the repairing shop and that of a medical man in his practice; and this was brought quite forcibly to my mind a little while ago, when I had occasion to write and ask a member of the Institution kindly to come and advise me with regard to a motor which was in feeble health. When he came, he said that he had been sitting up all night with an engine which was on the point of breaking down. It seemed to me to be closely the kind of work which the medical man is often called on to do, substituting only the human being for the machine.

The medical side of electricity has been prominent from the early days of the science. Its physiological effects were among the first observations made. In particular, the experiments of Aldini upon the muscles of recently killed animals seem to have created a deep impression upon the people of his day, and to have held out hopes of the discovery in electricity of valuable heating properties.

Electrical departments were in existence in some of the London hospitals 100 years ago. At St. Thomas's, in 1799, the electrical department was under the charge of a surgeon, Mr. Birch, who has left a very interesting "Letter on Medical Electricity," which is printed in a book called "An Essay on Electricity," by George Adams. The copy of this work which I possess is the third edition, printed in 1799, and having for frontispiece a woodcut representing a medical man applying electricity in a manner which clearly shows considerable scientific knowledge. As some of those present may not have seen it, I have brought down the woodcut, and it lies on the table here for inspection. Among other interesting observations of Mr. Birch, there is one which may cause us to smile, or rather to sigh, at the change between his times and ours. The surgeon writes, "The ingenuity with which these simple modes of application may be varied, to puzzle and deceive the observation of a bystander, is unbounded, and would have formed a grand basis for empiricism if they had been artfully employed; but as electricity has escaped abuses, I trust," etc. John Freke, F.R.S., who was elected surgeon at St. Bartholomew's in 1729, is incidentally referred to in Fielding's well-known novel, "Tom Jones," as an authority on the subject of medical electricity.

It is now 150 years since the beginning of medical electricity. During the whole of that time it has had to fight its way in the face of many difficulties, and the most serious of these has been the passive resistance of medical men themselves. The vitality which the subject has shown under adverse circumstances is most significant. Medical electricity advances steadily, and the progress during the last decade has been very great. The commercial application of electricity and its house-to-house distribution by electric lighting companies have called into existence a large number of new instruments and new methods of treatment, and is helping the spread of the study of medical electricity by simplifying the means of obtaining the current when required. The accumulator has been of great service by affording a trustworthy source of currents for the use of surgeons in their galvano-cauteries and exploring lamp instruments. The discovery of the X-rays, and their application to surgery and medicine, have also done good to the cause of medical electricity by bringing electrical apparatus into more extended use, and the founding of X-ray departments in hospitals gradually leads to the development of electro-therapeutic departments in places where these are not already in existence. Most of the London hospitals now have electrical departments, and these are of manifest utility. At St. Bartholomew's Hospital we have about 600 cases referred yearly to the electrical department from all quarters of the hospital, exclusive of the cases for X-ray photography, the numbers of which are even greater, and the results of our treatment will compare favourably with those in any other branch of medical practice.

It is a little difficult to speak on a medical subject before a non-medical audience without incurring the suspicions of those who are always on the alert for signs of unprofessional behaviour, and there is no branch of medical practice upon which the fierce light of criticism shines more sharply than upon medical electricity. I shall therefore have nothing to say on such matters as the relation of cases, statements of cures, and so forth, which might be thought to be unsuitable to my audience, but will try to meet you on the common ground of apparatus and methods, and in particular I shall try to lay before you some of the difficulties and problems which arise in the course of our medical work, in the hope that some of them may be solved by the advice and suggestions of those who are here present.

From conversations which I have had at various times with engineering friends, I am disposed to think that the number and extent of the applications of electricity to medical practice are not generally realised by electrical engineers. Indeed, when I have observed any reference at all to medical electricity in the proceedings of this and of kindred societies, the reference has usually been one of disavowal and dislike. I therefore feel that in making the present communication to you, I am undertaking the task of trying to show that electrical applications have a large and legitimate field of usefulness in medical practice; that it is quite possible to practise medical electricity without thereby becoming an outcast, and that the advertisements of electropathic or magnetic appliances do not represent the position of medical electricity any more than, shall we say, Keeley represented all that was best and truest in electrical engineering.

If what I have to say to you may seem to be about trifling matters, I hope you will bear in mind that our unit is the milliampere, while yours is the kilowatt, and that the currents which we handle and use would make but a small figure if their energy were expressed in terms of horse-power. Nevertheless, in the small technical matters which have to do with the management of various kinds of small electrical apparatus the medical man requires a thorough proficiency, because it is absolutely necessary that he shall be able to make his apparatus work. On that account we may appear, in certain matters, to take elaborate precautions which might seem to you to be hardly necessary. With our coils and batteries we require unfailing methods for increasing or decreasing the current sent through the patient, without stops or jerks. We have to deal with the electric light mains, either direct or alternating, or both. And we have evolved for ourselves a long array of contrivances for utilising the public supplies of electricity for medical purposes. Small transformers, portable accumulators, resistances to provide slopes of potential, which can be tapped as desired for varying voltages, contrivances for using the mains for all sorts of medical purposes, are all enlisted in medical work. The statical machine is also coming again into favour, and to use a statical machine one must know enough about its management to be quite sure that after a patient's arrival there shall be no awkward failure of the machine to excite. Otherwise we are likely to be condemned as not understanding our apparatus, and the patient may be lost. All these little matters can only be learned gradually, and through a course of failures and disappointments. And when they have been learned thoroughly, they constitute a very fair claim to the title of electrician.

The use of electricity in the production of hot-air baths with incandescent lamps or electrically-heated coils of wire as the source of heat is a development of some promise; while, in the immediate future, we can see the approach of new methods of treatment by the light of the arc lamp. Each of these will demand a fresh extension of the field of electrical operations which the medical man will have to learn.

And now I feel sure that some of you are ready to ask what can be done with all these numerous forms of apparatus. You might be inclined to ask me, as a patient of mine asked me the other day, whether I had ever done anybody any good by electricity. We will take the simplest things first. No doubt it is familiar to all of you that an electric shock produces a

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muscular contraction, but possibly you may not all be aware of the extent to which the study of the muscular contractions has been developed. The muscles and their nerves are tested by the application of the induction coil current, and by the direct current of a battery of cells; the effects at opening and at closing of the circuit, the comparison of the action of the positive pole with that of the negative, and the measurement of the current needed to produce visible contractions are all examined, and in this way a system of electrical testing has been devised which affords the most valuable indications in the diagnosis of diseases of the nervous system. An important part of the work in the electrical department of a hospital is the testing and reporting upon cases of injury or disease of the various portions of the nervous system and of the muscles, and the accuracy of the answers given by electrical testing is something to delight one. For exactness and simplicity in its responses, one might compare electrical testing to the processes of measuring with a yard measure or weighing in a pair of scales; and numerous cases which are quite obscure until tested electrically, become as clear as daylight as soon as the test has been made.

The behaviour of a muscle under electrical stimulation is peculiar, and I think it may be useful to describe it. A simple shock, such as a single discharge of an induction coil or of a condenser, or a spark from the prime conductor of a static machine, causes a single muscular twitch which within certain limits is proportionate to the energy of the discharge; the contraction lasts about one-tenth of a second. A rapid succession of shocks causes a succession of contractions which become fused so that the muscle enters into a permanent state of contraction which lasts as long as the stimuli are applied. Stimulation applied to a nerve causes contraction in its corresponding muscles, and when the stimuli are applied to the muscle itself it is through the agency of its nerves that the stimulation acts. With a continuous current the behaviour is different. Here there is a twitch at the moment of closing the circuit through the nerve or the muscle. The muscle then remains quiescent and almost completely relaxed, while the current still flows, and another twitch is produced when the circuit is broken. This is the sequence of events with the currents of about five milliamperes which are used for testing. With currents four or five times as strong the muscle enters into permanent contraction with continuous currents. These contractions at make and break may seem to recall the phenomena of electromagnetic induction, but the analogy is more apparent than real. In certain kinds of paralysis these reactions change, and all irritability of the muscle to coil currents disappears. Stimulation of the nerves gives no response either to coil or cells, but the contractility of the muscle remains for currents from the cells applied directly, and may be more easily excited than in health, while the contraction itself changes in character from a rapid twitch, lasting one-tenth of a second, to a slow sluggish movement, lasting three times as long. Stated briefly, the above are the observed facts of what is known as the reaction of degeneration. Its value depends upon the fact that it occurs only when the cause of the paralysis occupies certain definite portions of the nervous system. By its presence or absence we can therefore determine with great nicety the seat of the disease or injury. A point which is not yet explained is why the coil discharge should become ineffective on muscle which retains the power of responding to the battery current. What are the electrical differences between the two modes of stimulation?

Next as to electrical treatment. Progress in medical treatment usually moves along two lines. One of these is based upon experimental physiology—that is to say, upon a study of the various processes in healthy tissues, and depends on the application of the facts observed to various morbid states. The other line of advance is by direct experiment in a more or less haphazard manner upon the sick. In medical electricity, as in medicine generally, both these lines have been followed. If we consider the first, we can apply the observed fact that electricity is a stimulus to certain living tissues, by asking how stimulation may be made use of in disease. The fact that electricity is a stimulus is easy to perceive in the case of nerve and muscle, and in the case of the sensory nerves of the body, and it is not difficult to prove that it acts in this way upon all living tissues, and the employment of electricity in disease is very largely an application of this process of stimulation. Beard and Rockwell in the United States, and Débédat in France, have shown experimentally that in young animals the rate of growth can be accelerated by suitable electrification. The former electrified daily two young puppies, and found that they grew faster than those of the same litter which were not electrified. Débédat in the same way proved an increase of weight in certain muscles of rabbits as compared with other non-electrified muscles in the same animals; the latter thus showed a local effect from localised electrification, the former a general effect from general applications, and this division into general and local treatment is a useful one. Thus for general diseases one gives a general treatment, and for local diseases a local application. D'Arsonval, by calorimeter observations and chemical analysis of the expired air, has established the fact that electrification increases the activity of the tissue exchanges of the body. Capriati recently has shown by careful dynamometric researches that the application of electricity to the central nervous system in the form of a continuous current along the spine does undoubtedly increase the muscular power, and that applications to the muscles of a limb have the same effect. In the United States it is becoming fairly common for athletes to undergo electrical treatment when preparing for a contest. General electrification applied to cases of simple failure of nutrition, such as debility after illness, or debility of any kind, produces a rapid improvement in the condition of the patient. In rickets, which is a comparatively simple form of defective nutrition, electrical applications have been shown by many observers to have a very high value. The more complex forms of defective nutrition such as rheumatism, gout, and diabetes are not yet completely controlled by electricity, but indications are not wanting that in time good results may be expected. Already electricity is doing much for these conditions. In the field of paralytic conditions there are certain strict limitations to the utility of electrical treatment, and it is here that electricity has lost credit quite undeservedly. People have expected electricity to work miracles, and because it could not do so have condemned it as useless altogether. When paralysis is due to some mechanical obstruction or destructive process in the nerve centres of the brain or the spinal cord, or when it is due to certain progressive degenerations in the quality of those parts, then electricity is powerless to help. So, too, when paralysis is due to a breach of continuity in a nerve trunk, electricity can do nothing until the surgeon has intervened and reunited the severed ends. In the latter case electricity comes in quite properly afterwards to promote the recovery of functions which had fallen into abeyance; in the former the surgeon cannot help, neither can electricity. Therefore it is very important to insist that in paralysis there are cases suitable for electricity and cases which are unsuitable. Happily, the number of those which are greatly benefited by electricity is a considerable one.

Another field in which electricity is useful is in the relief of pain. Oftentimes it acts by influencing the circulation in the painful part and relieving congestion and pressure in the blood vessels. This I believe to be its mode of action in sciatica, lumbago and rheumatism, and in some neuralgias. At other times it seems to relieve a neuralgic pain by some direct influence upon the nerve trunk in which the pain is felt. Effects upon the circulation are probably the important factor also in the relief of sprains, and in removing the chronic stiffness which may be felt in or around joints as the result of injury or disease. In this there is scope for considerable development. The good results which can be obtained are undoubted, although it is not generally known that this is the case. Electricity can also be used to promote the passage of drugs into or through the skin, and this has a few minor applications in medical practice, among others for the introduction of cocaine to produce a local insensibility in minor surgery. Electrolysis, again, is often useful in many small matters of surgery. It is used almost exclusively as a means of destroying tissue. Small tumours of various kinds can be very conveniently treated by electrolysis. The process is carried out by the introduction of metallic needles into the tumour, the products of electrolysis being thus liberated in contact with the tissue to be destroyed. The chief convenience is the ease with which one can regulate the strength of current, and the amount of caustic chemical liberated, in exact proportion to the work required to be done. So fine and so delicate an application can be made, that the root of a single hair can be destroyed without leaving any visible scar, and the removal of superfluous hair in this way is a matter for which electrolysis is continually applied. Electrolysis with copper or zinc anodes with the object of procuring the liberation of salts of these metals in the diseased tissues has been recommended abroad, but does not seem to have received much attention in this country.

One of the most encouraging points at the present time in medical electricity is the improved quality of the scientific work which is being done in it. Last year, the French Government having declared the subject to be of public utility, a section of medical electricity was inaugurated at the Boulogne congress of the French Association for the Advancement of Science. I attended the meetings of the section during the greater part of the congress, and was struck by the number and high scientific quality of the communications which were made in it. It was one of the best attended sections of the whole association. France, indeed, takes a long lead in the subject of medical electricity. They have at the present time three periodicals devoted entirely to the subject, and abundance of material seems continually forthcoming to fill the pages. One of them, the *Archives d'Electricité Médicale*, is quite indispensable to students of medical electricity, for, in addition to its original

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matter, it provides its readers with abstracts and a bibliographical index which keep one in touch with all that is being done in medical electricity all over the world. The progress in the small matters of detail, particularly with regard to apparatus, which has taken place during the last 10 years, is considerable. I say 10 years, because that represents the time during which my attention has been specially directed towards medical electricity. It will be interesting to consider and compare the types of apparatus in common use to-day with those used formerly.

Electrodes.—The current is applied to the body of the patient by means of electrodes. These may be of the most varied forms, particularly with electrodes for internal applications. The cylindrical brass handles fitted with sponges, and held one in each hand, are obsolete, or deserve to be, and for most external applications their place is now taken by a plate of flexible metal enclosed in washleather, and a disc of metal also covered with washleather, and screwed into a wooden handle. The former is called the indifferent electrode, and serves chiefly to complete the circuit through the patient's body; the other, or active electrode, is the one which is manipulated and applied over the affected region. For testing, the active electrode is fitted with a closing key. Examples of electrodes and other forms of medical electrical appliances are shown upon the table. Bare metal must never be allowed to touch the skin unless electrolytic or painful effects are desired. Sores are easily produced in a few minutes by a few milliamperes of current if at any point the metal of the conductor touches the skin directly. For this reason some water-holding material, such as washleather, is always used to cover the metallic surfaces of medical electrodes.

The Battery.—The chief requirements in a medical cell are that it shall need no attention and will not spoil on open circuit. The past few years have seen the almost complete disappearance from medical work of open acid cells, such as the Smee cell, the Bunsen, and the bichromate cell. Formerly, when electrical treatment had to be carried out by means of ponderous oak boxes filled with cells of one or other of these kinds, the trouble and the dirt associated with them was enough to discourage all except enthusiasts. At the present day the Leclanché cell is the only type of battery which a medical man need consider, and even these are rapidly being abandoned, except for fixed installations, in favour of the modern, cheap, and convenient dry cell. With these small dry cells for currents of small magnitude and with a few accumulator cells for those medical purposes which require a current of an ampere or more, as, for example, for the heating of galvano-cauteries and the illumination of small exploring lamps, the medical man is sufficiently equipped, and is no longer compelled to handle and prepare caustic solutions. Large bichromate batteries still survive in remote districts for the occasional production of large currents, but they are every year becoming less numerous, as secondary cells and the means of charging them from dynamos become more general over the country. All this simplification tends very greatly towards the increased popularity of medical applications of electricity, because perhaps one chief cause of its neglect has been, hitherto, the trouble of the management of the apparatus. The batteries needed for medical work divide themselves into two distinct classes—batteries for applying currents to patients for testing and treatment, and batteries for galvano-cautery and lamp apparatus. The former is essentially a physician's battery, the latter is more for the surgeon. Most of the surgeon's requirements are met by a portable accumulator of four cells, for the little surgical lamps are for the most part eight-volt lamps, taking about an ampere, though usually they are overrun most cruelly. For galvano-cautery the currents average from five to ten amperes, but the cautery circuit has a low resistance, and a pressure of eight volts is much more than is required. Sometimes the four-cell accumulator is arranged so that a switch will recombine it as two sets of two in parallel for cautery work, or else it is left as a four-cell battery in series, the volts being expended in a resistance. For medical work a battery is fitted with 25 to 40 small dry cells connected in series, and having wires led off from them to a circle of studs, from which a moving pointer takes up into circuit as many cells as are required. It is usually fitted with a milliampere-meter permanently in circuit and a commutator for reversing the poles, also with an induction coil driven by a separate dry cell. The average working resistance of the human body and skin is about 2,000 ohms when properly moistened with hot water. Salt or soda may be added to the water to reduce the skin resistance, but plain water is best, as it corrodes the electrodes less. Next in importance to the battery of primary cells comes the induction coil. Indeed, if generality of use be considered, the induction coil should come first, as it is the form of electrical application which has the widest employment. The medical induction coil has developed in certain special directions, the chief requirement with such an apparatus being a means of careful regulation of its strength. Of the various ways of obtaining this regulation, the one best suited to our purpose is the plan of using a sliding secondary coil, which can be brought close to the primary or can be removed further from it, as desired. Much has been done of late years to improve the induction coil, and more has been written about the various effects to be got from coils of different sorts and construction. Attention has been given to the improvement of the vibrating spring or contact breaker, and the best American coils are now fitted with two vibrators, one of slow speed and one of high speed. In the United States, where the construction of electro-medical apparatus has been much elaborated, it is quite customary to supply coils with several interchangeable secondaries. The same is done to a less degree by makers elsewhere. The various effects which have been ascribed to different windings of secondary are best considered as being due to the very great differences in their self-induction, according as they are made with windings of great length and many turns, or of short length and few turns. The slower rise and fall of wave which is found with the high self-induction of the long coil of many windings has the effect of making the shock less sudden and less painful in its effects. So, too, in very long fine secondaries a large part of the volts are dropped inside the coil, and the E.M.F. at the terminals, though high on open circuit, may fall almost to nothing when closed through a comparatively low resistance. On this account very long coils with very high-speed contact-breakers have been much written about as affording painless currents for internal applications, but in my opinion the painlessness is due to the fact that very little current comes out of them. For practical purposes I have usually found it sufficient to use one secondary coil, which is tapped at one-third of its length, and so can give long-coil and short-coil effects from the one instrument. Medical induction coils are not fitted with condensers. When simple stimulation is required in the treatment of a case, the induction coil is probably the most convenient and cheap method of procuring it. The battery current has a superiority in certain things. For example, it gives a wider range in degree and quality of stimulation, and certain living tissues respond better to battery currents slowly increased and decreased than they do to the sudden jerks of the coil. The intense effect of the coil on the sensory nerves of the skin makes it difficult to use coil currents of sufficient strength to penetrate to the deeper parts of the body, and for deep parts currents of large magnitude are necessary to make up for the weakening effect of diffusion. The strength of current used in treatment ranges between four and forty milliamperes for the most part, though smaller and larger currents are sometimes used. The larger the currents the larger should be the surfaces of the electrodes. The measurement of induction-coil currents presents difficulties which have not hitherto been surmounted, and the rough comparisons which are made by means of a scale of millimetres at the side of the sliding secondary cannot be translated into units, and cannot be trusted to be alike for two consecutive days. Instruments which measure the mean current are of no use, because the physiological effect does not depend upon mean current, but upon the rate of change and the maxima. The use of a sinusoidal current from a dynamo, to take the place of the induction coil, might enable one to evade the difficulty, but the dynamo current of the mains, in certain cases at least, produces such painful skin affects as to be very unpopular with patients. It is difficult to say why this is so, but the subject wants further study. Possibly the use of condenser discharges, the condenser being automatically charged and discharged rapidly, might meet the difficulty of producing a current which would resemble that of the coil in its physiological action, and would allow of measurement. I would like to ask the advice of members of the Institution on this point: Would not the curve of discharge of a condenser have a close resemblance to the discharge curve of an induction coil? Could not one arrange a condonser of small capacity such as a Leyden jar of diminutive size, and employ some very fine adjustment of spark gap for measurement and regulation? I have thought that in this way using high voltages and small capacities, the disturbing factor of varying skin resistance would become comparatively unimportant.

Current from the Mains. — After its introduction into commerce the current of the electric lighting mains was quickly introduced into medical practice, and we make large use of it in the electrical department of St. Bartholomew's, which is connected with the mains of the City of London Electric Lighting Company. The current impulses from the alternating mains have a physiological action resembling those of the induction coil; that is to say, the effect upon nerve and muscle is to produce a permanent contraction so long as the current is applied. But it is superior to the induction coil in being a less violent stimulus to nerve and muscle by reason of the more even and gradual rise and fall of its waves. Larger currents can be borne than from the induction coil, and, judging from its effects in a long series of cases, it appears to be more thorough and more useful in its effects. Nearly all the cases formerly treated by the induction coil at the hospital are now treated by the current from the mains, the voltage being lowered to suit the require-

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ments of the case (to about 10 volts as an average), and indirectly we have gained largely in that the department is now free from the noise of eight or ten induction coils all vibrating and buzzing at once. Formerly, the effect of that noise during a long afternoon was most trying. There is one marked difference in the effect of the alternating current which limits its use, and that is, that if applied in the ordinary manner through moistened electrodes to the surface of the skin, it has a peculiar, disagreeable, burning effect. The more thoroughly the skin is moistened, the less this is noticed, and when the current is conveyed to the patient through the medium of water, as in a bath, this disagreeable cutaneous effect disappears entirely. Consequently a mode of treatment by means of baths and the sinusoidal current has been developed to a very considerable extent, and with decided advantage to our patients. Large numbers of our cases are cases of paralysis of the upper limbs from injury or disease of the nerves of the upper extremities, and for these we use an arm-bath. The arm-bath is a stoneware trough, of suitable shape, having a metal electrode at each end, it is filled with warm water, into which the patient plunges the forearm and hand. The use of hot water as a medium for conveying electricity to a patient has many advantages. The current is much better borne, and therefore a stronger current can be used. Manipulation of the electrodes and personal handling of the patient is done away with, and the affected part is kept warm during the application. For these reasons we use it largely, and I continue to advocate its use as one which again is likely to increase the popularity of electricity among the medical profession, because it tends to simplify its mode of application. In addition to small local baths for parts of the body, we have a large bath, in which the whole of the body is immersed; and for general morbid conditions, as distinguished from local ones, the electric bath with the induction-coil current, or, better still, with the sinusoidal current of the mains, is an extremely useful contrivance. In that section of medical electricity which comprehends general applications for general systemic diseases—a field of work which is only now being thoroughly explored—the electric bath is perhaps superior to any other mode of applying general electrification. The other modes of doing this are by the statical machine, or by the high-frequency and high-potential methods of Tesla and of D'Arsonval. The chief advantage of both these latter methods is that the patient need not disrobe; but, on the other hand, the electric bath has the great advantage that the currents which are being used can be more readily measured and adjusted to suit individual needs. Chance very largely decides the choice of one or other of these methods of general electrification. Whereas the sinusoidal current and the bath suits one medical man best, the other forms may be more convenient to the conditions of practice of another one. The electric bath, unfortunately, has been rather under a cloud during recent years, in this country at least, by reason of its association with those peculiar "massage" establishments which sprang up so thickly in London a few years ago. Now, however, most of these establishments have disappeared, and one may venture to speak of the definite advantages of the electric bath without feeling that one's words may reappear in the columns of some journal in association with advertisements of undesirable houses. At St. Bartholomew's Hospital, excluding arm-baths, about 1,000 baths, mostly with the sinusoidal current, are given each year, particularly for diseases like debility, rheumatism, sciatica, neuritis, lead-poisoning, and various forms of paralysis. No electrical department can be considered properly equipped without the electric bath, for in many morbid states its action is most valuable. The bath with direct current has also certain useful applications, although not so many as the induction-coil or the sinusoidal current bath. The direct-current bath, local or general, is useful in the relief of gout, rheumatism, sprains, chronic inflammations, and generally as an absorbent for the removal of fibrous adhesions or thickenings in or about the joints and limbs. It is also indicated in painful states, when a varying current is too stimulating to be well borne, as, for example, in acute sciatica, neuritis with pain, and so on. The alternating current of the mains also lends itself extremely nicely to such uses as for galvano-cauteries and for the small exploring lamps used by surgeons, and where alternating current is laid on they now for the most part have small transformers for use in this way. Instruments containing lamps and telescopes are now used for examining the interior of such cavities as the bladder and the stomach, which previously have been inaccessible to the sight; as well as for the illumination of more accessible parts, such as the throat, the ear, the nostrils, etc. The arrangements at St. Bartholomew's for the distribution of our current from the mains consist of a transformer, tapped at intervals in its secondary winding and led to a row of binding screws, from which any voltage between half a volt and 50 volts can be taken at will. The three rooms in which treatment is given are wired in three circuits as for electric lighting, and the voltage required can be switched on to any of the three rooms from the transformer. Thus we have at command low-voltage currents for galvano-cauteries and small lamps, and higher voltage currents for applications to patients. We use three or four volts for cauteries, eight or ten for lamps, ten to twenty for the baths. Several of our old sledge-pattern induction coils with sliding secondaries are now converted for use as subsidiary regulating devices for the baths. I cannot say much of the use of direct-current mains in medical practice from personal experience. Although I have been instrumental in connecting three places to the lighting mains, I have never been in touch with direct-current circuits. The use of the direct current from the mains for applications to patients, and for other applications requiring low voltages, is carried out either indirectly by means of charging accumulators from the mains and using them when disconnected for the patients, or else by means of shunt resistances. The latter method is to provide a resistance of several thousand ohms, which is connected across the mains. The resistance is a bare wire coiled on a support, and is fitted with a travelling contact-shoe, which can be moved so as to tap the windings at any point. The patient is arranged in a shunt circuit in parallel with any convenient length of the resistance. When only small currents are required a lamp is arranged permanently in series with the wire resistance. The slope of potential which can be tapped at different points by the movements of the slider permit fine regulation of current in the shunt or patient's circuit. With shunt resistances of suitable magnitude current can be obtained for treatment, for working induction coils, or for galvano-cauteries. In the latter case the waste is considerable, and it is my belief that an accumulator charged through a lamp would be much better, but in many cases the shunt circuit is preferred, in spite of its waste at the rate of more than a horse-power, whenever 10 amperes are wanted. Possibly something like a step-down induction coil might be devised for heating cauteries off the direct-current mains. One of the drawbacks of electric light supply is that those who have continuous current laid on cannot also have alternating. And so a medical man residing in a district supplied by direct current will have to generate any sinusoidal current needed by means of a motor-dynamo. These instruments can be bought, and are in use. On the other hand, a medical man supplied with alternating current will often sigh and wish that he could easily generate for himself a little continuous current. And here is a point which perhaps might be worth the attention of this society—viz., the contrivance of some simple rotary converter which could be attached to a lamp socket in a house supplied with alternating current, and which would give out continuous current sufficient to recharge a portable accumulator from time to time. Not much would be wanted, and perhaps it is just on that account that the instrument I have indicated is not easy to get; presumably it would not pay to make it. Still, a little rotary transformer, which would give out, say, an ampere at 10 volts of continuous current, would be welcomed by many medical men who live in districts of alternating supply. The mechanical efficiency of the machine is in no way important, considering the smallness of the needs. That which would be important with such an instrument is that it could be left to run for periods of an hour or two at a time without needing its owner to stand over it and watch it, and that it would not become overheated nor make a great noise.

The Statical Machine.—This form of apparatus—the first introduced into medical practice—is showing very decided signs of a revival. In the United States the statical machine is already very largely employed, and I am told that in New York alone there are no less than three firms busily engaged in turning out statical machines at the rate of two or three a week. Those who are only acquainted with the effects produced by small statical machines can have no idea of the difference between small and large instruments of this kind. The effects produced by a large statical machine are most decided, and it is only necessary for one to experience them once to see that treatment by them is by no means a mere treatment through the imagination. The most apparent effects of the statical machine are the profound and peculiar cutaneous sensory stimulation which can be produced by it, and the forcible muscular contractions which can also be produced by it when the administration is in the form of sparks. Its special field of usefulness probably lies, first, in its action as a general excitant; secondly, in conditions of neuralgia and other superficial pains; thirdly, in the conditions of muscular pain. In all these cases it acts quickly and thoroughly. It is quite common to receive a patient stiff and lame from lumbago or muscular rheumatism, and to see him leave in 10 or 15 minutes quite free, for a time at least, from his lameness or his stiffness. All this promises to be extremely valuable. The difficulty of understanding how a simple electrification by the static machine can influence the body makes many of us disincline to believe that there can be any effect; but after watching cases carefully for some time, I can now say with certainty that some direct action does take place.

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I have only had a proper static machine for a year and a half, and, therefore, still feel rather a beginner with it. A very interesting matter is that, whereas on the other side of the Atlantic the influence machine which is used is invariably a modified Holtz's, on this side it is the Wimshurst which is considered the best. The American Holtz machine certainly has been developed into a most beautiful instrument; and, although it has one drawback when compared with the Wimshurst—that of not being self-exciting—that is a point so easily got over by means of a small accessory exciting machine in the corner of the case as to have no real importance. Size for size, I am disposed to believe that the Holtz gives a better output than the Wimshurst. It appears to be a more cheaply-constructed machine, and needs no countershaft nor cross-belts. Recently a large American Holtz machine has been presented to St. Bartholomew's Hospital, so we shall have an opportunity of testing and of comparing its work with that of a large Wimshurst machine which I have recently had constructed for my own use. As a good Holtz machine is, so far as I know, a curiosity in this country, I shall have much pleasure in showing our machine to any members of the Institution who might wish to see it. The accessory apparatus and the technique of the statical machine have been very greatly simplified by the work of American physicians. The application of high-frequency currents to medical practice has not had much extension. In France it is used a little. The currents are taken from leads connected to the ends of the primary helix, and no secondary coil is used. An induction coil is generally used to charge the Leyden-jar condensers of the system. The applications are either by a sort of spark or brush discharge from one terminal to the patient; or the patient lying on a couch is attached to one pole, the other being connected to a sheet of metal under the couch. This is called the condenser bed. Finally, the patient may be enclosed in the actual helix connecting the jars, and his body thus made the seat of induced currents by "auto-conduction." Its chief applications have been as a mode of general electrification, but the brush discharge is also applied locally to the skin, and has seemed efficacious in curing certain skin diseases.

Ozone.—The use of electricity for generating ozone for medical purposes is attracting some interest. It is not so much that these applications of ozone are entirely new as that the apparatus is now becoming sufficiently improved to make its applications easier. But the rapid development of electricity in so many directions of late years has given medical men just at present so many fresh things to handle that ozone in its medical applications is, as it were, waiting until someone has time to attend to it. The workers in medical electricity, in this country at least, are so few.

Perhaps the most striking of all the applications of electricity to medical work in recent times has been due to the discoveries of Prof. Röntgen. The introduction of the X-rays has revived very greatly the interest in medical electricity. The Röntgen-ray work makes a very considerable addition to the work done in our electrical department at St. Bartholomew's Hospital, as it is in almost daily use for purposes of diagnosis in surgical cases. Physicians hitherto have paid but little attention to Röntgen rays, but its application to the diagnosis of diseases of the chest must be mentioned as perhaps one of the most promising things for the future. Certainly it is possible to diagnose pulmonary consumption and some other diseases of the chest more satisfactorily, and at an earlier state of the disease, by the X-rays than is possible with the stethoscope; and this one point alone appears to me to be of the highest importance. For example, recently I saw the X-ray photograph of a patient's chest. She was suspected of having pulmonary disease, and was sent to one of my colleagues for an X-ray photograph; examination by the ordinary methods of auscultation and percussion had given an uncertain reply. But the negative taken with X-rays showed without any possible doubt the presence of tubercles in the lung. If there were more time to spare I could go into the question of X-ray work more deeply on the grounds of its great development by medical practitioners, the localisation and stereoscopic methods of Dr. Mackenzie Davidson and others being singularly beautiful in their results; but I have the idea that most of us are a little sated with X-ray work just now, so I shall say no more except to refer to the extreme beauty of the fluorescent screen effects which are given by large static machines.

Discussion.

Prof. S. P. Thompson (president) said he should like to ask about the use of the word "electrification" by Dr. Jones. He used it in a different method to that common amongst electrical engineers. He himself did not understand that when a current passed through a thing that it was electrified, A body, he understood, must be charged in order to be called electrified. He also wished to know if it was of any use to simply charge a man with electricity, and if it affected him physiologically.

Mr. J. Wimshurst said he was glad to learn that prominence was being given to statical electricity. He then made some observations with reference to the Holtz machine, but stated that he would send in his remarks for insertion in the *Proceedings* of the Institution.

Major-General Webber said he thought that the meeting would be considered quite a memorable one in the annals of the Institution. He did not think that within those walls a paper had been read before which brought the engineer and physician so close together. Referring to the word "stimulus" as used by Dr. Jones, did a medical practitioner mean that electricity was only a stimulus to the animal frame, or was it an auxiliary to something which already existed in that frame? When Dr. Jones spoke of the method of testing for destroyed nerves by electricity, every telegraph engineer amongst them must have been reminded of his daily work, as he was always localising faults in exactly the same way as the localisation of the nerve injuries. The electrical distribution engineer might also ask the lecturer whether his work did not find an analogy within the human frame—viz., generation, distribution, and utilisation of energy. He should like to ask Dr. Jones if the electricity did not aid something going on within the body. Helmholtz had stated that the heart could raise its own weight of 9oz., 2,250ft. in one hour. This involuntary work of the heart had always seemed to him to point to one great fallacy in the physiological books—namely, that the heart was a pump. The only place in which he had traced an allusion to electric work going on in the body was as to the electrolysis taking place in the capillaries. In this it was stated that the positive was in the red capillaries and the negative in the blue capillaries. This being so, there must be another source of energy in the body, and not as Helmholtz had described. Anything which brought the engineer and medical practitioner closer together must be of use to their fellow-creatures at large, and the author had brought them much nearer to the use of electricity for medical purposes than they had ever been before.

Mr. Mudford suggested that a possible means of measuring the top of the wave in his induction coil would be to set up the needle of an ordinary milliampere-meter. At the height of the wave the needle would "kick off." It might be a little troublesome, but he had found it quite practicable.

Sir Henry Mance said that the author had omitted to say anything about polarisation with respect to the human body. He had once made experiments as to the resistance of the human body from wrist to wrist. He tested two natives and one European. The resistance in the natives was 13,000 ohms and 12,000 ohms respectively, while in the European it was 900, there being considerable polarisation.

Prof. Perry said that a means for charging small batteries off the alternate lighting mains was badly wanted. If a house was wired for 200 volts direct current, they could put a 200-volt lamp on in series with an accumulator in order to charge the cell. With reference to the electrolysis going on in the body, it was plain that this was not a heat-engine. The efficiency of the human body was high—in fact, 40 times higher than it would be considering the limits of the temperature in which it worked. The body was, he thought an electrical machine, somewhat akin to a gas battery. He had for years been trying to do in a model what the engine did in the human body. Dr. Schlee at Baden-Baden last year informed him that for 20 years he had been making experiments on atmospheric electricity, and had asked him (Prof. Perry) to invent a simple instrument which would give him quite cheaply the sort of measurement he wanted. An instrument of the kind would induce medical men to make investigations which they could not at present owing to the cost of instruments. Dr. Schlee had made a number of investigations, which the speaker was shortly publishing in *Nature*.

Mr. Coffin said he would like to mention the obstruction which there had been in the past from terminology. When Mr. Preece took part in the discussion on the previous paper, it seemed to have been on his mind that electricity was supplied to patients in a manner utterly regardless of quantity. That was, of course, absurd. There always would be a difficulty in the measurement of electrification, etc. The measurement of effect must always be an advantage in the medical use, but owing to the difference in the conductivity of skin, a doctor could never be certain exactly what current would pass through a patient. All must acknowledge the use of the electric bath, but even then the current passing through the patient could not be accurately measured. Electricity as a stimulant seemed to be a small cause producing large results, but it was not known how this happened. It was a very useful and hopeful thing to have such a discussion at a meeting of their society.

Captain Brett said that the author had not mentioned whether the X-rays were possessed of any curative properties. His curiosity in this respect was excited some time ago by some photos of a case of "lupus" treated by the X-rays at weekly intervals. There was a remarkable disappearance of the disease in a very short time. The need for a means of charging a small battery of accumulators was felt in the recent Egyptian campaign, where the X-rays were first used in warfare. However, a dynamo was found, also a bicycle; the energy was generated by means of defaulters on the bicycle, and the cells were thus charged. In England a small motor might well be used for this purpose.

Mr. W. M. Mordey said that something might be done perhaps with thermopiles in the place of the small batteries. These could be used where a gas flame was possible, and would give an ampere or two. He thought it would be a good thing if engineers who had the time would take up the design of medical electrical apparatus. The Rhumkorff coil, for instance, was exactly the same now as when it was invented, and there was no doubt that it could be improved. In Dr. Jones's instrument the laminated

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pole-pieces were short-circuited by a solid block of metal, and where the magnetism wanted to go in and out was also solid metal. Most of the medical electrical apparatus could also be greatly improved. He was pleased to find that the author had omitted to use the word "faradisation" and others of a similar kind which were found only in medical papers. Major Webber had spoken of the work done by the heart. He had just worked it out and found that it was not a very serious matter, being only about $\frac{1}{100}$ h.p.

Mr. A. P. Trotter suggested the use of an aluminium cell for charging accumulators from alternate-current supply mains. He asked whether Dr. Jones wished to measure the milliamperes, milli-coulombs, mean volts, or maximum volts of the coil discharges, and asked if he would give information about the action of electric current on the body for removing the sensation of tiredness when muscles had been exerted, but without doing mechanical work.

Dr. Lewis Jones, in reply, said he had tried to be as careful as possible with his terms. The term "electrification" he came to use because when patients were sent down to him for an electrical application they called it being electrified or galvanised, and so he had got into the way of using the word, as a non-committal term. He understood that the proper meaning of the word was the charging by electricity of a body in space. He was glad Mr. Mordey praised him for not using the words "faradisation," "galvanisation," etc.; he was doing his utmost to get along without these awful words. He had recently read in a French paper about "D'Arsonvalisation," and he thought that was too much to stand. General Webber had raised the question of the relation of electricity to vital force. Of course, it would be difficult for a nerve action to take place without electrical action of a kind, but whether these electrical charges were of great importance or merely wasted he could not say. He could say, however, that the rate at which a nerve impulse went down a nerve was very different to that of an electrical impulse. He himself thought the two things entirely distinct. With regard to polarisation, Sir Henry Mance had described the testing the resistance of two natives and one European, the resistance of the latter being much lower than the other two. This, he presumed, was in a hot country, and the lower resistance was probably due to the European perspiring more than the natives, the damp skin being the better conductor. He was sorry the makers of the Cox thermopile were bankrupt, as he had thought that perhaps something might be done with this in medical practice. As to the medical apparatus, most of that now used was German, as English makers did not pay much attention to the manufacture of that class of goods. The doctors wanted cheap apparatus, as they had to pay for what they had practically out of their earnings, and they could not afford to pay the prices asked by English manufacturers. Consequently, they had to use the ready-made German machines. As to the aluminium cell, he had spent some time in trying to make this give satisfactory results, but it would not work as he wished, and he was obliged to give it up. Mr. Trotter had mentioned the stimulative effects of the current. This had been shown in a paper read by Captain Orti, in which he stated that an electrical stimulation of the spine increased the muscular force for a day or two afterwards. Whether this was due to the effect on the circulation of the blood or to the direct effect upon the nerve, he could not say, but an application of electricity for any special purpose would often make a patient feel much better in general health as well. As to the Rhumkorff coil, he wanted something to measure the milliamperes, and also something to measure the effect of the shape of the curve of one impulse in the coil as well as the maximum height of the curve.

A vote of thanks was then passed to Dr. Jones for his paper, and the **President** announced that the paper for the next meeting would be on "Storage Battery Problems" by Mr. E. J. Wade.

The following is a list of the candidates balloted for at the meeting:

Members.—H. E. N. Appelbee, Corporation Electricity Works, Cardiff; W. B. Hird, B.A., 13, Albion-crescent, Dowanhill, Glasgow.

Associate Members.—J. Coats, 3, Catherine-drive, Govan; M. McA. Gillespie, British Westinghouse E. and M. Company, Limited, Cremorne Works, Chelsea, S.W.; G. H. Jackson, Electric Light Station, Northampton.

Associates.—A. F. Beach, 2, Jerningham-road, New Cross: W. B. Cheetham, Sefton House, Abergele-road, Colwyn Bay; H. L. Jones, M.D., 61, Wimpole-street, W.; W. J. A. London, 12, Victoria-square, Newcastle-on-Tyne; B. B. Maccall, 75, Waterloo-street, Glasgow; S. W. Martyn, 271, Athol-street, Liverpool; C. Nathan, 39, Victoria-street, S.W.; E. G. Scott, Electricity Works, Whitehaven; J. B. Shield, 197, Onslow-drive, Glasgow; W. Wallace, 132, Woodsley-road, Leeds; A. T. Yates, Oak Lodge, Carson-road, West Dulwich, S.E.

Students.—E. Carter, 130, Raby-street, Moss Side, Manchester; R. V. Lynn, 37, Foxley-road, North Brixton; D. Reid, 39, Newton street, Greenock; F. O. J. Roose, 45, Hill-street, Berkeley-square, W.; W. S. Ross, 12, Seymour-street, Hollinwood; C. P. Tonge, St. Barnabas Vicarage, Sutton, Surrey; A. C. Willmot, 182, Haverstock-hill, N.W.

Cable to France.—On Wednesday last a new submarine cable was laid from Cape la Hève, near Havre, to Beachy Head, by the cable steamer "Britannia."

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TRIPLE-CONCENTRIC CABLES.

SIR,—In the "Questions and Answers" column of your issue of March 9, best answer to No. 245, I notice that your correspondent, in pointing out some of the disadvantages of triple-concentric distributors over three-core distributors, makes the following statements:

"A rather serious disadvantage of the triple-concentric distributor is that two (and with some types of connections, all three) of the conductors have to be cut and connected mechanically every time a consumer's service is joined up.

"Another disadvantage of the triple-concentric distributor is that it is difficult to connect services to it with the current on, and in cases where the distributor is not fed from both ends it cannot be done."

As regards the first statement, I would like to point out that there should be no necessity for cutting the three conductors where a tapping is taken from the inner conductor, nor should it be necessary to cut two of the conductors in taking a tapping from the two outers. If the joint-box is of a design suitable for slipping on under the joint when the joint is completed, the core need never be cut, but the insulation of the core bared back sufficiently to allow of the branch cable being sweated on to it without the use of any gunmetal fitting, which, besides taking up unnecessary room, is not so easily sweated as a hand-made tee joint. When the tappings are taken off the two outers, there is no necessity to cut the middle conductor and link it. The same method as above mentioned for the core is, in my opinion, much more suitable for the middle-wire connection, and in this case the only conductor cut would be the outer, which being in most systems the neutral wire, is not of so much importance in comparison with the two inners.

As regards the second statement, it is quite possible "where a distributor is not fed from both ends" to keep the current on the whole length of the section while making the joint, in the following manner: Bare the outer, and before cutting it bind that portion of each end of it, which will be covered by the clamp or link, with No. 18 gauge binding wire. The wire should be tightly bound round the conductor for the full breadth of that portion which will be covered by each clamp, and sweated solid by means of solder poured from a metal pot (not worked on with a blow lamp). The wire binding takes the place of the collar, which is usually slipped between the conductors and its inner insulation, and answers the purpose just as well, if not better. Then put on the link connections, still before cutting the conductor, and when secured cut out the intervening strands of the conductor. If it is necessary to cut the middle conductor for the purpose of getting at the core, the same method may be adopted, only, of course, it will be necessary to temporarily insulate the outer fitting before doing so.

This method of keeping the main continuous may sound a more difficult affair than it really seems, but with a properly-designed joint-box it adds no more to the ordinary difficulties which have to be faced when working on live triple-concentric conductors, and has often to my knowledge been carried out on triple-concentric distributors where, for several reasons, it has been found necessary to keep a continuous supply on the main.

The difficulties in jointing triple-concentric cables are in no way minimised, in my opinion, by the designs of joint-boxes at present on the market; and although I by no means wish to recommend the use of triple-concentric distributors in preference to three-core or single cables, I think a good many of the objections to the use of triple-concentric cables might be overcome if cable manufacturers would take steps to try to make their joint-boxes more suitable to the cable's concentricities.—Yours, etc., J. C. A. W.

British Association.—Prof. Rücker has been elected president of the British Association for next year. A more representative president could hardly have been selected.

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TRAIN-LIGHTING.

It is rather ludicrous to ask how long incandescent electric lighting has been really practicable, yet there would be a certain method in seeking the answer to such a question; and if the reply was fifteen or eighteen years, no one would grumble. Assuming this to be more or less accurate, we can proceed to make a series of assertions. Oil is still the general illuminant in railway carriages, though gas is used to a moderate extent, and electricity to a lesser extent. One of the axioms among the foremost railway managers is that the cost of increase of convenience is more than repaid by increase of revenue. Starting with the year 1885, the then existing rolling-stock was fitted with some kind of light, mostly oil. Since then much rolling-stock has been replaced and much new added. Our question is whether the new rolling-stock has been fitted with improved lighting apparatus, and our reply is, generally not. Such a state of things is not satisfactory, and does not say much for the belief of railway managers in one of their accepted axioms. There is another side to the matter, the effect of badly-lighted carriages upon the sight of those who are compelled to travel. Just recently greater activity has prevailed, and one or two companies are now fitting their new rolling-stock with the Stone system, which has been found to be simple, fairly economical, and effective. While the question was replacing what already existed, and thus increasing capital expenditure to a very large extent, the companies could not be blamed for looking carefully before incurring expenditure and making a change, but when dealing with the equipment of new rolling-stock the matter is altogether different. Each carriage can be self-contained, so that the breaking up of trains does not interfere with the lighting. Mr. A. D. Adams, in the columns of the *Scientific American*, has been discussing the various systems in vogue for electric lighting of trains. He does not seem to be really acquainted with the system we have previously referred to, or with its great success on this side. However, he discusses at some length the value of gas lighting, and comes to the conclusion that a better light will be obtained by using the gas to actuate a dynamo than by burning it direct. The conclusion is old, but it needs to be driven home to those interested in the matter. We prefer Stone's system, but may be forgiven for dwelling a little upon Mr. Adams's contention. Of course, the gas used is not ordinary coal gas, but assuming it is, then Mr. Adams says: "A good coal gas of about 600 heat units per cubic foot will yield one brake horse-power hour for each 20 cubic feet of gas consumed in the cylinder of a modern gas-engine. This brake horse-power represents 746 watt-hours applied to the armature shaft, and allowing the low average efficiency of 85 per cent. for the dynamo and 95 per cent. for the line and connections, the lamps will receive $746 \times \cdot 95 \times \cdot 85 = 600$ watt-hours for every cubic foot of gas consumed by the engine." He goes on to point out that a 16-c.p. lamp takes from 50 to 60 watts, and thus to deduce the number of lamps and candle-power hours that can be obtained by

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giving 10 or 12 as the number of lamps and 160 or 192 as the number of candles. By burning the gas as gas we require four or five cubic feet per hour to give a burner equivalent to a 16-c.p. lamp, or five burners = 80 candles with four cubic feet each per hour for a total of 20 cubic feet, or 64 candles if the conditions require five cubic feet per burner. If these figures are at all correct, there is a good margin in favour of using gas to drive an engine to drive a dynamo, and although the initial cost of the electric installation is larger, that result is in the long run economical. The mere question of economy ought not to decide this question. More light is an absolute necessity of modern travel. The physical wear and tear of the hurry of life is enormous, and efforts should be made to minimise such wear and tear; hence the aim should be the best, not the cheapest. It needs no argument to prove that a sufficiency of light is required, and we contend that the best light is that obtained electrically. It gives less trouble, is equally certain, and is not less economical than any competitor. But, accepting Mr. Adams's figures, the mere question of economy would go to show the advantage of burning gas in the cylinder of an engine rather than in a gas-burner—in other words, to use it as a heat-giver rather than as a light-giver.

THEATRE LIGHTING.

The destruction of the Theatre Française by fire goes to point a moral to a tale. According to the published accounts the firemen did not come on duty till the performance was to commence. Had these men been present, we are told, there would have been no fire, or if a fire, it would have been seen and dealt with before becoming dangerous. There seems to be no doubt but that the origin of the fire was in some way or another connected with the electric lighting. Now, the lighting of a theatre is somewhat more complicated than the lighting of a room, but in either case the turning on or off a switch is a simple matter. There is less danger of an accidental short-circuit in an ordinary room than behind the scenes in a theatre; hence, in the latter case, it would seem to be an obvious rule that the electrical apparatus should not be touched except by the expert in charge. However, our point is a more technical one—the value of a fuse. It is understood by the general public that safety is obtained by the use of fuses; that conductors asked to carry much more than the normal current cause the fuse to go, and are placed out of circuit without getting to a dangerous temperature. As a matter of fact, are fuses so satisfactory as they are generally made out to be? No doubt they do go—sometimes and ofttimes in a most unaccountable manner—yet where they ought to act as a safeguard, they may unaccountably fail. We do not say this theatre was burnt because a fuse failed to act, but we do say that the vagaries of fuses are not altogether understood, and if they are to be used, far too little attention is paid to that particular point in the system to make it certain in action. Is it not too often accepted without question that the fuses are all they pretend to be, when in reality they are altogether different, because careless men have put in any conductor at a pinch, and no one in authority knows of the absence of the real fuse? Thus the extensive use of hidden fuses leads to two dangers—one that the fuse itself is imperfect, the second that it is absent and replaced by another conductor. To obviate the first trouble, we can abolish hidden fuses; to obviate the second, we must remodel humanity. Altogether, the question deserves careful attention. So far as we remember, there has been no alarm in any English theatre. Whether we can attribute this state of things to the fatherly supervision of the councils and the fire offices, or to the greater care in carrying out the work, is not for us to say. It is enough to reiterate that a fuse can be made effective, and careful supervision should prevent the possibility of tampering with devices that are inserted for protective purposes. One moral we will give, Use fewer hidden fuses, more fuse boards, and a system of wiring that stops nowhere between good insulation and a dead short.

REVIEWS.

American Telephone Practice. By KEMPSTER B. MILLER, M.E. *American Electrician* Company, 120, Liberty-street, New York.

This is a book the like of which could not have been produced in this country. That statement is easily made and easily proved. There is little real English literature on telephony from the practical side, for the simple reason that there are very few men having experience in this country who have been permitted to state their experience. Two or three papers before learned societies, and one or two books, sums up English technical work on telephony. The technical Press gives no information on telephony; it can get none. The service is taboo to everyone outside a ring, and information is for official eyes and ears only. And we wonder at the condition of things. We wonder that apparatus of outside make is preferred, though it is far and away superior to our own make. Had not the Western Electric Company installed a factory here, and had not the General Electric organised a department for such apparatus, the position of England as a maker of telephone apparatus would be about on a par with that of Timbuctoo. It may be that in the future things will change, but the curse of secrécy and red-tape clings round the curse of monopoly. Why, we know not; for monopolists, because of their monopolies, should hold broad views and help to educate the world and disseminate knowledge. Instead of broadness, they cuddle narrowness; everything is rigidly held within a ring fence, and no outsider is to see or hear, or if inventive, to gain hearing. But strong feelings as to the disgraceful state of English literature in this as in other electrical matters take us away from the main object of writing the notice of this book. Its merits can be summed up in one word, "Complete." History, early apparatus, latest apparatus, use under varying conditions and for various purposes, each and all are considered, and this in such a way that the veriest tyro must understand the reasons as well as the facts. Indeed, not only have we a sketch of the historic development of the principal pieces of apparatus, such as receiver and sender, but a description of details, also of accessories and their details, such as calling apparatus, automatic shunt, hook switch, and the like. It is not till we get to Chapter XII., on self-induction and capacity, that we have a complaint of any importance, but from our standpoint we emphatically decline to support the use of the symbol I for current. The use of that symbol is like the use of rings in some women's ears—a survival of ancient days. A careful reading of this part of the book, say Chapters XII. and XIII., will perhaps tend to show the difficult of insulating telephonic phenomena, and thus of obtaining absolute

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secrecy of transmission. The most important part of the work, however, is that dealing with switchboards and the apparatus connected therewith. Some time ago we saw at the Western Electric Company's Antwerp factory some lamp signal switchboards, and we believe that apparatus of this kind is now being introduced into English exchanges. A description will be found in Chapter XVIII. of this work. Enough; the work is very complete, it is amply illustrated, its description is terse and clear, and altogether it is the best book that has hitherto been issued upon this branch of telegraphy, a branch that is destined ere long to be as much a part of the equipment of every house as is a table or a chair. Mr. Henniker Heaton agitates for Imperial penny postage; we suggest universal telephony, instruments in every house, and an automatic penny payment for each time of usage.

FORTHCOMING EVENTS.

SATURDAY, MARCH 17.

Morley College Faraday Society.—At 8 p.m., presidential address on "The Modern Point of View of Electrical Phenomena," by Prof. Carey Foster, F.R.S. Tickets obtainable at the college.

Manchester Society of Junior Electrical Engineers.—At 7.30 p.m., paper on "Electricity as Applied to Mining," by Mr. H. Bentham.

MONDAY, MARCH 19.

Society of Arts.—At 8 p.m., Cantor Lecture III. of four, "Photography of Colour," by Mr. E. Sanger Shepherd.

TUESDAY, MARCH 20.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Papers on "The Great Central Railway Extension—Northern Division," by Mr. W. F. Bidder, and Southern Division, by Mr. F. Douglas Fox, M.A.

WEDNESDAY, MARCH 21.

Institution of Civil Engineers.—At 6.30 for 7 p.m., annual dinner, at Merchant Taylors' Hall, Threadneedle-street.

THURSDAY, MARCH 22.

Institution of Electrical Engineers. — At 8 p.m., ordinary meeting. Paper on "Storage Battery Problems," by Mr. E. J. Wade.

FRIDAY, MARCH 23.

Physical Society.—At 5 p.m., discourse on "An Electromagnetic Experiment," by Prof. S. P. Thompson, F.R.S.; "Some Experiments illustrating Syntony," by Mr. P. E. Shaw; and "An Electrical Micrometer," by Mr. P. E. Shaw.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "The Development of the Modern Locomotive Engine," by Mr. J. W. Cross.

GOVAN ELECTRICITY WORKS.

The burgh of Govan is among the municipalities who have recently used the provisional order obtained years ago, and since that time it had been used chiefly as a bogey to frighten off private companies who desired to provide the necessary supply of electrical energy. The application for a provisional order was granted in 1891, but it was not till 1897 that any attempt was made to use it. In that year a committee under the energetic convenership of Bailie Wrightman was appointed, and a little later Mr. William Arnot, M.I.C.E., M.I.E.E., was appointed consulting engineer. Plans of an installation to cost about £18,000 were prepared, and passed by the Council.

The installation, particularly the generators, presents some features of engineering interest. The station is situated in Helen-street, Govan, a little to one side of the district. This disadvantage is counterbalanced by the almost unlimited room for extensions and good railway siding accommodation. The buildings, which are of brick faced with red sandstone, were designed by Mr. Arnot, and consist of engine, boiler, and accumulator rooms, arranged in parallel bays, each having a length of 60ft. The boiler-room is 48ft. wide, and at the end is a chimney 110ft. high, with an internal diameter of 5ft. 6in., lined with firebrick 50ft. up, the chimney itself standing on a concrete block 22ft. in diameter. The engine-room is only 30ft. wide, and both rooms have a uniform height of 24ft. from floor to spring of roof, the ends, both of engine and boiler room, consisting of corrugated iron sheets, enabling the extensions now contemplated to be easily carried out. The accumulators are housed in a smaller building parallel to the engine-room, which has a height of 10ft. and a breadth of 15ft.

In the boiler-house are two Babcock-Wilcox boilers, each having an evaporative capacity of 400 gallons per hour at a pressure of 160lb. per square inch. The furnaces are Babcock and Wilcox Scotch type, suitable for burning the bituminous coal generally used in Scotland. In the flues is a Babcock and Wilcox superheater which raises the temperature of the steam to 400deg. F. Its position in the flues is such that with fairly steady firing no great fluctuations of temperature can take place; all the tube joints are expanded. In order to prevent overheating of the superheater while steam is being raised in the boiler, a four-way valve is provided, and before lighting up this valve is turned to the position marked "Flood." This fills it with water from the boiler drum. When steam is up, the valve is turned to "Drain," thus removing the water from the heater. Finally, by putting the valve in the shut position and opening the stop-valves to engines, the heater performs its normal duty. Thus there is no risk of overheating while the heater is not in use. Space has been provided for two other boilers before there is any necessity for extending the boiler-room. As the engines are non-condensing, a Babcock-Wilcox feed-water heater is provided. For boiler-feed purposes a three-throw feed pump by Messrs. Blake and Knowles is provided. This pump makes 32 revolutions per minute, and is driven through double-reduction spur gearing by a 5-h.p. British Thomson-Houston motor, which is shunt wound, has four poles, and runs at 1,000 revolutions per minute. The specified capacity of the pump is 1,500 gallons per hour against a boiler pressure of 160lb. per square inch, and is thus capable of supplying four boilers, when these are installed. No duplicate pump has been provided, but a Schaffer and Budenberg injector has been fitted to each boiler. The usual steam-ring main, drained by Geipel's steam-trap, is fitted between boilers and engine-house.

The engine-room contains two Belliss compound engines of 150 h.p., running at 440 revolutions per minute with steam at 150lb. Coupled direct to each engine is a six-pole generator, supplied by the British Thomson-Houston Company. The first thing which strikes a visitor is their apparent lightness when compared with bipolar machines of similar size. The armature is 26½in. in diameter, giving a peripheral speed of 3,080ft. per minute. There are about 95 slots round the perimeter, each slot containing four conductors wound edgewise, insulated throughout with mica, the winding being drum type. The pole-faces of the field magnet are laminated, each pole-face covering an area of about 76½ square inches. The air-gap, which is about $\frac{3}{16}$in. at the centre of the pole-pieces, increases to $\frac{9}{16}$in. at the pole-horns. Three carbon brushes per pole collect the current, and the machine is absolutely sparkless at all loads. The commutator is 19⅛in. in diameter, and has nearly 400 segments, each segment being only about ⅛in. wide. The field winding is shunt, with adjustable rheostats on the switchboard. The E.M.F. of the dynamos varies from 500 to 600 volts, and they are connected across the outers of the three-wire system. A balancer, consisting of two four-pole British Thomson-Houston machines coupled rigidly together, is provided. These run at 1,000 revolutions per minute, and can deal with 50 amperes on either side of the system, with an E.M.F. of 250 at light and 300 volts at full load. The field windings of these balancers are so compounded that the series coils of the machine which is at that particular moment acting as motor have a weakening effect, while on the generator side the coils compound up, the result being that at full load the E.M.F. on the dynamo side is 15 volts higher than on the motor side. For battery-charging purposes a motor-driven booster set is provided, consisting of three machines coupled rigidly together, the two outer ones being boosters while the middle one serves as a motor. The combination runs at 1,000 revolutions per minute, and each booster can deal with 40 amperes at 160 volts, the fields being shunt wound with a variable resistance in the circuit.

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The switchboard does not present any unusual features, being similar in design to most three-wire boards. It was made by the Edison and Swan United Electric Light Company, and consists of four panels—viz., positive, negative, middle, and battery panels. The instruments are of the Kelvin type, with the exception of the edgewise feeder ammeters, which are Evershed type. Each dynamo has an Ediswan maximum and minimum cut-out, and an Elihu Thomson wattmeter in circuit.

The underground mains are on the Callender system, the cables being supplied by the foregoing company, but laid by the burgh employés under the supervision of Mr. Arnot. They are lead-covered, with lock armour, laid directly in the ground. Up to the present 28 miles are laid, but extensions are contemplated.

The street-lighting consists of 85 arcs on eight circuits of 10 in series on the outers, with the odd five on one side of the three-wire system. The meters are of the Ferranti type, and charging is on the Wright demand indicator system, at a price of 6d. for the first hour and 2d. thereafter. Reason's patent fuses are used for connection between consumer and Corporation wires.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

Inaugural Address of Dr. Ed. Hopkinson.

(Concluded from page 345.)

This leads us into the large field of the right training of electrical engineers and managers for our electrical undertakings—a large field which I cannot do more than most briefly refer to to-night. I for one would most heartily endorse the dictum of Sir Andrew Noble that the education of our English public schools and universities lays a foundation for successful struggle in the world's field of battle which is absolutely without rival, but it is a foundation only; upon it must be built a superstructure of technical knowledge and skill. Much progress has been made and is being made in England, but it must be admitted we are still far behind, which I venture to think is chiefly due to the want of frank recognition of and hearty co-operation, not on the part of our public men, but of our managers and designers with the admirable institutions which already exist in this country. In laboratory and experimental equipment the technical schools and technical branches of the American universities far excel anything we have—with few exceptions—in this country, and it is not provided for the most part out of beer money or local taxation, but is the free and generous gift of manufacturing concerns and the captains of industry in the country, who are far-sighted enough to realise that by such support they are taking the first steps toward building up and ensuring the lasting prosperity of their own industries. We in the North of England have the opportunity afforded us for like support by the splendid institutions at our very doors, our university colleges, and our municipal technical schools, all of them now provided with, or rapidly making provision for, adequate laboratories and workshops and most scientific teaching, and lacking only the earnest co-operation of the responsible managers and controllers of our undertakings. As a significant illustration of what I have been saying I may mention that the professor of engineering at Cambridge told me a few days ago that the management of a large American concern about to start in this country recently applied to him to recommend a dozen of his students to take up responsible posts, after brief further training in America, believing that nowhere else could they obtain better material for their purpose.

If in the future the scientific training in a technical school or the technical departments of our universities is to largely replace the old systems of apprentices and pupilage, a much wider responsibility is thrown on the teachers and professors than the mere imparting of knowledge or development of manipulative skill. It rests with them to teach the general principles upon which all successful manufacture must be based, and to influence the entire mental attitude of their pupils towards the profession for which they are training. If they fail in this they may indeed instruct, but will not educate, and we shall have a new class of "technics," who will hinder rather than promote industrial progress. This is no imaginary danger. Russia has made advances in the establishment of technical schools which are not thoroughly in touch with the great manufacturing establishments of the country, and to describe a man as a "technic" is equivalent to saying he is the last man to whose advice or opinion you would attach any weight. To avoid such dangers, we cannot insist too strongly on the importance of the closest possible co-operation and interchange of opinion between the responsible and practical managers of our industries and members of the profession, on the one hand, and the managers and teachers of our technical schools, on the other hand. The free interchange of opinion and discussion of methods is essential to the welfare of both.

Take two illustrations of such general statements. We have been talking much of late, but doing less, towards standardisation of electrical work. Manufacturers know perfectly well the need of it, but are practically powerless, as they have no option but to provide what they are asked for. Now, if the profession generally could agree from time to time upon certain standards, and every young engineer before he leaves school or college be trained to repeat them, to understand the reason for them, and to look upon departure from them without cogent cause as bad practice, they would very soon be universally adopted. Or, as another example, I suppose nine-tenths of educated opinion in England has been for the last 10 or 20 years in favour of the adoption of the metric system, as tending toward more accurate work, involving much saving in labour of computation, and facilitating our relations in foreign markets. Enlightened manufacturers are fully alive to its advantages, but cannot make headway against the mere deadweight of characteristic English dislike to change. Now, if the teachers in technical schools would be bold enough to agree to write all their text-books in the metric system, set every problem or example in it, and make their pupils think in centimetre-grammes instead of foot-pounds, and be allowed to translate their results into hundredweights, ounces, drams, pennyweights, inches, sixty-fourths of an inch, and any other of our national abominations, as valuable arithmetical exercise only, we should very soon have such a preponderance of influence in favour of the metric system that its national adoption would no longer be delayed.

Technical education does not end in school or college, but must be continued through life, and one at least of the chief instruments of it is our technical Press and the publications of our technical societies. It is always rash to criticise the Press, but, perhaps, I may be allowed to submit for the benign consideration of the proprietors and editors of the technical journals some considerations from the readers' point of view, or, rather, I should say, the would-be readers' point of view, which militate against their usefulness. There are at least a dozen journals appearing weekly or monthly more or less exclusively devoted to electrical engineering. How can mortal man, or, at least, the busy mortal man, do more than purchase these, lay them on his office table, and marvel what the contents can be, and probably get no further than glancing at the weekly tables in a journal I will not name, but merely allude to as an excellent example of *multum in parvo*, and as full of real information and educational value as two pages can be. If these dozen journals could be condensed into two or one, with free use of scissors, and the excellent editorial and contributing staffs imbued with the fundamental idea that conciseness and perspicuity are the true criteria of style, and then published at a shilling instead of sixpence, if need be with, may I hint it, the advertisements in a separate cover—if such a combination could be effected, I believe it would be of tenfold advantage to the electrical engineering profession. Such a step has been taken with most excellent results in the combination of the "Scientific Abstracts" of the Institution of Electrical Engineers and the Physical Society. Could not this be carried further by the inclusion in the combination of the "Abstracts" of the Civil Engineers, a subject which has been, I believe, discussed, and which possibly an expression of the views of our branch institution, young

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and provincial though it be, might in some small degree influence.

We live in an age of Imperial federation and trade combination, of the adoption of the weaker by the strong, and the strengthening of such as do stand by consolidating the foundations and widening the scope of their operations. We, members of the late Society of Northern Electrical Engineers, after seven years of individual growth, have just taken an important step in this direction by our willing amalgamation with the older and more influential Institution of Electrical Engineers in London, which, while leaving us full control of our local organisation, will, I am convinced, greatly conduce to increased usefulness and promote those objects with which our society was founded. The time will, I trust, come when the same influence, working in other channels and with stronger currents, will finally lead to the combination of all British engineers, whether civil, mechanical, naval, or electrical, purely professional, or engaged in the control of manufactures, into one great institution, with a roll of at least 20,000 members, and an income sufficient to provide not only a great central house and library in the Metropolis, but also subsidiary houses and libraries in the chief centres of industry, and to ensure the rapid publication in convenient form of all new work which will widen the knowledge and resources of engineers, stronger than any of the trade guilds of the Middle Ages, or the great corporation of the learned professions, maintaining and extending the prestige, honour, and usefulness of British engineers throughout the world.

THE PACIFIC CABLE.

The following letter has been sent to the daily Press by the Eastern Extension Telegraph Company in order to correct several misunderstandings:

Sir,—As there appears to be much misconception in Parliament and elsewhere as to the exact nature and extent of the arrangement about to be entered into by the Governments of New South Wales, Victoria, South Australia, Western Australia, and Tasmania with the Eastern Extension Telegraph Company, my directors would feel obliged if you would be good enough to give publicity to the following statement. The arrangement is:

1. For the company, in conjunction with the Eastern Telegraph Company, to provide at their own cost—estimated at about one million and three-quarters—direct cable communication between South Africa and Adelaide, which, with the third route recently established between Great Britain and the Cape, would give Australia an alternative communication to the existing route, *vid* India, Egypt, and the Mediterranean.

2. To at once reduce the existing tariff between Great Britain and the contracting colonies (varying from 4s. 9d. to 5s. 1d. per word) to an uniform rate of 4s., with proportionate reductions for Government and Press telegrams; and, as the traffic responds to the reductions, to further lower the tariff on a sliding scale down to 2s. 6d. per word.

3. On the laying of the Cape-Australian cable to reduce the tariff between Australia and South Africa from 7s. 1d. to 2s. 6d. per word.

In return, the Eastern Extension Company only require the right of direct dealing with the public in the capitals of Australasia when the proposed Government Pacific or other competing cable is laid. This right has always been enjoyed in Great Britain, not only by British, but foreign, telegraph companies, and is recognised in Canada, South Africa, and elsewhere.—I am, etc., F. E. Hesse, manager.

With reference to the subject, we notice that in the House of Commons on Tuesday Sir Edward Sassoon asked the Secretary of State for the Colonies whether he was aware that the rights now on the point of being ceded to the Eastern Extension Telegraph Company by the Australian Governments materially altered and affected the conditions upon which the Pacific cable scheme, to which these Governments were signatories, had been based, and that the Canadian Government regarded these concessions as likely to defeat, and probably to lead, to the abandonment of the enterprise; and whether her Majesty's Government had intimated their acquiescence to the grant of these concessions; and, if not, whether they had addressed any remonstrances to the Australian Governments with the object of inducing them to renounce their intention of infringing the terms of the Pacific cable scheme. Mr. Chamberlain replied that the question how the proposed concession to the Eastern Extension Telegraph Company of the right to open its own offices in the Australian capitals when the Pacific cable had been laid would affect that scheme had been referred to the Pacific Cable Committee for consideration and report. The hon. member would see from the correspondence recently laid before the House that her Majesty's Government had asked the Governments of New South Wales and Victoria to defer concluding any agreement with the company until the Cable Committee had reported on the question.

CITY OF LONDON ELECTRIC LIGHT COMPANY.

The annual general meeting of the above Company was held at Winchester House yesterday.

After the usual notice had been read, the **Chairman** (Sir David Salomons) reviewed the changes in the Company's position during the past year. The competition feared a year ago was now authorised, and the Corporation were responsible for this. The directors had strenuously opposed the granting of the order to the Charing Cross and Strand Company, but they had failed. They had also offered to sell their undertaking to the Corporation, but this offer had not been accepted. They considered that the Corporation had broken pledges, and that the legal quibble on which their action had been defended was one which would render impossible all business with municipalities. The law case over the reading of certain clauses in the Company's agreement with the Corporation had been decided in the Company's favour, but this matter was going to appeal. As regards the prices paid for current, the policy of the Company had been to make reductions as soon as possible, but owing to the threatened competition they had been compelled to reduce to a price at which it did not pay. In fact the present prices were lower than in any other district in London. The effects of the lower rates were a decreased revenue per consumer with a large increase in the number of applicants. During the last half-year 12,000 more lamps had been applied for than during the corresponding half-year in 1898. The increased load, coming at a time when good coal was scarce, had strained the resources of the Company, but he trusted that in future the evenness of the supply would be kept good. They had previously provided in their estimates each year for an increase of some 60,000 lamps per annum, but now it would be necessary to look ahead to larger increases. The total equivalent number of lamps now connected and applied for was 468,831. After referring to the Bills now before Parliament, Sir David stated that, allowing for reserve, the machinery now fixed and on order would allow of 650,000 lamps being connected to the mains. He considered that the competing company would be handicapped by the present high price of material, and by the fact that their station would be outside London. He thought their competitors did not realise the task before them. The directors were now considering how they could improve their prospects, as the last six months' supply at 4½d. per unit had not paid. They were about to introduce a new scale of charges, which would enable the long-hour consumers to get a cheap supply, while the short-hour and unprofitable consumer would have to pay a higher rate. He moved the adoption of the report.

Mr. George Herring seconded the adoption of the report, and commented on the repudiation by the Corporation of their agreement with the Company because one or two members of the Corporation held shares in the Company. This the Company were powerless to prevent. He thought that the capital their rivals were asking for—£800,000—would prove to be too small, and he did not see what inducement they could offer consumers to change over. The charge per unit was to be the same, and as regards the quality of the supply the Charing Cross Company would also be as liable to have breakdowns.

Mr. Preber said that the three complaints brought against the Company by the papers were high price, bad light, and autocratic treatment. The first of these had been removed, and he trusted the others would be also. As regards the new issue, they were asked to pay about 10s. premium for the new shares. He would like to know what dividend was to be expected when the whole of the year's supply was at the rate of 4½d. per unit? Also what other districts did the Company intend to get powers to apply?

Mr. Young strongly supported the action of the Board during the past year. He should be pleased to take up the new shares allotted to him at par, and believed that the real value of the same was above the present market price. He condemned the action of the London Corporation in doing what no private individual would think of doing in his own business.

In reply to the above and other questions, the **Chairman** said that he could not disclose the terms of the new scale of charges, as these had not yet been finally settled. They would, however, retain the best consumers, while increasing the price to those who were not really profitable to the Company. The rival company might perhaps take over these from them.

The necessary resolutions for passing the dividend, approving the Bill now before Parliament, and re electing the retiring directors and auditors were then passed.

The meeting closed with a vote of thanks to the Chairman.

[An abstract of the report and accounts of this Company for the past year will be found on p. 392.—Ed. *E. E.*]

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PHYSICAL SOCIETY.

At the ordinary meeting on March 9, Prof. Everett, F.R.S., vice-president, in the chair, a paper on "**The Damping of Galvanometer Needles**" was read by **Mr. M. Solomon.** The solution of the equation of motion for a magnetic needle, swinging in a uniform magnetic field, points to the conclusion that the ratio of the period to the logarithmic decrement is independent of either the moment of the needle or the strength of the controlling field, and is simply a function of the damping coefficient and the moment of inertia of the moving system. This ratio should therefore be constant if these latter quantities are constant. Experiments to test the constancy of period to logarithmic decrement have been conducted at the Central Technical College at various times since 1891, and they have invariably pointed to a variation in the value of the ratio. The object of the present paper is to discover the cause of this variation. It may be due to an alteration in the moment of inertia or to an alteration in the damping coefficient. If the control magnets are either directly above or directly below the needle, there is no chance of any change in moment of inertia. The damping coefficient depends on three things: (1) viscosity of the air, (2) viscosity of the suspension, and (3) eddy currents. The author has carried out experiments with a galvanometer on open circuit and finds a constant value for the ratio. The viscosity of the air suspension therefore causes no variation. Upon closing the circuit and repeating the experiments the value of period over logarithmic decrements alters. The variation is therefore due to eddy currents. The damping factor due to eddy currents may vary owing to three causes: (1) change in moment of needle due to change in field strength; (2) effects of self-induction; (3) effects of rise of temperature on the resistance of the coils. The author points out that the two latter causes would tend to alter the ratio in the wrong direction, and he therefore concludes that the variation is due to an alteration in the strength of the swinging needle produced by altering the strength of the controlling field.

Mr. Blakesley said it was interesting to note the fact that the ratio of period to decrement was independent of the controlling field. In the case of a condenser discharging this ratio is independent of the capacity, in the case of a tuning-fork of the rigidity, and in the case of water oscillating up and down in a U-tube of the acceleration due to gravity.

Mr. Rosenbaum said that the ratio considered was constant in the case of a Nalder-D'Arsonval galvanometer.

Mr. Solomon said that his arguments did not apply to a galvanometer of this description, because the swinging system was not a magnetic needle, but simply a coil.

A paper on "**The Distribution of a Gas in an Electric Field**" was read by **Mr. G. W. Walker.** The author has considered a gas as consisting of a number of molecules, each containing two atoms of equal mass, one positively and the other negatively charged with electricity. When under the action of electrical forces some of the molecules split up, and we arrive eventually at a steady state in which there is a definite number of undissociated molecules and of free positive and free negative atoms. Treating the problem as one-dimensional, the potential at any point is expressed in general by elliptic functions, and is therefore periodic. Applying the results to the case of a vacuum tube, it is found that there is superimposed upon the gradual fall of potential along the tube minor periodic variations, which it is suggested are connected with the striæ of discharge. Both the matter density and the electric density are periodic along the tube. If the places of maximum matter density coincide with the places of minimum electrical action, then, whether luminosity is due to collisions or recombinations, there will be maximum luminosity at these points. In general, these points do not coincide, and thus the positions of maximum luminosity are not clearly defined. The analysis leads to the conclusion that the distance between the striæ is inversely proportional to the density of the gas and to the current strength, and these facts have been experimentally verified.

Mr. C. E. S. Phillips exhibited a "**Surface-Tension Lecture Experiment.**" The effects of surface tensions were exhibited by placing water between two pieces of microscope cover glass. When the glasses are circular they set in any position, and one can be made to rotate upon the other. If the plates are square or elliptical, they set in a definite position, to which, if displaced, they immediately return. Mr. Phillips pointed out how two circular discs, with liquid between, could be used from which to suspend the moving system of a galvanometer.

Mr. Cochrane suggested the use of some liquid which would evaporate less slowly than water.

Mr. Blakesley asked what accuracy could be obtained with such an arrangement, and what weight it would be possible to support without squeezing out the water.

The meeting then adjourned until March 23.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

253. How would you ascertain the number and diameter of tubes to be used in an exhaust-steam feed-water heater for dealing with a given quantity of feed water?—TELFORD.

254. State the advantages of coal conveyors, and give figures as regards economy.—F. B. A.

ANSWERS.

Question No. 247.—In a four-pole dynamo armature (slotted drum type) made for 2,000 amperes at 60 volts, with four sets of brushes, the lugs connecting commutator bars to armature winding are made of iron strip (about ·095 square inch sectional area). What are the probable reasons for using iron as lugs, and of so small a sectional area?

Best Answer to No. 247 (*awarded* 10*s.*).—This question suggests a construction with reference to commutator connections which seems to oppose all the rules for dynamo design in general practice. An iron lug has the following disadvantages as compared with one of copper: for equal dimensions about six and a half times the resistance; the resistance increases in a greater ratio with a rise of temperature; and it requires to be soldered and riveted to the segment, whereas one of copper or phosphor-bronze could be drop forged or cast in one with the segment. Let us consider the case given in the question. As there are four brushes, with the specified load of 2,000 amperes, each lug carries 1,000 amperes for four brief periods during each revolution of the armature, on each occasion for a time equal to that taken by a commutator bar to enter and pass away from under the brush. The current density is just over 10,000 amperes per square inch, and as the amount of heat produced is proportional to the resistance, and to the square of the current density, if

H_1 = heat produced in iron lug as above;
H = heat produced in copper lug at 2,000 amperes square inch = 1;
r = ratio of resistance of iron to copper;
r_1 = ratio of current density in iron lug to that usually allowed in copper;

we have $$\frac{H_1}{H} = \frac{r \times r_1^2}{1} = \frac{6\frac{1}{2} \times 5^2}{1} = 162{\cdot}5.$$

This condition certainly seems to favour the conduction of heat to the armature winding to an unpleasant extent. On the other hand, since at any moment the length of circuit constituted by the lugs is only equal to the length of two lugs, the loss in E.M.F. due to lug resistance is not of o much moment. The probable reason for using iron for the lugs is that a condition is introduced which to a small extent conduces to sparkless collection in the following manner:

The figure represents diagrammatically part of a four-pole armature, and in order to determine the effect of the iron lugs, let us consider the actions which take place in the conductors and lugs as the respective bars pass under the brush, B. The direction of current in conductor 4 has been toward the observer, and by way of lug *l*, segment, *r*, and brush, B. It is necessary that in the instant conductor 4 is passing under the brush, the current in it shall be reversed and again reach its full value in the opposite direction, which action is mainly accomplished by the fringe of the magnetic field of the pole-piece, N, into which it is just entering. Owing to self-induction (which is especially apparent with slotted cores) this reversal, particularly if the magnetic field be weak, is not always accomplished before the segment passes from under the brush, and the current consequently sparks across from bar to brush. However, before *r* leaves the brush, bar *q* enters under it, and a strong current, due to the E.M.F. in alternate conductors to the left of 4, flows through lug l_1 and sets up a magnetic field in the direction shown, which with a current

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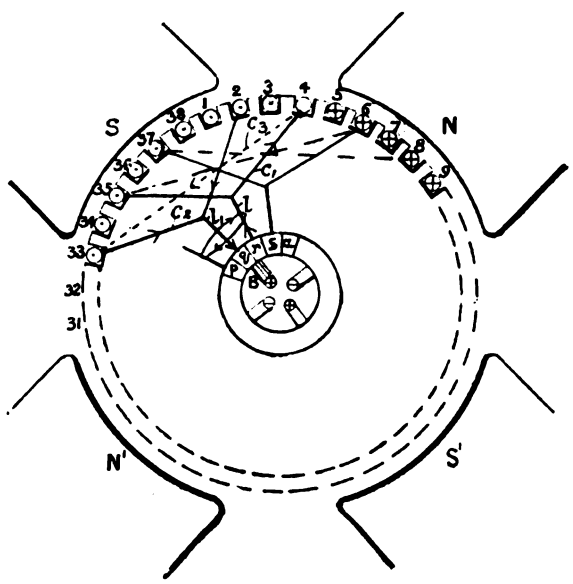
of 1,000 amperes is fairly strong, and embraces or links lug *l*. In consequence a reverse E.M.F, as shown by the arrow heads, is induced in the lug *l*, which forms part of the closed circuit for the moment constituted by the lugs, *l* and l_1, front connectors, C_1 C_2, conductors 4 and 33, back connector, C_3, bars, *q* and *r*, and the brush, B; the circuit is shown by thick lines. This induced E.M.F., it will be seen, coincides in direction with that which the current in conductors 4 and 33 (which form one coil) should have before *r* passes from under the brush, and even though this E.M.F. be very small, because of the very low resistance of the circuit in which it acts, a considerable current may be induced. It is obvious that the magnetic field produced as described is much stronger when iron lugs are used than if they were of copper. A similar action takes place, of course, with regard to every lug and its respective conductors, but reversed in direction as they pass under each brush. It must be remembered that the process is retarded to some extent by self-induction.



The small sectional area of the lugs is thus explained. The magnetic induction in every lug is reversed in direction at each consecutive brush, or four times per revolution, and hysteresis prevents the instantaneous setting up of the magnetic field, but as hysteresis decreases with increase of temperature, the lugs are made small in order this condition may be effected by the heating effect of the current.—G. EVANS.

Answer to No. 247 (*awarded* 5*s.*).—The iron commutator lugs are a somewhat out-of-date device for preventing or reducing sparking at the brushes. In modern moderate-current machines the method has been entirely superseded by the use of carbon brushes, but it is still of use in the case of heavy-current machines, for which carbon brushes are inadmissible on account of the very large and expensive commutators which their use would necessitate. Sparking in these heavy-current machines depends not so much on the volts per section, which are never large, as on the sudden large changes of current in the section undergoing commutation. In the machine under consideration the current carried by each conductor is (unless a multi-circuit winding is used, and this is not always desirable) 500 amperes. During commutation, therefore, the current in the short-circuited section has first to be reduced from 500 amperes to zero, and must then be increased to 500 amperes again in the reverse direction. To carry this out correctly the brushes must be set in one particular position, and must be of one particular width (peripherally) on the commutator. Should the width be made greater than this particular amount, either from density considerations or through wear of the brushes, the current in the commutated section instead of beginning to fall as soon as the short-circuit commences, may first increase to a very large amount and then fall off very suddenly, thus causing a serious disturbance of the commutating field. This disturbance may cause sparking, and will certainly cause loss by eddy currents in the pole-faces, besides unnecessarily heating the commutator and the armature windings. The same momentary rush of current during commutation will occur if the brushes are set at all incorrectly. The effect of the iron commutator lugs is, by increasing the resistance of the short-circuited section, to appreciably reduce these currents for a given inaccuracy in the setting or width of the brushes. The approximate numerical effect of the lugs can be determined as follows: The four-pole machine mentioned in the question would probably have something like 80 total conductors and 40 commutator parts, and the total $C^2 R$ loss in the armature winding would be about 1½ per cent. of full load, or 1,800 watts. The resistance of one section would, therefore, be $\frac{1,800}{40 \times (500)^2} = \cdot00018$ ohm. The resistance of the brush contact, which, of course, also forms part of the short-circuit, is, assuming copper gauze brushes with a constant resistance of ·003 ohm per square inch and working at a current density of 100 amperes per square inch, $\frac{\cdot003 \times 2}{5} = \cdot0012$ ohm at the moment when the brush surface is equally divided between the two commutator plates. Assuming the length of each of the two iron lugs which enter into the short-circuit to be 6in., and the resistance of iron to be ·000005 ohm per 1in. cube, the additional resistance for the lugs will be $\frac{\cdot000005 \times 12\text{in.}}{\cdot095} = \cdot00064$ ohm. The complete resistance of the short-circuit is therefore: without lugs, or with copper lugs of negligible resistance, ·00138 ohm; and with the iron lugs, ·00202 ohm; or an increase of nearly 50 per cent.—Q.

Answer to No. 247 (*awarded* 5*s.*).—The question is very vague in the particulars it gives, as it does not state whether the armature is two-circuit or multiple-circuit, neither does it state whether it is a singly-wound or multiple-wound armature, and unless these particulars are known it is impossible to say whether the sectional area of the lugs is large or small. Some time ago I built a machine having the output specified, and which was wound with a duplex multiple-circuit armature, and it was found upon testing to give very good results, but when running on its ordinary work it was subjected to very great and rapid variations of load, and sparking set up. This sparking was due to the brush lead requiring alteration with the varying loads, whilst, at the same time, the load variation was too frequent to allow of the lead being altered.

It is a fact known to all dynamo designers and others conversant with the theory of dynamos that the sparking due to a wrong position of the brushes is caused by the short-circuited currents—that is, when a brush rests on two segments the coil between these two segments is short-circuited on itself, and a current would flow under normal condition which varies inversely as the resistance of the coil. Now, a coil before arriving at the plane of commutation is carrying current, say, in a right-handed whorl. After passing this plane it carries it in a left-handed whorl, and, in accordance with Lenz's law, during the act of commutation there will be a force tending to prevent the stoppage of the current flowing in the right-handed whorl, and an equal force tending to stop a flow commencing in a left-handed whorl. For sparkless commutation the field strength, where this reversal of direction occurs, must be just strong enough that while the coil is under the brush the current is stopped, and a current of equal magnitude is started in the reverse direction. A field strength greater or less than this will cause sparking. (I do not attempt to prove this statement, as it is outside the question, but the student will find the subject fully treated in Weymouth's "Drum Armatures.")

With a constantly varying load of great amperage it is impossible to keep the plane of commutation in its proper position, and other means have then to be tried to secure sparkless commutation. Various methods have been suggested. The one adopted in the case I refer to was that of adding a great resistance to the path of the short-circuit current. This could not be done by winding with a high-resistance wire, for then the efficiency of the machine would have become very low, and as the heating effect is $= C^2 R$, the whole armature would have grown very hot on long runs. As the commutator lugs were some 6in. in length, they

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offered a convenient place to put in the resistance, especially as the current flowing from coil to coil does not travel down the lugs, but only has to flow through them when passing to or from the brushes. Hence it will be seen that the resistance of the short-circuit current path was enormously increased, and consequently the amount of this short-circuit current was so diminished as to be kept below the sparking limit when the copper lugs were replaced by high-resistance ones.

I might say, in conclusion, that this device is a old one, first tried, I believe, by making the whole commutator of iron, and also that its adoption in this particular case gave very good results; also, if the machine "D. T." mentions is the one I have referred to, he will find the lugs, which are of the section he gives, are not made of iron, but of a special material which has the appearance, but not the properties, of iron.—F. J. A. M.

Question No. 248.—In wiring over small areas, such as workshops and factories, for electric light and power, what economy is to be expected by the use of a three-wire system of distribution? Consider a specific case of a workshop 150ft. long by 30ft. wide with 200 volts on the two-wire system, and 400 volts between the outers of the three-wire system.

Best Answer to No. 248 (*awarded* 10*s.*).—It is not difficult to see that unless the installation is very extensive in area, there is very little benefit, as regards economy in distribution, to be derived from the employment of the three-wire system. Further, it is also true that for the purposes of distributing to the lamps or motors *in the various shops* little advantage, if any at all, is to be obtained as regards initial cost from a three-wire system, with 400 volts across the outers, over a two-wire 200-volt system. If the shops to be supplied are spaced considerable distances apart, an economy may be effected in the cost of the supply mains by adopting the three-wire system, but this appears to be a matter outside the present question, as it only seems to refer to the wiring in the factories themselves. An illustration will perhaps best explain the inadvisability of using the three-wire system in the buildings. The

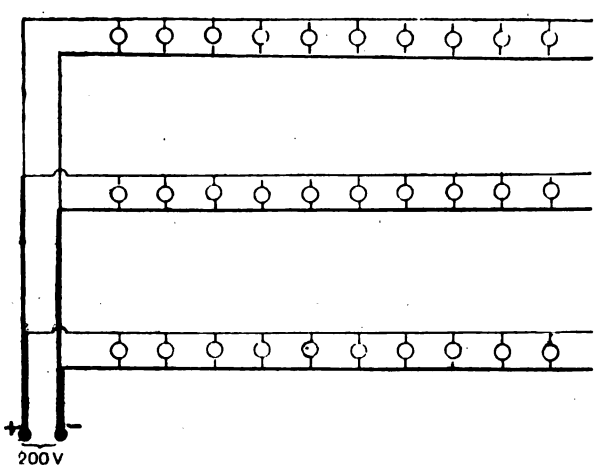

FIG. 1.

diagrams (Figs. 1 and 2) represent the wires required for supplying the lights on three floors of a building. We will assume there are 10 lamps required (or, may be, small motors; the same argument will hold good) for each floor. Then the + and − mains in Fig. 2—representing the three-wire system—will have only to carry half as much current as the mains in Fig. 1—representing the two-wire system. But it is quite conceivable that only five lamps might be required alight at one time on any one floor, and it might so happen that those shown connected between the + main and the neutral wire would be required. If this were so, the neutral wire, under those circumstances, would have to carry as much current as the maximum carried by the + or − wire, and would therefore have to be equally large. So that to be perfectly safe, the neutral wires throughout the buildings should be of the same size as the other mains for the three-wire system. Thus we see that the total cross-section of the copper in the wires for the two-wire and three-wire systems (for equal economy in distribution) should be in the ratio of 4 to 3—a small difference. The difference in the cost of the wires, however, would be in a less ratio than this, for three insulated wires would cost more than two if the total cross-sectional area of the three or two conductors in the two cases respectively were the same. We may suppose a slight advantage in the cost of the cables for the three-wire system still accruing, but it would be very little, indeed. This is further discounted by the extra cost of labour in running three instead of two wires, and it would be found that the two wires when installed would not cost any more, if as much, as the three wires for the other system.

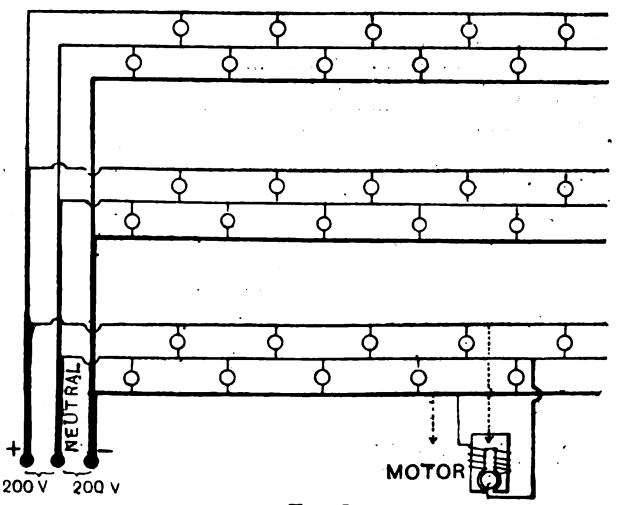

FIG. 2.

The chief hindrance to the introduction of the three-wire system in buildings is the danger involved. Referring, again, to Fig. 2 for a moment, it may be observed that if a person standing on a dry floor were to come in direct contact with the + and − mains, or through these being partly in contact with certain different metal work to which the person might have access, he could receive the full 400 volts pressure, which might result in an unpleasant accident. Similarly a higher strain than 200 volts may be thrown on the insulation of the wiring or a motor on the circuit. This has led the Board of Trade authorities to lay down a law prohibiting public supply companies introducing the + and − mains (when the potential difference between them exceeds 200 volts) entering the same building or part of a building, as the case may be. This effectually prevents the possibility of an accident of the kind hinted at, besides making the practice of employing the three-wire system referred to rarely, if ever, adopted.—P.

WORCESTER ELECTRIC LIGHTING ACCOUNTS.

The accounts of the electricity department of the Worcester Corporation for the year ended Dec. 31, 1899, have just been published, from which we extract the revenue account, general balance-sheet, and statement of electricity generated, sold, etc. An abstract of the report of Mr. E. E. Hoadley, city electrical engineer, to the Electricity Committee on the work of the department during the year is also appended:

Dr.	Revenue Account.	£	s.	d.
Coal		1,626	4	1
Oil, waste, and engine-room stores		157	0	4
Wages at generating station		953	5	7
Repairs to building, plant, and machinery		379	4	10
Repairs and maintenance of transformers, meters, etc.		132	12	2
Attending and maintenance of public lamps		309	16	10
Rents		38	19	0
Rates and taxes		47	3	8
Salaries—engineer's department		460	3	0
Stationery and printing		64	1	5
General establishment charges		31	16	6
Law expenses		102	1	7
Insurances		37	18	3
Free Wiring Company		47	9	9
Lamps		199	3	9
		4,587	0	9
Balance carried to net revenue account		3,791	3	4
		£8,378	4	1

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Cr.

	£	s.	d.
Sale of current, per meter at 1½d., 2½d., 3d., 3½d., 6d., and 7d. per Board of Trade unit	6,767	7	7
Public lighting	1,321	16	0
Rental of meters, etc., on consumers' premises	181	18	11
Repairs, testing fees, carbons, etc.	8	10	4
Rent of water mill at Powick	50	0	0
Rent of cottages	30	3	0
Sale of old iron, casks, etc.	10	9	0
Norwich and London Accident Insurance Company, amount of claim in respect of accident to workman	7	19	3
	£8,378	4	1

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	63,174	12	4
Sundry creditors	1,621	19	2
Net revenue account—balance at credit thereof	90	12	2
Sinking fund account	8,021	17	4
Treasurer	17,643	15	6
	£90,552	16	6

Assets.	£	s.	d.
Capital account—amount expended for works	79,235	14	10
Stores on hand: coal, £73. 11s.; oils, waste, and engine-room stores, £209. 10s. 11d.; carbons, £3. 14s. 8d.; lamps, £80. 15s. 2d.	367	11	9
Sundry debtors for current supplied	2,515	3	8
Public lamps	334	10	0
Other debtors	77	18	11
Sinking fund account	8,021	17	4
	£90,552	16	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		710,416
Quantity sold { Public lamps 109,600 / Private consumers by meter 441,837 }		551,437
Quantity used in works		8,495
Total quantity accounted for		559,932
Quantity not accounted for		150,484
Number of public arc lamps		57
Number of public incandescent lamps		3
Total maximum supply demanded (kilowatts)		999

MR. HOADLEY'S REPORT.

I have the honour to submit to you the following report on the results of the fifth year of working of the electricity department. For purposes of comparison, the results of the previous years' working are appended. From these it can easily be seen in which direction improvements have been effected, and in which we have not reached the standard of the preceding year. It is with great pleasure that I have to report that, in place of a loss on the year's working, there is a net profit of £90. 12s. 2d., and this notwithstanding the fact that the Ferranti engine has been practically of no use to us during the year. Looking at the figures in detail, the first thing to be noticed is the large increase in our coal bill, the actual amount paid rising from £1,211. 10s. 2d. in 1898 to £1,626. 4s. 1d., although coal was only 6d. per ton dearer than in 1898; the cost of coal per unit sold has risen from ·612d. to ·707d. This, on the face of it, looks bad, but when all the facts are known the results show that coal was really burnt more economically than in 1898. In the first place, last year was the driest we have had since the station started, and instead of doing 53·6 per cent. of our output by water power, we only did 41·7 per cent., or, in other words, we generated 413,694 units by steam, as against 283,072 in 1898. From these figures we find that instead of each steam generated unit costing us 1·027d. for coal, as in 1898, it only cost ·942d. The next item for oil, waste, and engine-room stores has been reduced from ·107d. to ·068d., and is among the very best results in the kingdom, being lower than in stations of such magnitude as Manchester, Bradford, and Brighton. The salaries and wages items also show a good reduction, from ·482d. to ·414d., and is below the general average. For repairs and maintenance of buildings, machinery, etc., the amount has risen considerably, from £196. 15s. 1d. to £379. 4s. 10d., or from ·099d. per unit to ·165d. per unit. Although this is somewhat a large increase, the figure ·165 is still good, being lower than obtains in 41 municipal electricity works. As this large increase was a surprise to me, I am giving the chief items which go to make it up: wages, £154. 13s. 9d.; firebars, £72; Babcock and Wilcox, repairs to boilers and tools for ditto, £17. 10s.; Brush Company, new piston rings for engines, etc., £40. In 1898 this item was phenomenally low, and the fact that so few repairs were done in some measure raised the amount for 1899 by putting in the present accounts repairs which really ought to have been done in 1898. Most of the other items are pretty much the same as they were last year, a slight decrease being observed in several, the exception being repairs and maintenance of mains, transformers, etc., which has risen from £42. 8s. 4d. to £132. 12s. 2d., the cause being a serious breakdown in the early part of the year, which, although it did not interfere with the supply of light, yet caused several transformers to be very badly damaged, and cost nearly £100 for repairs. The works' costs are £3,248. 7s., or 1·411d. per unit, as against £2,655. 16s. 11d., or 1·341d. per unit, being an increase of ·070d. per unit. In looking at these figures it must not be forgotten that last year was an exceedingly dry year, and from the much larger number of units which had to be generated by steam and the larger number of hours that the plant was kept under steam, a considerably larger increase was to be expected. With regard to the water power, in the early part of the year when we expect a good deal of benefit from its use, a series of floods lasting much longer than usual occasioned us considerable loss. In January and February there were 28 days on which the water power was not used at all, and during most of the remainder owing to reduced head it was of little use. During March, April, May, and June it was fairly good, but I should like to point out that in the latter three months, although a large percentage of our output was done on water, owing to the lengthening days, the total number of units generated is considerably decreased, and the actual number of units generated by water power is not so great as one might be led to think. From July right up to the middle of November we had a drought of most unusual length. In August, September, October, and the early part of November, the water power was practically no use at all, as, for the greater part of this time, the most that could be done was to run the little 36in. wheel for a few hours per day. This 36in. wheel, I might state, is capable of very little more than driving an alternator and overcoming the friction losses and the losses in the transformers; directly any little load came on or the waterworks wanted to put a motor on, an engine had to be started. The increase in the number of units sold is 66 per cent. greater than the increase in 1898, being 16 per cent. of the total output, as against 9·5 per cent. in 1898. This is partly accounted for by an increase in the number of units taken by the waterworks, but there has also been a large increase in the number of units sold for incandescent lamps. Fifty-one new customers have been added during the year, and for some days before and after Christmas there was quite a run of applications. Most of these, however, were not connected up last year, but will appear in the report for 1900. Only 17 consumers were got by the Free Wiring Company, an even worse result than last year. The average price obtained for private lighting has again decreased, showing that increasing advantage is being taken of the system of charging. The average obtained on all units has risen, however, from 3·619 to 3·638. This is owing to an increasing number being used for private lighting. The price obtained per unit for public lighting has risen slightly, not owing to an increase of revenue per lamp, but to a reduced expenditure on attending and maintenance. The Ferranti switchboard has been in use throughout the year, resulting in much greater convenience as well as perfect security to those members of the staff who have to operate it. The new Ferranti plant is now running regularly on the evening load, with very satisfactory results both as regards economy and parallel running. There are, however, still several alterations in matters of detail which I require to be done before the final certificate is given. A most anxious time was experienced during the week or two immediately before Christmas, as at this time the Ferranti set was out of action, and the water power was of very little use owing to the swollen state of the river, the consequence being that in order to meet the load each evening the remaining Brush plant had to be considerably overloaded. Had any breakdown occurred we should have had no reserve plant, and the supply must have been cut off until such time as repairs could have been effected. I feel I should be failing in my duty did I not point out to you the insecure position we are in as regards breakdown. The Board of Trade rule states that a proportion of plant equal to the largest unit in the station shall be kept as reserve. In our case this is the 300-kw. Ferranti set. We must, therefore, be prepared for a time when owing to accident it may be impossible to run this set. There is left plant capable of doing 500 kw., or only 400 kw. in time of flood, which is the time we must consider. Last Christmas we just managed to do our maximum load of 440 kw. Next Christmas it is just possible that in the event of a flood and an accident to the Ferranti set occurring at the same time, we may manage to get through the load, then increased to a good deal more than 440 kw., but at Christmas, 1901, I feel sure that the present plant will not be sufficient to adequately meet the load. As it is hopeless in the present state of the industry to expect delivery of plant before next Christmas, even if ordered now, it is better that the whole matter should be considered in conjunction with the tramways question, but it should not be delayed longer than is absolutely necessary, as manufacturers are exceedingly busy, and unexpected delays generally crop up.

UNITS GENERATED BY STEAM AND WATER POWER, WITH PERCENTAGES FOR 1899.

Month.	Total units.	Steam.	Water.	Steam. Per cent.	Water. Per cent.
Jan.	73,232	62,003	11,229	84·7	15·3
Feb.	59,024	37,497	21,527	63·5	36·5
March	55,616	10,728	44,888	19·5	80·7
April.	44,624	7,646	38,978	16·4	83·6
May	41,280	4,046	37,234	9·8	90·2
June	38,096	10,601	27,495	27 8	72·2
July	42,736	25,063	17,673	58·6	41·4
Aug.	47 280	41,585	5,695	87·9	12·1
Sept.	56,128	53,163	2,965	94·7	5·3
Oct.	70,064	56,328	13,736	80·4	19·6
Nov.	82,496	40,955	41,541	49·7	50·3
Dec.	97,840	64,079	33,761	65·5	34·5
Total	710,416	413,694	296,722	58·25	41·75

NOTE.—August, September, October, and part of November, only 36in. wheel for a few hours per day. No water used from Sept. 4 to 8 owing to repairs to weir. Floods: Jan. 1 to 4, Jan. 13 to 28, Feb. 8 to 18, Dec. 30 and 31.

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BUSINESS NOTES.

TRACTION.

Rossendale Valley Tramways Co.—The directors have decided to substitute electricity for steam power on their lines.

Stockport.—The Manchester Corporation have withdrawn their opposition to the Stockport Corporation Tramways Bill.

Swansea.—We are informed that the official opening of the Swansea electric tramway system will take place on May 1.

Southport.—The Tramways Extension Bill was before the Committee of the House of Commons on Tuesday and Wednesday.

Battersea.—The Vestry have decided not to oppose the County Council Tramways Bill at the present stage of the proceedings.

Barcelona Tramways Co.—The traffic receipts for the past year were £88,235, showing an increase of £26,430 as compared with 1898.

Wardle.—The District Council and the Rochdale Corporation have agreed upon terms for the future working of the tramways in the Wardle district.

Loughborough.—It is announced that the Light Railways Commissioners will hold a public enquiry into the local light railways scheme on March 19.

Halifax.—The Lancashire and Yorkshire Railway Company have given notice that they will oppose the Halifax Corporation Tramways Extension Bill.

Branksome.—At a recent meeting of the Urban District Council the Surveyor reported that plans of the proposed tramways had been deposited at the offices of the Council.

Mile End, E.—The Vestry have adopted a report of the Highways Committee recommending them to oppose as far as possible the London County Tramways (No. 2) Bill.

Wolverhampton.—The Corporation on Monday considered a report of the Tramway Committee as to the acquisition of the Wolverhampton Tramway Company's undertaking.

Tramway Contracts.—We learn that a firm of Belgian contractors, Messrs. Denerbe and Co., of Jemappes, have been given the contract for laying 12½ miles of tramway at Bradford.

Birkenhead.—The Town Council last week referred back to the Tramways Committee a resolution accepting a scheme of tramways as submitted by the borough surveyor in connection with the terminals at Woodside Ferry.

Runcorn.—It is stated that it is probable that the Urban District Council will transfer their provisional order for supplying electricity to the promoters of the proposed electric railway from Warrington to Weston Point.

Blackpool.—It is stated that another tramway is to be constructed from Blackpool to Lytham. Gas trams are now used, and it is intended to apply this session for power to substitute the overhead electric system, and to double the lines.

Birkenshaw.—The Tramways Committee of the District Council have decided to deposit with the Light Railway Commissioners a series of objections to the British Electric Traction Company's tramways scheme so far as Birkenshaw is concerned.

Beetle.—The Town Council have sanctioned the expenditure of £9,595 for the electrical station plant, feeders, mains, and overhead construction in connection with the conversion of the Derby-road and Rimrose-road tramways for electric traction.

New St. Helens and District Tramways Co.—We have been furnished with a return showing that from March 1 to 7 6,359 miles were run by 10 cars daily (with the exception of the 3rd, when an additional car was employed), 5,750 units were used, giving a total of 57,988 miles and 51,681 units for the period from June 1 to March 7.

Leeds.—Plans and drawings having now been prepared showing an extension of the existing Kirkstall electric tramway along the high road through Horsforth, Rawdon, Yeadon, to Guiseley and Menston, a distance of about eight miles, the plans have been laid before a sub-committee of the Leeds Corporation Tramways Committee.

Cape Town Current Case.—The Supreme Court has now given its decision in the suit of the Eastern Telegraph Company against the Cape Town Tramways, in which the plaintiffs sought to recover £50,000 damages for alleged injury to their business through the escape of currents from the electric trams. The Court was unanimous in favour of the defendants.

Sheffield.—Mr. A. L. C. Fell, electrical engineer, in a report to the Tramways Committee, referring to the explosion on Spital-hill on Feb. 27, said that the question of ventilating the cable-boxes was a very difficult one, and a great many methods had been tried without success. He was making some experiments with ventilators, and would report the results to the committee shortly.

Mersey Railway.—At a special meeting of the shareholders of the Mersey Railway Company, held in London recently, it was resolved to apply for parliamentary powers to work the tunnel railway by electricity, in conjunction with the Wirral Railway, who are also about to apply for powers to work their system by electricity. The cost of the conversion on both railways is estimated at about half a million sterling.

Middlesex Trams.—The Light Railway Commissioners sat on Wednesday to hear an application of the Middlesex County Council and the North Metropolitan Tramways Company for an order for the construction of light railways affecting Tottenham, Wood Green, Southgate, Finchley, and Hendon. Mr. Cripps, for the promoters, said that the scheme would connect Central London with the outlying districts. The enquiry was adjourned.

Devon South Hams Light Railway.—The Dart Navigation Commissioners have held a meeting to consider the advisability of requesting the Board of Trade to withhold consent to the construction of a light railway to Dartmouth, involving the building of a bridge across the River Dart, which would be a great impediment to the navigation of the river. It was unanimously decided to oppose the application before the Light Railway Commissioners.

Leith.—A conference has been held between a sub-committee of the Town Council and the directors of the Edinburgh and District Tramways Company as to the conditions of the proposed lease of the Leith lines to the Edinburgh and District Tramways Company in the event of them being purchased by the Corporation of Leith. We understand that certain agreements were come to, including one which required that the lines indicated should be equipped electrically within four years.

Waterloo-with-Seaforth.—In consequence of a letter from the Liverpool Overhead Railway Company stating that the company considered that so long as they worked the tramways they should not be called upon to construct the line to Rimrose Bridge for five years, the Tramway Committee have decided that the Council refrain from requiring the construction of the line by the Overhead Railway Company for a period of five years, provided the tramways were worked to the satisfaction of the Council.

Bradford.—The returns of the results of the working of the electric tramways for the week ended March 11 show that on the Bolton section 2,915 miles were run, and the receipts amounted to £114. 9s. 3d., or 9·46d. per car mile. The total receipts since April 1, 1899, amount to £5,800. 11s. 4d., or 11·4d. per car mile. On the Horton section during the week 5,856 miles were run, and the receipts were £276. 8s. 3d., or about 11·32d. per car mile. The total receipts since April 1, 1899, amount to £12,930. 13s. 11d., which is equal to 12·72d. per car mile.

Darlaston.—At the last meeting of the District Council the General Purposes Committee reported that the Council had obtained the right to purchase the tramway lines between Moxley, Darlaston, and James Bridge, and recommended them to postpone the exercise of their powers of purchase for seven years, at the expiration of which period the Council should have the right to purchase and to grant a lease to the company for 18 years at a rental which would enable the Council to repay the money borrowed for the purchase. The recommendation was adopted.

Madras Tramway Co.—The statutory meeting of creditors and shareholders of the Madras Electric Tramway Company, Limited, was held last Friday at the Board of Trade offices, Lincoln's-inn. The winding-up order was made on the petition of the Electric Construction Company, Limited. The Company, it was stated, decided at the outset to adopt the conduit system of traction. It was tried on Section 1, and, proving a failure, the overhead system has since been substituted over the whole of the tramway. It was decided that the official receiver should continue to act as liquidator.

Hyde.—At the meeting of the Town Council on Monday it was stated that a letter had been received from the parliamentary agents of the Corporations of Hyde and Dukinfield stating that the chairman of committees of the House of Lords had decided not to allow a late Bill to be introduced in respect of a joint tramway scheme for Hyde and Dukinfield. The town clerk and borough surveyor have therefore been instructed to take steps in opposition to the application for Oldham, Ashton, and Hyde Electric Tramway Company to the Light Railway Commissioners. A joint committee are negotiating with Stockport Electricity Committee for the construction of a joint electric tramway from Gee Cross.

Buenos Ayres Electric Tramways Co.—The Buenos Ayres Electric Tramways Company, Limited, has been formed to take over the concession for a system of electric tramways granted to Mr. Charles Bright by the municipality of Buenos Ayres in August, 1898. The Company has a share capital of £350,000, divided into equal proportions of 6 per cent. cumulative preference and ordinary shares of £5 each, of which the preference are now offered for subscription, together with an issue of £175,000 5 per cent. first mortgage debentures, repayable at £105 in 1935, or before that date on six months' notice. The purchase price has been fixed at £525,000, £58,330 in debentures, £58,330 in preference shares, and the whole of the ordinary shares are payable to the vendor upon transfer of the concession, and for the balance the contractor undertakes to construct the tramway, to provide the Company with a working capital of £22,000, and to equip the lines electrically within two years.

LIGHTING AND GENERAL.

Leyton.—The total connections at present amount to 2,200 8-c.p. lamps.

Dover Electricity Supply Co.—The directors recommend a dividend of 3 per cent.

Doncaster.—We learn that the Corporation will be prepared to supply the electric current on April 2.

Wolverhampton.—The Corporation have applied for sanction to borrow £11,000 for electric lighting purposes.

St. Annes.—The Urban District Council have decided to apply for a loan of £18,161 for electric lighting purposes.

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Sudbury.—The Town Council have decided to apply for a loan of £650 for electric lighting works on the Went's Estate.

Brierley Hill.—The draft order for electric lighting by the District Council has been approved by the Board of Trade.

Harrow.—The Urban District Council have expressed themselves in favour of the North Metropolitan Electricity Supply Bill.

Whitby.—An enquiry is to be held to-day into the borrowing by the Town Council of £26,000 for electric lighting purposes.

Maidenhead.—The question of the introduction of electric lighting into the town is being favourably considered by the Town Council.

Friern Barnet.—The Urban District Council have decided to take steps to obtain a provisional order to light the district with electricity.

Removal.—We are informed that Mr. A. P. Lundberg is removing from Bradbury-street, N., to larger premises at 477-487, Liverpool-road, N.

Leicester.—The profit on the Corporation's electric light undertaking for the half-year just passed is £1,089, or a total profit for the year of £1,426.

Worcester.—From the report of the Electricity Committee of the City Council it appears that the installation is now becoming to some extent a paying concern.

National Telephone Co.—Letters of allotment for the issue of 100,000 ordinary shares of £5 each and the £500,000 4 per cent. debenture stock have been posted.

Fife.—At the monthly meeting of the Lunacy Board the proposed electric lighting of their institution at Springfield was remitted to a committee for report.

St. Annes-on-the-Sea.—The Prism Globe Company, Limited, have obtained the contract for the globes and incandescent fixtures for the street-lighting of this town.

Bury St. Edmunds.—The electrical engineer, Mr. Roe, reports that the electricity works should be in a position to generate electricity by the end of this month.

Leyton.—At the last meeting of the Urban District Council the Engineer reported that the equivalent of about 2,200 8-c.p. lamps were connected to the temporary plant.

Sutton Coldfield.—Application is to be made for £26,000 to carry out Mr. Hawtayne's electric supply scheme. The entire scheme, with extensions, is estimated at £36,000.

Hammersmith.—The Vestry have received an intimation from the London County Council that they are prepared to advance them a loan of £44,100 for electric lighting purposes.

Barnsley.—At the meeting of the Town Council on Tuesday the Chairman of the Parks Lighting Committee stated that they soon hoped to be able to reduce the price for electricity.

The Hebrides.—The Post Office authorities have informed the Inverness County Council that they cannot see their way to lay the additional cable asked for between Lochmaddy and Skye.

Telegraph Manufacturing Co.—The transfer-books of the preference shares will be closed from 17th to 31st inst., both inclusive, for payment of the dividend for the half-year ended 31st inst.

Ilfracombe.—The Town Council, not wishing to part with their provisional order for electrically lighting the town to a private company, have decided to deal with the matter themselves at a later period.

London.—The London County Council have decided to formally disapprove of the intention of the City of London Electric Lighting Company to lay mains across certain streets in Southwark as far as London Bridge.

Crewe.—Colonel Langton Coke, of the Local Government Board, held an enquiry on Tuesday into an application by the Corporation to borrow £10,000 for lighting side streets by electricity. There was no opposition.

Kirkella.—An application of the National Telephone Company for permission to erect 38 posts on the highway from Kirkella to Raywell has been granted subject to the usual conditions by the Sculcoates Rural District Council yesterday.

Sheffield.—The Electric Light Committee of the Corporation has resolved that in order to furnish a supply of electric energy in the Attercliffe district, an extension of the electric light supply mains is to be carried out from a point in the Wicker to Attercliffe Common.

County of London and Brush Provincial Electric Lighting Co. The directors of this Company recommend a dividend on the ordinary shares for 1899 at the rate of 4 per cent. per annum, after adding £10,500 to reserve for depreciation, repairs, and renewals, and carrying forward about £12,000.

Morecambe.—The Electric Light Committee of the Urban District Council have decided to adopt water-tube boilers. At a special meeting of the committee it was decided to communicate with the Local Government Board with respect to sanction to a loan for electric lighting purposes.

Acton.—In reply to a letter from the Aberystwyth and Chiswick Electric Supply Corporation, asking if the District Council would object to their supplying electric current on the side of Woodstock-road, the Council have decided to favour the application if they receive applications from tenants in the road.

Paisley.—Arrangements have been made to enable telegrams of subscribers to the National Telephone Company's exchange at Paisley to be transmitted to and from the Glasgow head post office by means of the trunk telephone circuits and the company's exchange system when the local post office is closed.

Direct Spanish Telegraph Co.—The directors of this Company have declared, in addition to the dividend of 10 per cent. per annum on the preference shares, a dividend at the rate of 4 per cent. on the ordinary shares for the half-year ended Dec. 31.

Commercial Cable Co.—The accounts of this Company for the year 1899 show that after paying dividends amounting to 8 per cent., placing 150,000dol. to reserve for insurance of stations, apparatus, and repair steamer, and transferring 350,000dol. to the reserve fund, there remains a balance of 228,063dol. to be carried forward.

London Gazette.—A first and final dividend of 5s. 9½d. per pound has been declared *re* A. Blackburn and J. Walker, trading as Blackburn, Walker, and Co., Upper-lane Mills, Cleckheaton, Yorkshire. Mr. R. J. Ward, 17, North-street, Brighton, has been appointed trustee in the estate of B. Symmons, 2, North-street-quadrant, Brighton.

Derby.—The Town Council have decided to purchase a 100-h.p. surface condenser at the contract price of £705, and to apply to the Local Government Board for permission to borrow the money. The Town Council have passed the report of the Technical Instruction Committee which proposes to spend £800 on apparatus for teaching electricity, physics, etc.

Carlisle.—The Electric Lighting Committee of the Town Council have decided to become members of the Municipal Electrical Association. The engineer has reported to the committee that he has arranged with Prof. Kennedy for the machinery supplied to the original specifications being taken over as from the beginning of May, 1899.

Eastbourne.—With the meeting held on Monday afternoon at the Clifton Hotel the Eastbourne Electric Lighting Company practically came to an end. A sum of £3,000 is to be distributed as compensation to the engineer (Mr. Wilkinson), and the secretary and accountant (Mr. Towner). The former is to receive two-thirds of the amount, and the latter one-third.

Barnard Castle.—The Urban District Council have come to an understanding concerning the draft agreement for the proposed electric undertaking, and have passed a resolution to the effect that 30 years be the terms of purchase under the Act of 1888, with 15 per cent. on the capital expenditure. The terms for public lighting are to be formulated in a separate agreement.

Perth.—The Police Commissioners have resolved to make application to the Secretary for Scotland for permission to borrow £50,000 for electric lighting and £50,000 for the gas undertaking. An application to the Dean of Guild Court for permission to erect an electric light station on a portion of the town property has been granted, and the work will proceed immediately.

Ayr.—A report prepared by the Corporation electrical engineer, Mr. A. J. Fuller, as to the consumption of the electric light in Ayr shows that the units consumed during the winter have been 188,000, as against 140,000 during the winter of 1898-99. The Corporation have agreed that for street lighting by incandescent lamps the charge should be £2. 10s. per annum for 32-c.p. lamps instead of £2. 10s. per annum for 16-c.p. lamps as hitherto.

Browett, Lindley, and Co.—We are asked to state that as some misunderstanding has arisen with reference to the notice which has been issued for creditors to send in their claims to the liquidator, such notice applies only to the creditors of the old company (incorporated in 1890), which is being wound up for the purpose of reconstruction only, and which has already paid off its known debts in full and has returned its shareholders their full capital, together with a premium. It does not refer to the new company of the same name (incorporated in 1899).

Trowbridge.—Mr. F. E. G. Bradshaw, surveyor, has reported to the Urban District Council on the provision of electric lighting in the district. He gave various reasons why the municipality should undertake the lighting, and stated that he thought a suitable site adjacent to the river could be secured. A station laid down to supply 4,000 lamps of 8 c.p. would cost from £10,000 to £11,000. He suggests that in the event of the Council deciding to apply for a provisional order, a deputation should be appointed to visit some well-known works and obtain first-hand particulars.

Shoreditch.—At the last meeting of the Guardians, Messrs. Kincaid, Waller, and Manville's scheme for the electric lighting of the cottage homes, and also a scheme submitted by Mr. W. P. Adams, Queen Victoria-street, was discussed. Since the possibility of advantages to be gained by lighting the homes by electricity was first thought of by the Board the cost of an installation has very materially increased, in common with all works of a similar nature, and at the present time the prices which rule are abnormally high. Desirable as the introduction of electricity may be from many points of view, it was considered that the present time was inopportune, and no further steps are to be taken with the scheme.

Brighton.—The balance-sheet of the Corporation electricity works for 1899 shows that 3,815,743 units of electricity were generated during the year, of which 2,604,039 were consumed in private use, 602,584 on the public lamps, 160 630 in the works, and 448 470 not accounted for. There are 257 public arc lamps and 1,027 incandescent. The cost of generating the electricity was £17,269. 11s. 9d., and of distribution £11,745. 14s. 6d. Sales to the public realised £35,321. 3s., while the charge against public lamps was £8,546. 16s. 11d. The actual profit on the year was £16,700. We understand that it is proposed to rearrange the lighting of the Brighton Dome, and the new scheme provides for a large centre chandelier, to be fitted with about 150 8-c.p. lamps.

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Stock Exchange.—The Stock Exchange Committee has appointed Wednesday, March 21, as a special settling day for the Brush Electrical Engineering Company's issue of £108 710 4½ per cent. perpetual second debenture stock and for the Electric Lighting and Traction Company of Australia's issue of 20,000 6 per cent. cumulative preference shares of £5 each, £4 paid, Nos. 1 to 20,000. The committee has further been asked to allow the following securities to be quoted in the official list—viz.: the Blackpool and Fleetwood Tramroad Company's further issue of 3,000 shares of £10 each, fully paid; the Brush Electrical Engineering Company's issue of £108,710 4½ per cent. perpetual second debenture stock; and W. T. Henley's Telegraph Works Company's further issue of 18,000 4½ per cent. preference shares of £5 each.

Lighthouse Communication.—A meeting of the committee appointed to consider the question of the extension of the system of electrical communication with lighthouses and light-vessels, and the possibility of using such communication for the transmission of private messages, was held on Wednesday at the Board of Trade. There were present: Sir Courtenay Boyle, K.C.B. (chairman); Captain H.S.H. Prince Louis of Battenburg, R.N., G.C.B.; Mr. G. E. Y. Gleadowe, C.M.G.; Mr. J. C. Lamb, C.B., C.M.G.; Rear-Admiral H. B. Stewart; Captain the Hon F. C. P. Vereker, R.N., and Mr. E. G. Moggridge (secretary). Mr. C. McArthur, M.P., Colonel Hozier, C.B., and Mr. A. L. Jones attended on the invitation of the committee, and stated their views on the question of the employment of the system of electrical communication with lighthouses.

Tunbridge Wells.—At last week's meeting of the Town Council the Telephone Committee reported that they found it necessary that there should be inserted in the proposed license from the Postmaster-General both maxima and minima rates of charges, and they recommended the Council to suggest rates for insertion in the proposed license as follows: Maximum annual rental, £10; minimum, £5. 17s. Maximum toll rate with ½d. call, £4; minimum, £3. 10s. Maximum toll rate with 1d. call, £3; minimum, £2. 10s. Toll rate (maximum) for each call, 1d.; minimum, ½d. Public telephone rate per call, maximum, 2d.; minimum, ½d. The tariff which the committee propose to charge is the above minimum, but experience may show that it is possible to work at lower rates, and the Corporation might then with the sanction of the Postmaster-General give the subscribers the benefit thereof. The report was adopted.

Appointments Vacant.—The Electric Light Committee of the Sheffield Corporation invite applications for the post of engineer of their electric light and power undertaking at a commencing salary of £500 per annum.—The Corporation of Glasgow are prepared to consider applications for the post of assistant manager to the Corporation telephone exchange.—The Hanley Council require the services of an assistant electrical engineer to take charge of an eight-hour shift.—The Mexborough Urban District Council invite applications for the appointment of consulting electrical engineer, who will have to advise as to the best system of public and private lighting for the district, and prepare the plans, etc., for and carry out to completion the necessary works in connection with the system selected.—An accumulator paster and lead burner is wanted; also draughtsmen, jointers, etc. Particulars of above vacancies will be found in our advertisement columns.

Gloucester.—The great chimney stack at the Gloucester electricity works has now reached completion, and on Wednesday an interesting ceremony took place, several members of the Corporation and other favoured individuals being elevated to the summit. The chimney, which is 150ft. high from the ground level—about 75ft. less than the Cathedral tower—weighs 681 tons, and contains 102 tons of stone, whilst 227,300 bricks were used in its building. Three hundred cubic yards of concrete form the base of the foundation, which goes down 16½ft. The stack is unusually thick in proportion to its height. At the base it is 15ft. square, and at a height of 35ft. assumes a hexagonal shape, with a taper of 1 in 48. There are two ribbon lightning conductors, which connect with four terminals at the summit, the other ends being carried to earth at a distance from the base. The whole structure is of the finest workmanship, and has been erected by Messrs. John Gurney, Gloucester.

Telegram Censorship.—The Postmaster-General has informed the Association of Chambers of Commerce that "the Government have decided to relax the censorship on telegrams at Aden to the extent that telegrams to or from Zanzibar, Seychelles, Mauritius, Madagascar, British East Africa, German East Africa, Mozambique, and Lourenço Marques relating to commercial or private affairs may be sent in code language at the sender's risk, on condition that copies of the code used, with translations of the code words, are previously deposited with the authorities at Aden. Two independent codes will be accepted in respect of each country, and it will be necessary for the mercantile community of this country, if they desire to avail themselves of the concession, to agree as to the codes which should be selected for the United Kingdom, and to furnish a translation of the codes in English. The Postmaster-General states that he will be glad if the association will consult the Chambers of Commerce on the subject and favour him with an early reply."

Londonderry.—Mr. Macrory's report on the electric lighting has been adopted. The total expenditure, including extensions, amounts to £42,466. The Thomson-Houston Company will be asked to submit in writing the modifications of their offer suggested by them. Notice of the following motion has been given: "That we approve of the report of Sir William H. Preece on the private lighting of the city by electricity, and recommend to Council to carry out the scheme as proposed by Mr. John Christie; and also to lay the additional cables suggested by Sir William in paragraph 73 of his report, at an additional cost of £6,000, the laying of which will bring a very large portion of the city within easy reach of light and power; and also to carry out the further extensions to-day reported on by Mr. Macrory to Shipyard, Nazareth House, Bayer's shirt factory, and Waterside; and we further recommend that application be made to have a loan sanctioned, and that Mr. John Christie be appointed on terms in his letter of May 22 last to carry out the works."

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Walthamstow. — The Corporation invite tenders for cables. Tenders by 23rd inst.

Birkenhead.—The Corporation invite tenders for overhead line equipment. Tenders by 20th inst.

Barrow-in-Furness. — The Corporation invite tenders for boilers, condensers, etc. Tenders by 19th inst.

Bucharest.—The Post and Telegraph Department require tenders for a quantity of iron wire. Tenders by 24th inst.

Bucharest.—The Post and Telegraph Department require tenders for a quantity of copper wire. Tenders by 23rd inst.

Wasmes (Belgium).—The Municipality are open to receive tenders for the electric lighting of the district. Tenders by May 31.

Leeds.—The Tramways Committee invite tenders for one, two, or three steam dynamos. Tenders by March 21. Details in our advertisement columns.

Keighley.—The Corporation invite tenders for wiring the new municipal offices now in course of erection. Tenders by March 31. Details in our advertisement columns.

Maidstone.—The Corporation invite tenders for the supply and erection of steam and water pipes and valves. Tenders by April 3. Details in our advertisement columns.

Swansea.—The Corporation invite tenders for the supply and laying of insulated electric mains, conduits, junction boxes, etc. Tenders by 19th inst. Details in our advertisement columns.

Plymouth.—Tenders are invited for 12 months' supply of alternating-current meters, alternating-current transformers, and arc lamp carbons. Tenders by 22nd inst. Details in our advertisement columns.

Doncaster.—The Corporation invite tenders for lighting the corn exchange by electricity. Specification may be obtained at the office of the Resident Electrical Engineer, 3, Priory-place. Tenders by 28th inst.

Dundee.—The Town Council invite tenders for the supply and delivery of feeder mains, joint-boxes, and underground conduits for tramway purposes. Tenders by 21st inst. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of I.R. covered cables, W.I. and C.I. piping, box frames, and covers, stoneware casings. Tenders by March 30. Particulars in our advertisement columns.

Southampton.—The Harbour Board invite tenders for supplying and fixing a motor-transformer, with accessories, upon the Board's premises, Town Quay, Southampton. Tenders by April 7. Details in our advertisement columns.

Mexborough.—Tenders are to be obtained shortly by the Urban District Council for a dust destructor, which is to be utilised for the purpose of creating heat and providing power for the proposed electric lighting installation for the town.

St. Annes-on-the-Sea.—The Urban District Council invite offers from firms willing to undertake a contract for free wiring in the district. Tenders by March 23. Particulars in our advertisement columns. The chairman of the Electricity Committee and the engineer have been empowered to accept tenders for batteries.

Campo de Criptana.—Installation and working for 20 years of public and private electric lighting. Applications to be made to the Municipality of Campo de Criptana (province of Ciudad Real, Spain), or to the L.G.B.—*i.e.*, the Ministerio de Gobernacion, in Madrid, where specifications may be obtained. Open till March 26.

Manchester.—The Tramways Committee of the Corporation invite tenders for the execution of general builder's work at the intended electric car shed, Queen's-road, Cheetham. Particulars may be ascertained from Mr. J. M. McElroy, general manager, Tramways Department, Town Hall, Manchester. Tenders by 26th inst.

Fulham.—The Vestry invite tenders for the supply, as and when required, of 100 five-ampere meters, 100 10-ampere meters, and 50 20-ampere meters. The meters must be capable of working on an alternating-current circuit having a frequency of 50 periods per second and a pressure of 200 volts. Tenders by 19th inst. Details in our advertisement columns.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and erection of the following: boilers and accessories—viz, six Lancashire and four water-tube boilers and two economisers; polyphase generators—viz., two 1,000-kw. and two 500-kw. low-speed generators. Tenders by April 26. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for the wiring and fitting up for electric light the new fish market in the Hayes,

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Cardiff. Plans may be seen and specifications and particulars obtained at the office of the Electrical Engineer, Eldon road, Cardiff, after the 15th inst., on deposit of £1. 1s., which will be returned upon the receipt of a bona fide tender. Tenders by April 3.

Lancaster.—The Committee of Visitors of the County Asylum, Rainhill, invite tenders for the supply and erection of three Lancashire boilers and superheaters and one Green's economiser; three 175-b.h.p. steam dynamos, with booster, switchboard, feed pumps, piping, tanks, cranes, and other accessories; secondary battery (1,200 ampere-hours capacity) and accessories; feeder mains (solid system); and wiring of buildings. Tenders by March 22. Details in our advertisement columns.

Rainhill (Lancs.).—The Committee of Visitors of the County Asylum, Rainhill, invite tenders for the supply and erection of (1) three Lancashire boilers and superheaters and one Green's economiser; (2) three 175-b.h.p. steam dynamos, with booster, switchboard, feed pumps, piping, tanks, cranes, and other accessories; (3) secondary battery (1,200 ampere-hours capacity) and accessories; (4) feeder mains (solid system); (5) wiring of buildings. Plans, etc., may be obtained from Mr. Thomas L. Miller, M.I C.E., 7, Tower-buildings, Water-street, Liverpool. Tenders by 12 noon on March 22.

Dartford.—The Urban District Council invite tenders for the supply and erection of the following plant: Lancashire boilers, with fittings, economiser, feed pumps, etc., pipework. etc., in engine and boiler house, surface-condensing plant, two steam dynamos (vertical enclosed high-speed engines) and motor boosters, storage batteries, main switchboard and connections, six-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed type) and posts, station lighting. Tenders by 27th inst. Details in our advertisement columns.

Stockport.—The Corporation invite tenders for an electrical installation to the following buildings: Contract No. 1—public baths St. Petersgate, Stockport. Tenders for No. 1 contract to be endorsed and addressed to Mr. Councillor Wood, Gas Office, Stockport. Contract No. 2—the free library, market hall, waterworks offices, and sewage works. Tenders for No. 2 contract to be addressed to the Mayor of Stockport, Gas Office, Stockport. Tenders by 12 noon on 22nd inst. Specification and details of the work required may be obtained from Mr. Meunier, Gas Office, Stockport, on payment of 10s. 6d., which will be returned on the receipt of a bona fide tender.

RESULTS OF TENDERS.

Leyton.—The Urban District Council have accepted the tender of Mr. Bertram Thomas, of Manchester, for a switchboard, at £848.

Burton-on-Trent.—The tender of Messrs. Gardner Bros., of Burton, for electrical installation at the farm, at £554. 11s., has been accepted.

Keighley.—The contract for the dynamos has been let to Messrs. Parker, Limited, of Wolverhampton, and that for the engines to Messrs. W. H. Allen, Son, and Co, of Bedford.

Salford.—The tender of Messrs. Edward Wood and Co., Limited, Salford, at £11,870, has been accepted for the iron and steel work required in the erection and completion of the Strawberry-road electricity generating station.

Stoke.—The Guardians have accepted the following tenders: Lancashire Dynamo and Motor Company, of Manchester, for the installation of the electric light at the workhouse, £1,600; Mr. G. Margetts, of Manchester, for the wiring and accumulators, £1,126.

Bangor.—The following tenders have been accepted: Messrs. Hamilton and Sons, to construct the inclined roadway to the refuse destructor, at £695; Messrs. Meldrum Bros., Atlantic Works, Manchester, to construct the destructor cells and tipping floor, at £2 420.

St. Annes-on-the-Sea. — The following tenders have been accepted: Messrs. McCulloch, 100 lamp-posts; Prism Globe Company, 100 lamp fittings; Reason Manufacturing Company, 100 switches with sockets; Messrs. Venner and Co., electrical fittings at schedule rates; and Reason and Co., ditto, at schedule rates.

Bath.—The Corporation have received the following tenders for the supply, etc., of cables (high and low tension), arc lamps, posts, and accessories, transformers, sub-station switchboards, and main works switchboards: Callender's Cable and Construction Company, 90, Cannon-street, London, E.C., cables, £7,357. 8s.; W. Lucy and Co., Limited, Eagle Ironworks, Oxford, arc lamps, posts, and accessories, British Thomson-Houston lamps, £2,991; British Electric Transformer and Manufacturing Company, Limited, Globe Works, Woodfield-road London, W., transformers, £458. 8s.; Cowan's, Limited, Salford, Manchester, sub-station switchboards, £236; British Westinghouse Electric and Manufacturing Company, Limited, Westinghouse-buildings, Norfolk-street, Strand, London, W.C., main works switchboard, £1,918. 18s.

COMPANIES' MEETINGS AND REPORTS.

SOUTH LONDON ELECTRIC SUPPLY.

The annual general meeting of the above Company was held at Winchester House yesterday, Mr. George Ellis taking the chair.

After the Secretary had read the notice calling the meeting, the **Chairman** with a few remarks proposed the adoption of the report for the year ending Dec. 31, 1899, which was seconded and carried with practically no discussion.

Mr. Algernon Turner, C.B., then proposed the re-election of Mr. Bennett Fitch as director. He said he knew that another gentleman was to be proposed in Mr. Fitch's place and wished to express his opinion of the valuable services which Mr. Fitch had rendered to the Company. Mr. Fitch was a practical engineer, and his experience as a director of the St. James's and Pall Mall Company had been most valuable to the Board when discussing the many points which had arisen during the construction of their works.

A **Shareholder** seconded the proposal to re-relect Mr. Bennett Fitch.

Mr. J. B. Atherton proposed that Mr. F. G. Leslie be elected a director of the Company. His proposal was not due to any personal feeling against Mr. Fitch. He and other large shareholders felt that the affairs of the Company had not prospered in the way they should have done, and they wished to get new men on the Board.

Mr. Pearson seconded the proposal, and also disclaimed any personal feeling against the retiring directors. He thought that the present Board had been slow in developing the business of the Company, and that more business experience was wanted. He also hinted that the chairman, living 90 miles away from the works, could not give the attention to the business which was needed.

Mr. Bennett Fitch said he believed the works of the Company had been erected as quickly as was possible, and that everything that could be done had been done. He would point out that the gentleman proposed by Mr. Atherton lived in Liverpool, and hence was open to more objection on the grounds of residence than the chairman. He read a letter he had received, which explained that at first it was proposed to oppose the re-election of Captain E. Ironside Bax also, but that the opposition now proposed to elect an additional director instead.

On the amendment being put, 15 voted for it and 20 against it, and Mr. Atherton demanded a poll.

It was then proposed and seconded that Captain E. Ironside Bax be re-elected as a director.

This was carried unanimously.

Mr. Atherton then proposed that Mr. Jacob Atherton be elected an additional director of the Company. He referred to the good business capabilities of his brother, and said that the shareholders who he represented were not satisfied with the progress which had been made by the Company.

Mr. Pearson seconded, but the proposal was negatived by 18 to 17. On a show of hands a poll was demanded. The auditors were then re-elected.

On a poll being taken, shareholders holding 22,874 voted for Mr. F. G. Leslie and shareholders having 11,034 shares for Mr. Fitch. Mr. F. G. Leslie was accordingly declared elected.

Mr. Jacob Atherton was elected an additional director by 23,924 shares as against three.

METROPOLITAN ELECTRIC SUPPLY.

The thirteenth ordinary general meeting of the shareholders of this Company was held at Winchester House on Tuesday last, Mr. W. H. Cripps presiding.

The **Chairman**, in moving the adoption of the report, said that the capital expended by the Company up to the end of 1898 was £993,000, and the amount expended up to the end of the year just passed was £1,244,000, showing an expenditure during the year of just over a quarter of a million. The capital had been expended chiefly under two items—first, the expenditure at Willesden on the new station; and, secondly, in putting down their new low-pressure mains. The former had necessitated an expenditure of £141,000, and the latter of £110,000. Looking to the account on the credit side, they would see that the total amount received during the year was £231,000. Of this, £106,000 represented the balance of the shares issued to the founders in exchange for their shares of the previous summer, and the remaining £125,000 was attributable to the issue of half the new debentures. They would require a further capital, and it was proposed to issue, to meet their immediate wants, the remaining half of the debentures—£125,000. As regarded revenue, the units sold in 1898 were 6,800,000, and in the past year 8,300,000, an increase of one and a half million in the units sold. The revenue, which in 1898 was £146,000, had risen during the year to £173,000, or an increase of £27,000. They spent £111,000 in 1898, as against £125,000 in the past year, being an increase of £14,000. Of that latter amount no less than £10,000 was an increase in the cost of coal. They had to use more coal for the production of a great amount of electricity, and the price was higher. The chief reason of their large expenditure of coal was the difficulty under which they were working during the year, when they had the greatest trouble in keeping up the supply. A depreciation was put at £13,000. Deducting the increase in expenses from the increase in gross revenue there remained, after deducting the amount for depreciation, a balance of £53,392 to be carried to revenue account. This exceeded the amount last year by £12,000. The £52,000, with a balance brought forward from last account, and other receipts, made a total of £57,728. After deducting debenture and share interest and other charges, a balance of £25,560 remained available for dividend. It was proposed that they should declare a dividend of 5 per cent. per annum for the second half of the year, which would give them £4,400 to carry over, being £3,000 more than they carried over the previous year. It was with satisfaction that he was able to state

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that the Willesden works had proved themselves satisfactory. The present capacity of these works was 4,500 kw., or about 7,500 h.p. They had already made arrangements to increase the output, and by the end of the year would be able to rely upon a capacity of 6,000 kw. With regard to the Central Electric Company, who had obtained powers for erecting a generating station in the Marylebone area, they obtained a clause limiting their powers of supply to the districts of the Westminster and the St. James's and Pall Mall Companies. Considering the difficulties under which they had been working last year, and that they had spent £200,000 at Willesden, which until Dec. 15 last year did not earn a penny, it was not unsatisfactory that they had been able to maintain their dividend.

The report was then adopted.

GATESHEAD AND DISTRICT TRAMWAY.

The report and balance-sheet presented to the eighteenth annual meeting on Wednesday of the Gateshead and District Tramways Company states that the receipts from passengers, etc., show a decrease of £315. 2s. 11d. over those of the preceding year, and at the same time there is an increase in the expenditure of £219. 9s. 2d. The directors anticipate that it will shortly be possible to make a start with the work of reconstruction and it will be pushed on with all possible speed. The net profit for the year amounts to £3,093. 7s. 7d., and, adding the balance from last account, £2,004. 3s., the total divisible profits amount to £5,097. 10s. 7d. Out of this sum there was paid a dividend of 5s. per share in October last, £1,993 and the interest on mortgages, £810, leaving a net balance available of £2,294 10s. 7d. The directors propose to apply this amount as follows: in payment of a dividend at the rate of 4s. 6d. per share, free of income tax, £1,793. 10s. 4d.; carrying forward to next account, £501. 0s. 3d.

Mr. C. R. Greene (chairman), who presided, in moving the adoption of the annual report of the directors, said, like other public companies, the Company had suffered from increased expenses which were quite unavoidable. The net result, however, was, he thought, quite satisfactory.

Mr. Emile Garcke, in seconding, said all the preliminary arrangements with a view to the adoption of electrical traction had been practically completed. The directors had succeeded in making satisfactory arrangements for providing the finances for carrying out that important work, which would involve the expenditure of something like £200,000 of additional capital; and that they were on the point of placing contracts for the reconstruction of the permanent way, and for the provision of new cars and the electrical equipment. The work, they believed and hoped, would be started almost immediately. The light railway order which the Company applied for last year for further extensions was approved by the Light Railway Commissioners, but was still awaiting confirmation by the Board of Trade.

The report was adopted.

On the motion of the **Chairman**, seconded by **Mr. W. H. Parkinson**, a dividend at the rate of 4s. 6d. per share, less income tax, was declared.

Mr. W. H. Parkinson was re-elected a director, and Mr. Thos. Wallace was re-elected auditor.

ALLIANCE ELECTRICAL.

The ordinary general meeting of this Company was held at Winchester House this week, Mr. George Verity presiding.

The **Chairman** said that since the report of the directors and the accounts were prepared, the attention of the directors had been called to the possibility of legal difficulties arising if the whole profits of the business from Feb. 1, 1899, to Feb. 1 last were treated as profits available for dividends. According to the agreement for the purchase and sale it was stipulated by Verity's, Limited, the vendors, that the sale should take effect as a going concern, and that consequently all profits from Feb. 1, 1899, should be available for dividend on shares in this Company, and the accounts of the Company had been made up on that basis. As he pointed out, however, it was doubtful if this could be done. The real sufferers were the holders of the ordinary shares—the vendors—because the only effect on the whole of the preference shares was to keep undistributed and in the hands of the Company available for its business a considerably larger sum than the Company would have retained had this scheme of the report and the balance-sheet been carried out. In other words, instead of the ordinary holders getting a dividend at the rate of 10 per cent. from Feb. 1, 1899, they could only get a dividend at that rate from the end of July, 1899, while for the other period up to that date they had agreed to be content with interest on the purchase money at the rate of 5 per cent., the end of July being taken as if that were the actual date on which the purchase was completed. Summed up, therefore, the net result was that, instead of paying 10 per cent. on the ordinary shares for the period between Feb. 1, 1899, and the end of July, 1899, they paid interest at the rate of 5 per cent., and the Company retained the difference. The alterations involved in the balance-sheet were as follows: Instead of the item of the interim dividend at the rate of 10 per cent. on the ordinary shares, amounting to £2,500, the item would appear as interest at 5 per cent. per annum for six months—viz., £1,250 on £50,000 ordinary share capital. This would make the amount already deducted as being divided from the net profit, £2,653, and consequently the larger sum of £6,994 remained to be dealt with instead of the item £5,744. The directors proposed to apply the amount not divisible—namely, £2,059—in entirely writing off the preliminary expenses of the Company—namely, £2,017—and the balance of £41 off the patterns account. After providing £100 for the profit-sharing scheme and for the dividend at the rate of 10 per cent. recommended on the ordinary shares, together with the interest on the preference shares, it left a sum of £637 to be carried forward.

The report was seconded by **Mr. J. Elwin-Coles** and adopted.

HOVE ELECTRIC LIGHTING.

The eighth annual general meeting was held last week at the Cannon-street Hotel, E.C., Colonel A. J. Filgate presiding.

The **Chairman**, in moving the adoption of the report, said that the capital expenditure during 1899 amounted to £16,210, increasing the total outlay up to the end of the year to £93,660. Another 250 h.p. steam dynamo had been ordered for delivery in the autumn, and the plant should then be sufficient to meet the demand likely to arise next winter. If, however, the demand continued to increase, the erection of another station must be contemplated. The reduction in price had helped to swell the consumption, and had increased the Company's profits. About 3½ years ago the Company commenced to supply customers with current at 220 volts instead of 110, and they had now more customers at the higher voltage than at the lower. To induce customers to change over to 220 volts, they had agreed to supply all on that voltage from Jan. 1 at 7d. per unit for the first hour instead of 8d. They had found a site in every way suitable for a new station, but before they could erect buildings on it a wayleave for their mains had to be obtained from the Hove Corporation, and permission had not yet been granted. To meet the outlay last year 2 000 new £5 shares were issued at £7. 10s., the premium, amounting to £5 000, being added to the reserve fund. More capital would have to be issued this year, but the directors were not prepared yet to say in what form. The gross revenue last year was £12,070, or £2,590 in excess of that of the previous year, while the working expenses had been only £583 more. The net revenue was £7,097, showing an increase of £2,007. The directors recommended a dividend for the half-year at the rate of 9 per cent. per annum, making with the interim distribution 7½ per cent. for the year, leaving £614 to be carried forward. He afterward referred to the accident to their machinery on the night of Feb. 26, and stated that the supply of electricity throughout the town was fully restored in five minutes.

Colonel H. Wood, C.B., seconded the motion, which was adopted.

OXFORD ELECTRIC.

The ninth ordinary general meeting of the shareholders of the Oxford Electric Company, Limited, was held recently, Sir Henry Mance presiding.

The **Chairman** stated that after writing off £184. 19s. 11d. on account of hire-purchase installations, etc., they had available £3,573, which it was proposed to appropriate as follows: £2,500 in payment of a dividend on the ordinary shares of 5 per cent. per annum, and £1,000 to be added to the reserve and renewal of plant account, which will then amount to £1,750, leaving £73 to be carried forward. More than 3,000 equivalent 8-c.p. lamps had been added to the system during the year. The principal installations that had been made during the year were considerable additions at New College and Exeter College, the East Gate Hotel, the Bell Inn, and at Messrs. Phillips and Sons. Two churches had also been connected. The cost of coal per Board of Trade unit generated, in spite of the increased price, compared favourably with that of the previous year, being ·63d. as compared with ·65d. in 1898. The efficiency of the system had also improved, being 74 per cent., or 2 per cent. higher than the year before. The sales by meter had increased 13 per cent. The additional consumers had been 83, and the total number now on the list was about 500. The revenue of the last quarter of the year was, in round figures, £4,750. They proposed to make a substantial reduction in the price for current. The maximum rate at present was 7d., and it was proposed to reduce that maximum to 6d., which meant a reduction of about 14 per cent., but they proposed also to discontinue the 2½ per cent. discount. He hoped they would be satisfied with their account of their stewardship. They were trying to make electricity as cheap as possible, and the light for the poor as well as the rich.

The report was seconded by **Alderman Buckell** and adopted.

IMPERIAL TRAMWAYS.

The directors, in their report for the year ended Dec. 31 last, state that the operation of the Middlesbrough, Stockton, and Thornaby electric tramways has been conducted with the greatest regularity and smoothness, and is highly appreciated by the populations of the three municipalities, the number of passengers carried in the 12 months being 8,307,322. The gross receipts have amounted to £45,372. 13s. 8d., and the expenditure (including provision for depreciation and renewals) to £30,761. 2s. 3d., leaving a net profit of £14,611. 11s. 5d., representing as nearly as possible 6¾ per cent. upon the capital employed. The light railway extensions proposed to Middlesbrough were favourably entertained by the Commissioners, but arrangements have to be made with the owners of three toll-gates and with reference to the railway crossings on the route, and so far it has been found impossible to arrive at any agreement; meanwhile the progress of the order remains in abeyance.

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NEWMARKET ELECTRIC LIGHT.

The annual meeting of this Company was held on Monday last, Mr. G. H. Verrall presiding.

In moving the adoption of the directors' report and accounts, the **Chairman** said that the authorised capital was £30 000, and it had been decided to issue £15 000 in £10 shares and £15,000 in 5 per cent. debentures. In the nine months ended December last, they had made a profit of £99. 16s. 5d., or £47. 8s. 9d., less interest on debentures issued. They were now supplying over 2,000 8-c.p. lights, and had applications for nearly another 1,000. They were compelled to increase their plant to such an extent that they could double their output.

Mr. F. E. Gripper, a director, said there was every prospect of a substantial dividend being paid next year.

The report was adopted.

UNITED ALKALI.

The report of the directors of this Company for 1899, to be submitted at the meeting to be held at Liverpool to-day, states that there is a net profit of £198,766, which is increased to £228,043 with £29,277 brought forward. An interim dividend on the preference shares at 7s. per share for the first half of the year has been paid, and the directors now recommend a dividend at the same rate, leaving £36,868 to carry forward.

CITY OF LONDON ELECTRIC LIGHTING.

Directors: Sir David L. Salomons, Bart. (chairman); George Herring; Edward Lucas; Colonel B. H. Martindale, C.B.; Frederick W. Reynolds; Philip D. Tuckett.

Abstract of the report of the directors and accounts, presented to the shareholders at the ordinary general meeting held yesterday at Winchester House, Old Broad-street, E.C.:

The expenditure on capital account during the year ended Dec. 31, 1899, amounted to £138 766. 18s. 4d. The total revenue for the year was £187,253. 16s. 7d., from which must be deducted the following items: expenses of generation and distribution, £69,478. 15s. 11d.; rent, rates, taxes, general and special charges, £30,451. 2s. 6d.; transfer to depreciation fund No. 1, £21,000; transfer to reserve fund, £2,349. 10s. 7d.; leaving £63,974. 7s. 7d., to which must be added the balance brought forward from 1898, £3,381. 13s. 6d., making a total available revenue of £67,356. 1s. 1d. Of this sum the following amounts have been distributed: interest on debenture stock for year ended Dec. 31, 1899, £19,333 6s. 8d.; interim dividend on £400,000 6 per cent. preference shares, paid in July last on account of the distribution for the year, £11,600, leaving for further distribution £36,422. 14s. 5d. The directors now recommend that the following dividends for the year ended Dec. 31 1899, be declared, subject to the deduction of income tax, to members registered in the books of the Company on March 1, 1900: preference shares 12s. per share, being a distribution for the year at the full rate of 6 per cent. Of this sum 6s. per share was paid on account in July last, and it is proposed that the balance of 6s. per share be paid on March 16, 1900. Ordinary shares 8s. per share, being a distribution at the rate of 4 per cent. for the year. It is proposed that this dividend be paid on March 16, 1900. This will absorb £34,800, and leave a balance of £1,622. 14s. 5d. to be carried forward. It is proposed that the warrants for the respective dividends shall be posted on March 16, 1900. The generation and distribution expenses for the year, including repairs and renewals, were 49·31 per cent. of the gross earnings, as compared with 36·1 per cent. for 1898, 31·3 per cent. for 1897, 34 per cent. for 1896, 36·87 for 1895, 46 for 1894, and 54·2 for 1893. The increase in the percentage during the past year is due to a largely increased output having been supplied at a greatly reduced rate of charge to the consumer. The number of customers and the equivalent of 8-c.p. lamps connected at Dec. 31, 1899, were 8,378 and 429,628 respectively. On Feb. 21, 1900, there were 465 712 8-c.p. lamps (equivalent) applied for, out of which 444,361 were connected. The units sold for private lighting for the year 1899 were 7,446 703, as compared with 5,837 317 for 1898. The statutory provision for the depreciation and reserve funds, in accordance with the City of London Electric Lighting Act, 1893, has been made, of which £23,349. 10s. 7d. have been set aside out of revenue. The directors are promoting a Bill in Parliament for the compulsory acquisition of certain properties, which interfere with the full development of the site of the Bankside station, and for relieving the Company of the statutory obligations as to the provision of depreciation and reserve funds, imposing in lieu thereof no larger obligations than are imposed on other companies who have to keep their accounts in the form required by the Board of Trade, and for various other necessary matters. The directors have resolved to issue 20,000 ordinary shares of £10 each, being the balance of the additional £400,000 ordinary share capital created by a resolution passed at the general meeting of the Company held on Feb. 24, 1897. This issue of 20,000 ordinary shares will rank for dividend as from Jan. 1, 1900, *pari passu* with the existing ordinary shares, and will be allotted at par *pro rata* to the holders of preference and ordinary shares who were registered in the books of the Company on March 2, 1900, or to their nominees. The approval of the Board of Trade has been received to the Company's system of continuous current, and to the alteration of standard pressure. The additional buildings and plant are rapidly approaching completion, and the alteration of consumers' fittings to adapt them to the higher pressure is being actively proceeded with. The directors regret that this Company's opposition to the applications by other companies for powers to supply electric energy in the Company's area has been unsuccessful. The expenditure in connection therewith, amounting to £3,645. 19s. 9d., the balance of suspense account, £4 260. 14s. 3d., and replacements, etc., £3,647. 14s. 3d., have been written off out of the balance of premiums. In accordance with the articles of association, two of their number, Sir David Lionel Salomons, Bart., and Mr. Philip Debell Tuckett, now retire, and, being eligible, offer themselves for re-election. Messrs. W. H. Pannell and Co. retire, and, being eligible, offer themselves for re-election.

Revenue Account.

Dr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Generation of electricity—		
Coal and other fuel	3,857 13 3	40,169 15 10
Oil, waste, and stores	456 9 6	2,151 2 3
Water	176 18 2	1,746 3 0
Salaries of engineers	630 0 0	2 362 0 0
Wages and gratuities	1,584 2 7	8 323 8 10
Sundry expenditure	431 12 3	700 15 3
Total generation expenses	£7 136 15 9	£55,453 5 2
Distribution of electricity—		
Proportion of salaries of engineer and assistants	499 0 0	940 1 8
Attending mains and street boxes	253 4 1	1,103 9 4
Wages and gratuities to linesmen, fitters, and trimmers of lamps	1 351 2 9	292 4 3
Wages and gratuities to transformer men and sundry stores	—	1,381 15 6
Carbons and other materials	682 11 9	119 15 8
Sundry expenditure	132 15 0	132 15 0
Total generation and distribution expenses	£10,055 9 4	£59 423 6 7
Rents, rates, and taxes—		
Rents payable	699 18 7	4 899 9 11
Rates, taxes, and lighting	1 208 12 2	8 460 5 4
Management expenses—		
Directors' remuneration and salaries	982 19 7	6 880 17 6
Printing and stationery	113 6 5	793 5 4
General establishment charges	130 10 2	913 11 2
Meter reading	—	216 1 5
Auditors' fees	17 8 1	121 16 11
Trustees' fees	13 2 6	91 17 6
Legal charges	124 14 2	872 19 1
Special charges—		
Collection charges and various fines	173 1 3	739 11 5
Bad debts	—	673 0 2
Official testing of meters	—	8 10 0
Insurances	155 3 5	1,551 14 6
Claims for accidents, etc.	—	24 17 0
Professional charges	—	230 8 0
Repairs to properties sublet	—	354 0 11
Total expenditure	£13,674 5 8	£86 255 12 9
Total of both public and private lighting		£99 929 18 5
Balance carried to net revenue account		85 612 1 8
		£185 542 0 1

Cr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Sale of current	—	160 411 15 9
Revenue under contracts	13,088 9 0	—
Meter rentals	—	6 169 6 10
Rents receivable	386 12 8	4 639 12 1
Transfer fees	12 9 6	149 13 6
Rental of fittings, testing fees, and sundry receipts	—	684 0 9
	£13,487 11 2	£172 054 8 11
Total income		£185 542 0 1

General Balance Sheet

Dr. Liabilities, etc.	£ s. d.
Capital account—amount received	1,400.000 0 0
Due from sundry tradesmen and others	37 326 6 3
Sundry creditors on open accounts	3 285 0 6
Loans from bankers	90,000 0 0
Sundry deposits from consumers	384 9 4
Depreciation reserve funds	125,283 7 6
Balance of premiums on issues as per last balance-sheet, £77,507. 6s. 3d., less transfers, £15 636. 8s. 3d.	61,870 18 0
Balance at credit of net revenue account, £48,022. 14s. 5d., less dividend paid, £11 600	36,422 14 5
	£1 754,572 16 0

Cr. Capital Expenditure and Assets.	£ s. d.
Capital expenditure	1,513.456 0 10
Stores at stations and elsewhere	35 591 8 3
Payments on account of contracts not completed	16,040 0 0
Sundry debtors for current supplied	61 955 19 8
Other debtors and payments in advance	3 372 2 2
Cash at bankers and in hand	2 574 13 11
Sundry deposits	2,001 0 8
Investments at cost and dividends accrued thereon	119,581 10 6
	£1,754,572 16 0

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BRUSH ELECTRICAL ENGINEERING.

Directors: J. B. Braithwaite, jun., M.I.E.E. (chairman); Arthur Ayres, M.I.C.E.; John S. Raworth, M.I.C.E.; Aymor H. Sanderson; Colonel Frederick George Steuart; Edward Woods (past-president Institution of Civil Engineers). Consulting engineer: John S. Raworth, M.I.C.E. General manager: R. Percy Sellon, M.I.E.E.

Eleventh report, to be presented to the shareholders at the general meeting of the Company to be held at Cannon-street Hotel, E.C., on 19th inst. at 12 noon:

The profit and loss account shows an available gross profit of £37,233 13s. 3d. After deducting maintenance, general charges, interest on debenture stock, and cost of issuing £75,000 perpetual second debenture stock, there remains a balance of net profit of £19,410. 1s. 7d. The directors recommend that this sum be applied as follows: dividend at the rate of 6 per cent. per annum on preference shares for the half-year, £5,400; dividend at the rate of 6 per cent. per annum on ordinary shares for the half-year, £5,400; bonus payable to employés under profit-sharing scheme, £1,080; depreciation reserve fund, £2,500; balance carried forward, £5,030. 1s. 7d. Capital expenditure to the extent of £23,571. 3s. 11d. has been incurred during the half-year on extension of buildings and plant at Loughborough. The Company's works are well filled with orders for steam-engines, electric lighting and traction machinery, and tramway rollling-stock. An issue of £125,000 4½ per cent. perpetual second debenture stock has been made during the half-year. Of this sum £75,000 was offered to and subscribed for by the public, the balance of £50,000 being reserved to enable holders of the existing redeemable second debenture stock to exchange their holdings for the new stock at par. Holders of redeemable second debenture stock to the amount of £33,710 have exercised this option, and notice has been given to the holders of the remaining £16 290 that they will be paid off at £105 per cent. on July 1 next. The directors regret to announce the death of their colleague, Mr. B. H. van Tromp, during the half-year under review. Mr. J. S. Raworth and Colonel F. G. Steuart are the directors who retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire and offer themselves for re-election.

Dr. BALANCE-SHEET, DEC. 31, 1899.

	£	s.	d.
Authorised capital—			
150,000 6 per cent. preference shares of £2 each.	300,000	0	0
180,000 ordinary shares of £2 each	360,000	0	0
	£660,000	0	0
Capital issued—			
90,000 6 per cent. preference shares of £2 each...	180,000	0	0
90,000 ordinary shares of £2 each	180,000	0	0
	360,000	0	0
4½ per cent. perpetual first debenture stock, secured by debentures	125,000	0	0
4½ per cent. perpetual second debenture stock, part of £125,000 secured by debentures	75,000	0	0
4½ per cent. redeemable second debenture stock, part of £105,000 secured by debentures, £76,770; amount redeemed, £26,770	50,000	0	0
Loans and overdraft from bankers against securities *per contra*	34,166	8	8
Sundry creditors—head office, £48,913. 1s. 3d.; Australian branch at Oct. 31, 1899, £431. 6s. 4d.; bills payable—head office, £5,193. 15s. 8d.; Australian branch at Oct. 31, 1899, £86. 16s. 4d.	54,624	19	7
Depreciation reserve fund	15,000	0	0
Workmen's Compensation Act insurance fund	1,000	0	0
Balance of profit and loss account	19,410	1	7
	£734,201	9	10
Cr. Freehold and leasehold factories at Loughborough and Lambeth, including plant and machinery, as per last account	£ 173,720	s. 12	d. 7
Additions during the half-year	23,571	3	11
	197,291	16	6
Patents and goodwill, as per last account	181,397	8	9
Goods in hand, in process of manufacture, etc., at Loughborough and other places, £129,680. 5s. 9d.; Australian branch at Oct. 31, 1899, £8,081. 0s. 9d.	137,761	6	6
Sundry accounts, less reserve for doubtful debts—head office	122,752	1	1
Australian branch at Oct. 31, 1899	4,678	2	2
Ditto balance of items in transit and invoices rendered, less cash received from Oct. 31 to Dec. 31, 1899	1,407	4	10
Bills receivable—head office	1,093	3	8
Cash at bankers and in hand; head office, £1,092. 3s. 8d.; Australian branch at Oct. 31, 1899, £774. 6s. 5d.	1,866	10	1
Shares and debentures at or below cost price	70,953	16	3
Depreciation reserve fund, invested in consols: Queensland 4 per cent., West Australian 3 per cent., British Columbia 3 per cent., Chinese 6 per cent., American Railroad Gold Bonds, etc.	15,000	0	0
	£734,201	9	10

Dr. PROFIT AND LOSS ACCOUNT.

	£	s.	d.
Directors' fees (exclusive of consulting engineer's fee)	750	0	0
Auditors' fees	145	0	0
Salaries	3,309	7	6
Law charges	77	1	0
Insurance	333	15	9
Actual expenditure incurred under Workmen's Compensation Act	73	14	1
Postage, stationery, and printing	468	3	10
Rent, rates, and taxes	694	7	3
Advertising and London office expenses	821	9	7
Debenture stock, trustees' fees and expenses	149	1	4
	6,822	0	4
Maintenance of buildings and plant	2,703	3	3
Maintenance of patents	160	9	9
Interest on perpetual first debenture stock	2,812	10	0
Interest on perpetual second debenture stock	450	8	4
Interest on redeemable second debenture stock	1,125	0	0
Cost of issuing £75,000 perpetual second debenture stock	3,750	0	0
Balance, profit carried to balance-sheet	19,410	1	7
	£37,233	13	3
Cr.	£	s.	d.
Balance brought forward from last account	5,100	7	3
Gross profit on trading after making reserve for doubtful debts	28,347	17	6
Transfer fees	35	8	6
Premiums received on issue of £75,000 perpetual second debenture stock	3,750	0	0
	£37,233	13	3

LONDON UNITED TRAMWAYS.

Directors: George White, Esq., Bristol (chairman); Edward Everard, Esq., Bristol; Hugh C. Godfray, Esq., London; J. Clifton Robinson, Esq., C.E., London (managing director). Secretary: Samuel White, Esq.

Report of the directors to be submitted to the general meeting of shareholders to be held at the offices of the Company, Clare-street House, Bristol, on March 17, 1900, at 11 a.m.:

The gross receipts for the period amounted to £54,368. 14s. 8d., compared with £47,544. 13s. 3d. for the previous year, an increase of £6,824. 1s. 5d. The net profit amounts to £13,271. 0s. 3d., which also represents a substantial increase of £2,641. 6s. 4d. over that of 1898. It will be observed that additional capital has been expended during the year to the amount of £166,255, the whole of this sum being laid out upon the new works at present unproductive, but the directors have only transferred from the contingencies fund in respect of interest during construction the sum of £5,400, which is equivalent to the dividend upon £90,000 preference capital. These amounts, with the balance brought forward from the last account, give a total net revenue of £18,916. 9s. 2d. to be dealt with. From this sum the directors have replaced £3,000 at the reserve fund for contingencies; debenture interest for the year and the interim dividends paid for the half-year to June absorb £8,325, and it is now proposed to declare final dividends of 6 per cent. per annum on the preference shares and of 10 per cent. per annum on the fully-paid ordinary shares, which together will appropriate £6,700, leaving a balance of £891. 9s. 2d. to be carried forward to the credit of the new account. To meet the capital outlay the remainder of the authorised preference share capital has been issued during the year, and the premiums received have been carried to the contingencies fund. The total reserve funds now amount to £36,190. Very satisfactory progress has been made with the important works incident to the conversion of the system for electric traction and the extension of the tramways. The erection of the central power station has been undertaken by the Company without the intervention of a contractor, and contracts are in a forward state of execution for the steam and electrical equipment of the station and for 150 electric cars, the first instalment of the new rolling-stock. The directors anticipate that the first portion, covering about 10 miles of tramways, will be operated by electric traction during the ensuing summer. The Company's application for light railway extensions intended to bring the districts of Twickenham, Teddington, Hampton and Hampton Wick into connection with the authorised electric system came before the Light Railway Commissioners in June last. The proposals were supported by the whole of the local authorities, but opposed by the London and South-Western Railway Company on the ground of competition, so that, while expressing themselves favourably towards the scheme, the Commissioners had no alternative, in view of the protection afforded the railway company by the Light Railways Act, but to decide that the scheme must be submitted to Parliament. Accordingly, a Tramway Bill is being promoted in the present session to authorise the Hampton Court extensions, and agreements have again been concluded with all the local authorities concerned except the Teddington Council, who, whilst approving the tramways and consenting for Standing Order purposes, seek now to impose conditions of so onerous a character that the directors can confidently rely upon the decision of the Parliamentary Committee. Powers are also sought by the Bill for the authorisation of the connecting line between the existing tramway at Acton and the authorised lines at Hanwell, and agreements have at length been come to with the Ealing Council as well as those of Acton and Hanwell, who supported the Company's application on the former occasion.

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POTTERIES ELECTRIC TRACTION.

The report of the directors of this Company for the period from Nov. 21, 1898, to Dec. 31, 1899, states that the tramways of the North Staffordshire Company, about 6½ miles, were opened for working by electricity on May 16 last, and since then various sections of the extension tramways, about six miles, have been opened for traffic. The construction and equipment of the extension tramways and light railways are being pushed forward as rapidly as possible. The gross profits for the period covered by the account amount to £20 884, including the amounts received from the North Staffordshire Company for dividends and interest on the shares and debentures held by this Company, and in respect of the working agreement. After deducting all expenses chargeable to revenue, there remains a net profit of £10,949. This amount the directors propose should be applied as follows: To provide for dividend on cumulative preference shares from Aug. 15 to Dec. 31, 1899, £3,750; to repayment to British Electric Traction Company of amount advanced for dividend on cumulative preference shares to Aug. 15, 1899, and income tax thereon, £5,833; to depreciation fund, £500; leaving to be carried forward £866. Until a larger proportion of the lines is completed and opened for traffic it will not be possible to work the system with greater economy and efficiency, but the directors consider the results of the electrical working satisfactory and encouraging, having regard to the fact that during the whole period the system has been in a state of transition and incomplete.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER.

Directors: Frederick W. Reynolds (chairman); Aymor H. Sanderson; Francis E. Savory; R. Percy Sellon; the Chevalier Soares. Consulting engineer: C. P. Sparks, M.I.C.E. Engineer: M. C. Flemyng. Secretary: H. B. Renwick.

Report of the directors to be presented to the shareholders at the sixth ordinary general meeting of the Company to be held at the offices of the Company, Moorgate-court, E.C., on March 19, 1900, at 12 noon:

The capital account shows an expenditure during the year of £8,620. 5s. 4d., chiefly upon lands, machinery, and mains, making to Dec. 31 last a total sum of £59,866. 9s. 4d. The balance to credit of the net revenue account, including the balance brought forward, and after payment of interest charges and reserve for depreciation, is £1,522. 8s. 6d. Out of this sum the directors recommend the payment of a dividend on the ordinary shares of the Company at the rate of 4 per cent. for the year, less income tax, which will absorb £1,211. 8s. 6d., leaving a balance of £311 to be carried forward. The equivalent of 14,256 8 c.p. lamps were connected to the Company's mains at Dec. 31 last, showing an increase equivalent to 1,904 8-c.p. lamps connected for the year. The County of London and Brush Provincial Electric Lighting Company's interests in the Company have been taken over by the Bournemouth and Poole Electricity Supply Company, Limited, to whom the Company is now indebted for the amount of its loan account. The sum of £850 received from the County of London and Brush Provincial Electric Lighting Company, Limited, in respect of an option over the unissued share capital of the Company, has been appropriated to writing off the suspense account. A substantial reduction is to be made in the price of current, and in the charges for meter rentals on and after March 31, 1900. Mr. Aymor H. Sanderson and Mr. R. Percy Sellon have been appointed directors of the Company. The retiring directors are Mr. A. H. Sanderson and Mr. R. Percy Sellon, who, being eligible, offer themselves for re-election. The auditor, Mr. R. H. Marsh, also retires, and offers himself for re-election.

Revenue Account.

Dr.	Generation of Electricity.			£	s.	d.
Coal and other fuel	£839	3	7			
Oil, waste, water, etc.	72	5	4			
Engineers' salaries	87	0	0			
Wages	317	19	6			
Stores and works expenses	21	4	7			
Repairs: buildings, £12. 10s. 3d.; engines and boilers, £112. 7s. 3d.; other machinery and tools, £40. 4s. 10d.; accumulators and accessories, £14. 7s. 8d.	179	10	0			
				1,517	3	0
	Distribution of Electricity.					
Engineers' salaries	70	14	11			
Wages	38	12	4			
Repairs: mains, £19. 15s. 9d.; apparatus, £10. 8s. 10d.	30	4	7			
				139	11	10
Rents payable	67	0	0			
Rates and taxes	464	3	7			
				531	3	7
Directors' remuneration	106	10	0			
General establishment charges, stationery, etc.	154	0	10			
Auditor of Company	15	15	0			
Auditor appointed under the provisions of the order	13	13	0			
				289	18	10
Law expenses				28	2	7
Insurance				93	8	3
Balance carried to net revenue account				3,102	17	3
				£5,702	5	4

Cr.	£	s.	d.
Sale of current	5,312	16	10
Rental of meters	276	14	11
Rents receivable	99	2	3
Discounts	13	11	4
	£5,702	5	4

Balance Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	56,330	0	0
Sundry creditors on open accounts	4,792	17	0
Depreciation fund account	1,300	0	0
Balance from net revenue account	1,522	8	6
	£63,945	5	6

Cr. Assets.	£	s.	d.
Capital account—amount expended	59,866	9	4
Stores on hand: coal, oil, waste, etc., £96. 5s. 6d.; general stores, £21. 18s.	118	3	6
Deposit with the Richmond Corporation	100	0	0
Sundry debtors	2,982	10	9
Applications for provisional orders	67	4	6
Cash at bankers and in hand	910	17	5
	£63,945	5	6

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units	206,205
Quantity sold to private consumers by meter	191,084
Quantity used on works	1,950
Total quantity accounted for	193,034
Quantity not accounted for	13,171
Total maximum supply demanded (kilowatts)	244

BURY, ROCHDALE, AND OLDHAM TRAMWAY.

The twenty-second half-yearly report of this Company shows a gross profit of £2,982. The debenture-holders being entitled to one-half of the balance of net profits, after deducting interest at 2 per cent. per annum on the debentures and a dividend of 5 per cent. per annum on the share capital, the directors recommend the payment of a dividend of 6 per cent., which will absorb £1,260; £500 is to be placed to reserve account against depreciation, and the balance of £14 carried forward.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY.

Directors: Aymor H. Sanderson (chairman); J. Atkinson Hosker; F. W. Reynolds; F. E. Savory; R. Percy Sellon. Consulting engineer: C P. Sparks, M.I.C.E. Engineer: E. L. Ingram, A.M.I.E.E. Secretary: H. B. Renwick.

Report of the directors to be presented to the shareholders at the third ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on March 19, at 2 p.m.:

The whole of the undertaking of the Bournemouth and District Electric Supply Company, Limited (in course of voluntary liquidation), has now been vested in the Company. Expenditure has been incurred during the year on capital account in respect of the Bournemouth Provisional Order, 1890, particulars of which are given in capital account. The agreement, dated Nov. 6, 1899—duly confirmed and adopted by the shareholders—for the purchase of the interests of the County of London and Brush Provincial Electric Lighting Company, Limited, in the Richmond (Surrey) Electric Light and Power Company, Limited, has been carried out. The balance of the authorised share capital of the Company was issued to the shareholders in December last, and the premium received therefrom, after deducting the expenses of issue, has been carried to reserve. The balance from revenue account, together with the balances brought forward from last year, amount to £8,993. 8s. 7d., from which must be deducted interest charges, depreciation, etc., leaving the sum of £6,799. 13s. 5d. to the credit of net revenue account. Out of this sum the full year's dividend on the preference shares (first issue) has been paid, and the directors now recommend the payment of a dividend on the ordinary shares of the Company (first issue) at the rate of 5 per cent., less income tax, for the year ended Dec. 31, 1899. These payments absorb £5,510, leaving a balance of £1,289. 13s. 5d. to be carried forward. The equivalent of 44,096 8-c.p. lamps were connected to the Company's mains in Bournemouth at Dec. 31 last, showing an increase of 10,364 8-c.p. lamps for the year, and applications representing a further 681 8-c.p. lamps were then awaiting connection. Terms have been arranged for the supply of power for a period of years to the Poole and District Electric Traction Company, Limited, for the purpose of working the tramways between Bournemouth and Poole. A provisional order for the borough of Christchurch and the districts of the Urban District Council of Winton and the Rural District Council of Christchurch, was granted to the Company by the Board of Trade, and confirmed in the last session of Parliament. The Richmond (Surrey) Electric Light and Power Company, Limited, has declared a dividend upon its ordinary shares at the rate of 4 per cent. per annum in respect of the year ended Dec. 31 last. Of the revenue received from the Richmond undertaking, the sum of £2,400 has been applied to reduction of the cost of purchase in respect of interest and dividends accrued at the date of purchase. The retiring directors are Mr. F. E. Savory and Mr. R. Percy Sellon, both of whom, being eligible, offer themselves for re-election. The auditor, Mr. R. H. Marsh, also retires and offers himself for re-election.

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BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital authorised	150,000	0	0
Capital issued—			
7,500 preference shares of £10 each	75,000	0	0
7,500 ordinary shares of £10 each	75,000	0	0
	150,000	0	0
Less calls not due or in arrear	10,756	10	0
	139,243	10	0
Sundry creditors on open account	64 910	10	9
Bills payable	3,548	17	10
Loans against security	16,000	0	0
Reserve from premium on shares, £2,250; less preliminary expenses, £24. 5s. 9d.	2,225	14	3
Leasehold and special redemption accounts	453	12	1
Reserve for bad and doubtful debts	48	10	4
Depreciation fund account	2,204	15	1
Balance at credit of net revenue account, £6,799. 13s. 5d.; less interim dividend, £1,305	5 494	13	5
	£234,130	3	9

Cr. Assets.	£	s.	d.
Capital appropriated to the Bournemouth Provisional Order, 1890, including goodwill	143,230	0	7
Investments in the Richmond (Surrey) Electric Light and Power Company, Limited: 6,266 shares of £5 each, £53 650; mortgage, debentures, and loans, £26,050	79,700	0	0
Provisional orders: Poole and Branksome Order, 1897, £494. 11s. 9d.; Christchurch and District Order, 1899, £484. 0s. 6d.	978	12	3
Stores on hand	647	6	6
Sundry debtors	7,448	11	9
Office furniture and books, £38. 0s. 2d.; less amount written off, £18. 0s. 2d.	20	0	0
Cash at bankers and in hand	2,105	12	8
	£234,130	3	9

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£	s.	d.
Coal and other fuel	1,938	11	9
Oil, waste, water, etc.	346	8	6
Engineers' salaries	372	15	2
Wages	883	10	4
Stores and works expenses	78	4	8
Repairs to buildings and machinery	325	13	6
Distribution of Electricity.			
Engineers' salaries	94	0	4
Wages to linesmen, etc.	172	8	8
Repairs to mains, apparatus, etc.	107	4	0
Rents payable, £140. 6s.; rates and taxes, £450. 11s. 7d.	590	17	7
Salaries, local office	229	14	4
Stationery and printing	85	13	3
Postage and general charges	113	8	8
Auditor of Company	26	5	0
Auditor of County Council	10	10	0
Law expenses	19	11	4
Insurance	97	16	3
Leaseholds redemption fund	10	8	5
Reserve for bad debts	10	0	0
Balance	8,883	10	4
	£14,466	12	1

Cr.	£	s.	d.
Sale of current	13,299	8	1
Rental of meters and indicators	802	11	11
Interest and discounts	230	15	3
Trading account	63	15	1
Rents receivable	63	5	3
Testing fees	6	9	0
Transfer and probate fees	0	7	6
	£14,466	12	1

PROVISIONAL PATENTS, 1900.

MARCH 5.

4157. **Improvement in electric accumulator traction.** Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster, London.

4168. **Improvements in devices for rapidly transmitting impulses of current.** Luigi Cerebotani and Albert Silbermann, 111, Hatton-garden, London. (Complete specification.)

4190. **Improvements in solution for galvanic batteries.** Léon Boulard, 18, Buckingham-street, Strand, London.

4193. **Improvements in signalling devices for telephone systems.** Philip Middleton Justice, 55, Chancery-lane, London. (Henry M. Williams, United States.) (Complete specification.)

4196. **A new or improved time apparatus for making and breaking telephonic and telegraphic circuits.** Rodolphe de Lamprecht, 99, Cannon-street, London.

MARCH 6.

4230. **Improvements in electric gaslighters.** Hugh Donald Fitzpatrick, 100, Wellington-street, Glasgow. (Conrad Hubert, United States.) (Complete specification.)

4236. **Improvements in filaments for incandescent electric lamps.** Thomas Archer Rose, 9, Adam-street, Strand, London.

4242. **Improvements in switches or circuit-breakers for high-potential electric circuits.** The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

4262. **Improvements in storage batteries and in the method of making electrodes therefor.** Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (The Knickerbocker Trust Company, United States.) (Complete specification.)

4268. **Improvements in tools for use in the laying of tile conduits for electrical conductors.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (American Vitrified Conduit Company, United States.) (Complete specification.)

4287. **Improvements in telephonic intercommunication systems.** William Aitken, Oxford-court, Cannon-street, London.

MARCH 7.

4358. **Improvements in electric bell pushes.** Henry Charles Swindell, 77, Colmore-row, Birmingham.

4365. **Improvements in translucent reflectors for incandescent electric lamps and the like.** David Shoolbred, 5, Budge-row, Cannon-street, London. (Complete specification.)

4369. **Improved couplings for electrical connections.** John Joseph Rawlings and William Robert Rawlings, 61, Carey-street, Lincoln's-inn-fields, London. (Complete specification.)

4376. **Improvements relating to the electrolytic production of metal bars for the manufacture of wire.** Elisha Emerson, 45, Southampton-buildings, Chancery-lane, London.

4383. **Improvements in, and, or connected with electric controlling apparatus.** John Cromwell Lincoln, Norfolk House, Norfolk-street, Strand, London. (Complete specification.

4387. **Improvements relating to systems of alternating-current electrical distribution.** Charles Ira Young, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 8, 1899, being date of application in United States.)

4390. **Improvements in electrical switches.** Verity's, Limited, and Richard Hawke Rogers, 11, Burlington-chambers, New-street, Birmingham.

MARCH 8.

4406. **Improvements in and relating to electric fittings.** James Dewar, 96, Buchanan-street, Glasgow.

4457. **Improvements in door locks operated by electricity for engaging and disengaging bolts.** Wilhelm Schade, 18, Fulham-place, Paddington, London. (Complete specification.)

4461. **Improvements in or relating to electric cables or conductors.** William John Glover, 6, Lord-street, Liverpool.

MARCH 9.

4472. **Improvements in electric motors.** Auguste Michel Edouard Berthier, 151, Strand, London.

4489. **Improvements in primary batteries.** Arthur Miller Young, 4, St. Ann's-square, Manchester.

4500. **A new or improved self-locking elbow-joint for electrical fittings.** Hugo Hirst and John Hillery Collings, 73, St. Stephen's-road, Upton Park, London.

4508. **Improvements in electric signalling systems for railways.** Manious Garl, 78, Fleet-street, London. (Complete specification.)

4509. **Improvements in electric traction.** Edward Henry Tyler, 15, Kirkstall-road, Streatham Hill, London.

4527. **Improvements in multiple-contact telephone transmitters and circuits relating thereto.** Charles Adams-Randall, 98, Prince of Wales-mansions, London.

4528. **Improvements in electric telephony.** Charles Adams-Randall, 98, Prince of Wales-mansions, London.

4555. **Improvements in or connected with electric distribution.** James Grieve Lorrain, Norfolk House, Norfolk-street, Strand, London. (Frederick Bedell, United States.)

4557. **Improvements in the distribution of electric current and apparatus therefor.** William Phillips Thompson, 322, High Holborn, London. (Julien Dulait and Otto Garbe, Belgium.)

4561. **Improvements in or connected with electric trolleys and other electrically conducting mechanical parts.** Alpha Francis Cothias, 6, Lord-street, Liverpool. (Complete specification.)

MARCH 10.

4570. **Improvements in overhead travelling electric cranes.** William Henry Vaughan and Thomas Foster, 17, St. Ann's-square, Manchester.

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4586. **Improvements in telegraph receivers.** Luigi Cerebotani and Albert Silbermann, 111, Hatton-garden, London. (Complete specification.)

4591. **Improvements in electricity meters or measuring apparatus.** Percival Warwick-Davies, 4, Danes-inn, Strand, London.

4607. **Improvements in electrical gaslighters.** Hubert von Arnswaldt, 6, Lord-street, Liverpool. (Complete specification.)

4617. **Improvements in applying electric currents to electric lighting.** Hugh Fitzalis Kirkpatrick Picard, 24, Southampton-buildings, Chancery-lane, London.

4622. **Improvements in and mechanism for reversing electro-motors.** August Reichwald, 33, Chancery-lane, London. (The firm of Fried Krupp, Germany.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published March 31.

1899.

4727. **Electric conductor conduits and turn-outs for tramway and railway propulsion.** Taylor.

4931. **Means for generating and impressing semi-cycles of electromotive force on electric circuits for telegraphic and other purposes.** Wise. (Crehore and Squier.)

4931A. **Telegraphy.** Wise. (Crehore and Squier.) (Date claimed under Patents Rule 19, March 6, 1899.)

5104. **Reinforcement of electrical waves and avoidance of loss by straying reflection and the like by means of a condenser.** Braun.

5211. **Electric incandescent lamps.** Miller.

5469. **Incandescent bodies for electric incandescent lamps.** Wise. (Thowless.)

5548. **Multiplex selective system of wireless telegraphy.** Cohen and Cole.

5734. **Hydrocarbon engines for driving dynamo-electric machines and dynamo-electric machines driven thereby.** Vitali.

6954. **Electric lamps.** Berditschewsky-Apostoloff.

7415. **Electrical cooking apparatus.** Cary and Delevy.

8522. **Storage batteries.** Welford.

9414. **Controlling electric motors and apparatus for that purpose.** Leitner.

9456. **Electric storage or secondary batteries.** Niblett and Sutherland.

9512. **Voltaic batteries.** Abel. (Société d'Etude des Piles Electriques.)

10223. **Electric controllers.** Boult. (von Zweigbergk.

11424. **Accumulator batteries.** Marino.

11552. **Electric tumbler switch.** Voigt and Haeffner.

16650. **Conduits suitable for electric mains.** Petersen.

18350. **Electrolytes.** Marino.

20328. **Dynamo-electric generators or transformers.** Robison.

21378. **Combined maximum and integrating electric meter.** Halsey. (Date applied for under International Convention, March 27, 1899.)

1900.

547. **Process of and apparatus for magnetic separation.** Payne.

2077. **Accumulator battery.** Cheval and Lindeman.

2871. **Electric ignition devices for explosion engines.** Boult. (Société Anon. des Moteurs et Voitures "Aigle.")

2357. **Electromagnetic bell signalling apparatus.** Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Mar. 10	4,104	3,776	+ 328	39,328	37,547
Blackpool-Fleetwood	,, 10	182	212	- 30	1,472	1,676
Bradford City Trams	,, 11	391	297	+ 94	27,409c	—
Bristol Tramways Co.	,, 9	2,569	2,460	+ 109	—	—
City & South London	,, 11	1,303	1,072	+ 231	11,775	11,143
Dover Tramways	,, 10	142	147	- 5	1,451	1,430
Dublin U.T., elec. cars	,, 9	2,784	927	+1,857	—	—
Dublin S.D. Electric	,, 9	643	625	+ 18	—	—
Halifax Corporation	,, 11	588	355	+ 233	28,648a	10,084b
Hull Corporat'n E.S.	,, 10	716	—	—	5,332	23,759c
Liverpool Corporat'n	Feb. 24d	6,882	5,723	+1,159	52,098	46,118
Liverpool Overhead	Mar. 11	1,369	1,364	+ 5	14,301	12,982
Sheffield Corporation	,, 11	1,890	—	—	—	—
South Staffordshire	,, 9	645	588	+ 57	5,955	5,934

a Since April 1, 1899. *b* Since June 29, 1898.
c Total receipts. *d* Partly electrical. *e* Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Tuesday.
Commercial and Industrial.—		
Anglo-Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5 ..	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5 ..	5½ 6½
—— 5 per cent. Mortgage Debentures	100 —	98-103
British Electric Works, Ordinary, 50,001-95,000	1 —	15/16-1 1/16
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	¾-1
—— 4½ per cent. First Mortgage Debentures	103 ..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4½-5½
Brush Electrical Engineering, Ordinary	2 —	1½-2½
—— Non. Cum., 6 per cent. Pref.	2 ..	2½-2¾
—— 4½ per cent. Debenture Stock	100 ..	108-112 xd
—— 4½ per cent. 2nd Debenture Stock	100 ..	103-105
Callender's Cable, Debentures	100 —	111-115
—— Ordinary	5 ..	14-15
—— 5 per cent. Pref.	5 ..	5½-6
Crompton and Co.	5 —	3½ 4
—— 5 per cent. Debentures	— ..	98-101
Edison and Swan United, Ordinary	5 ..	2-2½ xd
—— 5 per cent. Debentures	5 ..	3½-4½ xd
—— 4 per cent. Deb. Stock, Red.	100 ..	93-95
Electric Construction	2 ..	2½-2¾
—— 7 per cent. Cumulative Pref.	2 ..	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	104-107
Giffre Electro-Chemical and Power, Ordinary	1 —	¾-1
W. T. Henley's Telegraph Works, Ordinary	5 —	14-15
—— 4½ per cent. Preference	5 ..	5½-6
—— 4½ per cent. Debentures	100 ..	110-114 xd
India Rubber, Gutta Percha, and Telegraph Works	10 ..	31-33
—— 4 per cent. Debentures	100 ..	101-105
Telegraph Construction and Maintenance	12 ..	37-41
—— 5 per cent. Bonds	100 —	102-105
Telegraph Manufacturing, Ordinary	5 —	9-10
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	11-12
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	104-106
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅝-¾
Bournemouth and Poole, Ordinary	10 ..	12-13
—— 6½ per cent. Cum. Pref.	10 ..	10-11
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 —	8½-9½
Charing Cross and Strand	5 ..	9½-10½
—— 30,001-50,000	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 —	5½-6 xd
Chelsea Electricity Supply	5 —	7-8
—— 4½ per cent. Debentures	100 —	110-112
City of London, Ordinary	10 ..	9½-10½
—— 6 per cent. Cumulative Pref.	10 ..	13-14
—— 5 per cent. Debenture Stock	100 ..	122-127
County of London and Brush Provincial, Ordinary	10 ..	9½-10½
—— 6 per cent. Cum. Pref.	10 ..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Ed.	— —	100-102
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	4½-5½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	8 —	8-8½
London Electric, Ordinary	3 —	1½-2½
—— 6 per cent. Pref.	5 —	4½-5
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 —	101-103
Metropolitan, Ordinary	10 —	13½-14½
—— 62,501-85,000	10 ..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100 —	114-117
—— 3½ per cent. Mortgage Debenture, Red	100 —	95-97
Notting Hill Electric Lighting	10 —	16-17
Oriental, 1879	1 —	1½-1¾
—— £5 Shares	5 —	¾-⅞
—— £4½ Shares, New	4½ —	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	6¾-7¼
River Plate Electric Light and Traction, Deb.	100 —	75-85
Royal Electrical Company of Montreal	1½ ..	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100 ..	104-106
South London, Ordinary	3 ..	3½-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15½
—— 40,081-52,080	5 ..	14½-15½
—— 7 per cent. Pref.	5 —	8½-9½ xd
Westminster, Ordinary	5 —	13½-14½ xd
Electric Railways.—		
Central London, Ordinary	10 —	93-101½
—— Pref. Half-Shares	5 —	4½-5½
—— ,, deferred	5 —	4½-5½
City and South London, Consolidated Ordinary	100 —	63-67
—— ,,	5½ —	4½-5½
—— 4 per cent. Debenture Stock	100 —	125-130
—— 5 per cent. Pref. Stock '91	100 ..	140-145
—— ,, ,, '96	100 —	132-137
Liverpool Overhead, 5 per cent. Pref.	— —	12½-13½
Waterloo and City, Ordinary	100 —	101-104
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10 —	17-18 xd
Brisbane Tramway	100 ..	104-106
British Electric Traction, Ordinary, 1-80,000	10 ..	17-18
—— 60,001-75,000	10 ..	16½-17½
—— 6 per cent. Cm. Pf. 30,001-60,000	10 ..	13-13½
—— 5 per cent. Perpetual Debenture Stock	100 ..	126-129
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5 —	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4-4½
—— 5 per cent. Deb. Stock, Red.	100 —	105-108
Costa Rica Electric Light and Traction, 5 per cent. First Deb., 1-1,000 of £100 and 1,001-1,680 of £50 each	— ..	75-85
Isle of Man Electric Power, 1-95,000	1 ..	13/16-15/16
—— 6 per cent. Preference, 100,001-170,000	1 ..	15/16-1 1/16
Kidderminster and District Lighting and Traction, Pref.	8 ..	8-8½
New General Traction, Ordinary	5 —	3½-4½
—— 6 per cent. Cum. Pref.	5 —	4½-5½
North Staffordshire Trams	6 ..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	18-19
—— Preference	10 ..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10 —	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10 —	10-11
Telephones.—		
Consolidated Telephone Construction and Maintenance	½ ..	½-¾
National Telephone, Ordinary	5 —	5-5½ xd
—— 6 per cent. Cum. First Pref.	10 —	14-15 xd
—— 6 per cent. Cum. Second Pref.	10 —	14-15 xd
—— 5 per cent. Non. Cum. Third Pref.	5 —	5½-5¾ xd
—— 3½ per cent. Deb. Stock, Red.	100 ..	97-100
Oriental Telephone and Electric Company	1 —	¾-1

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NOTES.

Bradford Technical College.—We learn that Prof. Oliver Lodge is about to give a course of lectures at the Bradford Technical College on the subject of "Electrical Vibrations. These should prove exceedingly interesting, as Prof. Lodge has conducted a very large number of experiments on this subject.

Steam Power.—From recently published statistics it appears that there were in Prussia last year no less than 2,799 steam-engines, with a capacity of 258,511 h.p., exclusively used for the generation of electric current, while there were about another 1,000 engines, with 74,831 h.p., which were used partly for this and partly for other purposes.

Our Volunteers.—The first detachment of the Electrical Engineers (Royal Engineers) Volunteers left for South Africa on Friday last, in the transport "Tagus." Colonel Crompton has not gone with this detachment, but is organising the next, which, if the war lasts, will be sent on shortly. The news from the front, although much more favourable than when the offer of Electrical Volunteers was accepted by the War Office, is such as to lead us to believe that there will be ample scope for the corps to distinguish itself before the war is concluded.

Aluminium Arcs.—An aluminium electrode, which has been patented in America recently, is destined for use in arc lamps. It is claimed that more light is produced by using aluminium for the negative and carbon for the positive electrode, because aluminium is used up more slowly, while at the same time the whole of the carbon is used up. If the aluminium lasts so much longer than the carbon, a saving of both labour and material would be affected, but we rather doubt the fact.

The Late Prof. Hughes.—Sir W. H. Preece very kindly points out an error in our last issue in the note relating to the will of the late Prof. Hughes. He correctly says that Hughes's fortune was really based upon his agreements for the sale of his patents and the shares he received under these agreements from the United Kingdom Telegraph Company and the Submarine Telegraph Company, especially with the former. Again, Hughes, though born in England, elected, after his return from America, to remain a citizen of the States, and thus, it may be assumed, prevented any honour being bestowed on him by the country of his birth.

Three-Wire Patent.—On the 20th of this month the patent issued in 1883 to Mr. Thos. A. Edison for the three-wire, five-wire, and multi-wire system of distribution will lapse in the United States. This invention of Mr. Edison was forestalled in this country by the patent of the late Dr. John Hopkinson, which lapsed several years ago. We understand that Mr. Edison's patent, which has been owned by the General Electric Company, has been generally respected in the States. It will be remembered that Dr. Hopkinson's patent was the subject of a law case, in which its validity was upheld, and which enabled the owners to draw royalties during the last few months of its existence.

American Institute of Electrical Engineers.—We have received a copy of the *Transactions* of the American Institute of Electrical Engineers for the month of December, 1899. The bulk of the volume is devoted to discussions carried on simultaneously in New York and Chicago on the possibilities of wireless telegraphy. The discussion in New York was opened by Prof. R. W. Fessenden, while that in Chicago was opened by Mr. A. Abbott. In each case the opener of the debate gave some experimental results personally obtained, which added considerably to the interest of the meetings. We have referred to the discussions before, but would recommend the volume to anyone who is interested in wireless telegraphy, as they contain most useful figures.

Electricity and Lead-Poisoning.—On Wednesday last a number of doctors and others interested in the Pottery districts met at Trentham Hall, by invitation of the Duchess of Sutherland, to discuss the use of electricity in counteracting the distressing results following lead-poisoning. A paper was read by Dr. Lewis Jones, of the electrical department of St. Bartholomew's Hospital, and Dr. Armitage, of Wolverhampton, opened the discussion. Dr. Armitage stated that he had tried an electrical treatment in 40 cases of severe lead paralysis in the Pottery districts with very successful results. In the majority of cases a cure was effected, notwithstanding that the patients were not under his control except during the administration of the bath. The need of more extended experiments was referred to, and also the advisability of having electric baths in various parts of the Pottery districts, so that a larger number of patients could be treated.

Paisley Telegraphs.—We notice, with respect to the provision of a continuous telegraph service to Paisley, that the Town Council have received a letter from the Postmaster-General to the effect that the circumstances are such as not to warrant him in keeping open the Paisley post office continuously for the transaction of telegraphic business. He, however, states that subscribers to the National Telephone Company at Paisley can have telegrams sent to and from Glasgow head post office by means of the trunk telephone service. In order to have this done, however, the subscriber must pay an annual fee of £1. 1s. and also the trunk telephone fee for each message. This appears to us to be convenient enough to subscribers to the National Telephone Company, but in a place of the size of Paisley one would hardly expect the Postmaster-General to close the telegraph office as one does an ordinary shop, as the expense of keeping the office open need not be very large.

An Electric Bath.—We notice in the columns of the *American Inventor* an illustration of an electric sunlight bath, which is said to have wonderful medical properties. The interior of the bath is provided with a glass couch, on which the bather reclines, and he is surrounded on every side by mirrors, which project on to his body the rays from a large number of incandescent lamps. We are told that the usual duration of an electric bath is from two up to ten minutes, and that the actual cost for electrical energy during that time is from 1d. to 1½d. The results are said to be much superior to those obtained from a Turkish or Russian bath, the cost of which is naturally more. Unfortunately, we are not informed as to the price charged for a bath, nor the means by which the temperature is regulated to suit the comfort of the bather. The description, however, of the "countless number of bright rays which not only fall upon the surface of the skin, but penetrate to the remote recesses of the body," convince us that the price cannot be inconsiderable.

Municipal Trading.—At the annual meeting of the Associated Chambers of Commerce held at Southampton, Mr. Sydney Morse moved that it was desirable that Parliament should define the limits of municipal trading, and that, pending enquiry into the subject, no enlarged powers for trading purposes should be granted to municipalities. After Mr. Morse had spoken in favour of his motion, Mr. Whitehead, of Bradford, proposed an amendment regretting that the Government had as yet been unable to appoint a joint committee on municipal trading.

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He added that he did not think that until this committee had presented its report he could or should vote in support of the views held by Mr. Morse. The subject was then discussed to a considerable extent, and ultimately the amendment was carried by a lagre majority. At the conclusion of the meeting the invitation from the chairman of the British Chamber of Commerce in Paris for the association to hold its autumn meeting in that city was unanimously accepted. We presume that this meeting will be held before the close of the Paris Exhibition.

Automatic Telephony.—We learn that there is going on in New England, U.S.A., a very interesting argument for and against automatic telephony. The argument commenced owing to the application of the Hampden Automatic Telephone Company for a franchise in Springfield, Massachusetts. As would be expected, Mr. Farnham, a Bell telephone expert, said that automatic telephony was not practical. He had examined 300 patents, and also had personally tested such telephones. In these tests he had found that out of 100 calls, half were fruitless. He raised numerous other objections to the system, and stated that the Bell system gave a quicker service. He took the other points in favour of automatic telephones, such as accuracy, secrecy, and cheapness, and showed, at any rate to his own satisfaction, that the Bell system was immeasurably superior in every respect. Mr. Keith spoke in favour of the automatic telephone, and we are informed that his evidence in certain parts was exactly contradictory to that of Mr. Farnham's. It appears that he took the same points as the previous speaker, and also proved his case. The argument appears to have been an interesting one, but we do not see that any definite conclusion was arrived at.

Brighton Corporation Bill.—The consideration of this Bill came before Mr. Schwann's committee of the House of Commons during the early part of the week. The preamble of the Bill, which concerned the tramways themselves, was found to be proved with the exception of one short portion. With regard to the question of generating electricity, evidence was given to the effect that it was proposed to erect a generating station at Shoreham Harbour, this being a very favourable position. The Corporation already had one generating station and supplied electricity in the borough. The demand for electricity, however, was increasing so rapidly that it was considered desirable to have another station outside, and to convey the electricity to Brighton by cable. When the supply was set up in 1892 the consumers numbered 213, and they were now 2,400; of 8-c.p. lamps in 1892 there were in use 11,000, and now they numbered 130,000; the units of electricity sold had in the same period increased from 156,000 to 3,208,000, and the capital engaged from £53,000 to £229,000. There was a large field still for increase, 18,000 houses remaining unsupplied. Other evidence was given in favour of the Bill, but at the time of writing the enquiry was still proceeding.

Dresden.—Electric lighting and traction work seems to be making rapid headway in Dresden, and the steady increase in the number of lamps connected, together with the proposed conversion of the remaining horse-worked tramways for electric traction, have necessitated considerable extensions of the generating plant. When the extensions to the tramways of the city now in hand are completed, there will be a total length of track amounting to 70 miles worked by means of electricity. The present generating station, however, is not equal to the increased demand for current which these extensions involve, so that a new station is being erected in the west of the town, which, together with extensions which are being made to the old works, will involve an expenditure of £260,000. In the new station there will be five steam sets of 1,000 h.p. each installed, while a further addition of two such sets will be made to the original plant, together with the additional boiler power, etc., rendered necessary. The tramways at Dresden, it will be remembered, are in the hands of two distinct companies, which purchase the necessary current for working their lines from the Corporation, the method of charging being an interesting one. The price paid represents the costs of generation plus 20 per cent., with a maximum charge of 1·44d. per kilowatt-hour.

The Madras Tramways.—We have in a recent issue referred to the fact that the Madras Electric Tramways Company were in liquidation in consequence of the foreclosing of a mortgage. The collapse of the company is attributed by *Indian Engineering* to faults in the early management, and it is stated that the system has worked well, and that the cars have been well filled during the last few years. Our contemporary states that a new administration able to take over and extend the service, would certainly make the undertaking pay. An offer has been made by one of the largest creditors of the undertaking to sell the tramways to the municipal authority. This question, we understand, is to come up before a committee who are to report upon the desirability of the municipal ownership of tramways. We are also informed that the proposal to raise the required amount (15 lakhs of rupees) as a loan, on the security of the rates, does not meet with the approval of the Madras Government. As it is stated that the tramways are offered for half the cost of constructing them, it would seem to be a good chance for the municipal authority to undertake the working, but we are surprised that private enterprise has not offered some solution to the situation. If the Corporation should decide to buy, it will certainly start in a much better position than some of our English corporations, in that it will secure the undertaking at less than its first cost.

Indiarubber.—At a recent meeting of the Society of Civil Engineers of France a process devised by Deiss for the extraction of indiarubber was described. In the process the bark and roots of the indiarubber tree are cut up and then soaked in dilute sulphuric acid. The effect of this is to decompose the woody portions without affecting the indiarubber. In this way a division is made between the valuable rubber and the rest of the bark and roots, and it is claimed that the rubber so produced is quite pure. An important question in a process of this kind is that of cost. It was stated by the author that 1lb. of indiarubber could be produced by the process at a cost of about 1½d. It seems to us to be an extremely low cost for the large amount of matter which has to be handled to produce the given amount of indiarubber, and we are not clear that the author includes more than the factory charges in his estimate. If such a factory were to be constructed in a tropical situation, and it was decided to use the roots and bark of the rubber trees in the neighbourhood, the district immediately round the factory would soon be denuded of these trees, and the cost of transport of the bark and roots would naturally go up considerably. As far as the rubber industry is concerned, we do not think any process which relies on the destruction of the trees is to be recommended. Even with the present methods of collection far too much destruction takes place, and if the bark and roots of the rubber tree become marketable it would be difficult to prevent the trees in whole districts being destroyed.

American Electrical Standards.—The need for an official verification of standards and measuring apparatus of all kinds is set forth by Dr. F. A. Wolff in the *Electrical*

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World. In his article he gives a history of the efforts which have been made from the earliest times to obtain accuracy in standards. He goes on to state that after the legalisation of the international electrical units, the United States Government felt it their duty to provide facilities for the official verification of electric standards and measuring apparatus. The first steps in this direction were by the use of wire coils of the Reichsanstalt type for the measurement of electrical resistances. Four of these coils were purchased and standardised at the Reichsanstalt, where they were kept under observation for a month. In addition, two coils formerly purchased were in the possession of the Office of Standard Weights and Measures, and the new and old will be compared periodically so that any changes may be made known. The temperature coefficients of the coils were carefully determined and compared with others of a similar denomination. Various methods of comparison are employed, the Wheatstone-Kelvin bridge, however, being chiefly used for comparing coils. The E.M.F. is measured by taking the E.M.F. of a Clark cell at 15deg. C. as the unit. Cadmium cells have, however, also been employed for this purpose. The verification of alternating-current measuring apparatus has not yet been undertaken by the office, nor yet condensers and self-induction standards. These the author thinks it very important that the office should take in hand at once, and states also that the photometry of arc and incandescent lamps requires attention.

Pipe-Joint Resistances.—Mr. A. A. Knudson, in a letter to the *American Electrician*, gives some more figures on the resistance of the joints in water-pipes to the flow of an electric current. As has been pointed out before, the return current from an electric tramway tends to increase the resistance of joints in water-pipes when the same are used as part of the earth return. Mr. Knudson experimented with several sections of pipes, some 4in. in diameter and some 6in., in which there were some 27 joints, made with lead and caulked. When these resistances were again ascertained some 11 months afterwards, he found that in every case the joint resistance was considerably higher. In some cases this increase was 100 per cent., while in one instance the resistance had increased by 60 times during the year. This increase is due to electrolytic reactions between the lead and the iron. In consequence, it is clear that the resistance of a line of water-pipes is dependent on the length of time they have been in the ground, and Mr. Knudson considers that any pipe line more than five years old should not be connected with the return of an electric tramway. He concludes that there is no absolute cure for electrolysis except the abandonment of the earthed return, much in the same way that the telephone companies had to give up earth returns when electric tramways first started. In that case the cheapest means of providing a return is to use a double overhead or underground system. The first of these systems is said to have been used on the lines at Cincinatti and Washington, but we gather that there are objections found to the system, which makes it unlikely that it will be introduced elsewhere in the States.

Ventilation.—In a paper read before the Civil and Mechanical Engineers' Society of London at the beginning of the month, Mr. Mervyn O'Gorman traversed a number of methods of designing heating and ventilating apparatus. He showed, for instance, that to get heating and ventilation without draughts it was not advisable to provide the radiators, whether heated by electricity or steam, with corrugated surfaces. He advocated, instead, that the surface of these radiators should be smooth, so as to heat by radiation rather than by convection. The ideal system, in the author's opinion, is to use the walls themselves as the radiators. In such a case a cast-iron dado would be provided round the room, in which the heat would be generated. An example of what can be done in this way in securing immunity from draughts can be tried experimentally by heating the walls of the building by raising the temperature of the air to, say, 100deg. F., so that the walls are dried and absorb heat. If the heating of the air is then discontinued, an equable temperature is obtained for a considerable time. With respect to electric fans, the author advocated the use of good standard motors coupled to the fans rather than the combinations which are often sold, and in which the motors are not of good mechanical construction. In order to reduce the noise, heavy frames for the fans should be employed, and they should be secured to the main walls of the building. In the concluding parts of his paper Mr. O'Gorman gives some interesting figures obtained from actual practice as to the quantity of air required in a given room in a given time, and also as to the variations in this quantity corresponding to the number of people using the room.

Electric Wiring.—A paper on the electric wiring of buildings was read in February before the Institution of Engineers and Shipbuilders in Scotland. The discussion which followed was of a very interesting character. Thus Mr. F. Bathurst thought that the wood-casing system of wiring, although convenient for surface work, was utterly unreliable for placing beneath floors or under plaster, and he advocated the use of iron piping for the purpose. Mr. H. A. Mavor referred to the statement by Mr. Chamen that the Board of Trade rules were beyond the scope of the discussion, and said he believed that Mr. Chamen had brought his paper before them largely with a view to stemming the tide of bad workmanship, but he thought the matter before them was one with which neither the author, in his official capacity, or the Board of Trade had anything to do, and their interference might be disastrous, as it had been in other directions. He thought the Board of Trade jurisdiction should stop at the door of his house, and let him earth his conductors if he wished to. The wiring might, in his opinion, be done perfectly safely by the use of small porcelain insulators fixed in the rooms by means of ordinary wood screws. Mr. Archibald Denny stated that his firm usually adopted the tree system of wiring, owing to the large number of wires required in the distribution-box system. The great difficulty, however, was the moisture, but this could be got over by using properly covered wires. He thought that iron pipes as conduits were bad, they being simply water-traps. It was probable that the concentric system was the best for ship wiring. Mr. G. A. Clark, in correspondence to the institution on the paper, very strongly advocated the use of lead pipes for the wire conductors. The discussion was ultimately adjourned.

Trolley-Fed Automobiles. — We notice in the *Electrical World* a fully illustrated description of some experiments now being tried in France with trolley-fed automobiles. This system, which was invented by Mr. Lombard Gerin, needs two trolleys and two wires. The trolley carriage is itself an automobile, and has a speed slightly above that of the vehicle. This is effected by a little non-synchronous induction motor, which is supplied with three-phase currents produced by the motor of the vehicle. The small trolley motor is thus regulated by the motor of the vehicle. The trolley is supported and guided by two aluminium wheels, which lead the current to the vehicle by a cable some 25ft. to 30ft. long. The cable is attached to the top of a pole on the vehicle, at a height

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from the ground of about 13ft., there being at the place where it is attached a six-pole junction box, so that the carriage can be disconnected from the line. The control of the trolley motor is effected in the following manner: On the armature of the vehicle motor are three rings, connected to three points of the winding. The collectors of these rings are connected to three conductors, of which the extremities connect to the winding of the stator of the small trolley motor. The large motor then acts as a three-phase generator of variable frequency and E.M.F., these being low or high according to the speed of the vehicle. This small trolley motor is hermetically sealed, and the whole arrangement, which is entirely of aluminium, weighs only 40lb. and absorbs only about 500 watts at its greatest speed. An electrical brake is provided, by which, if necessary, the trolley motor can be controlled. A pole-changing switch is also included in the three-phase circuit, which permits of the motor running in either direction. It is stated that in most cases 220 volts will be a sufficient potential for the service.

Municipal Lighting in Germany.—An article is concluded in the current number of the *Elektrotechnischer Anzeiger* which deals with the electric lighting of towns, with special reference to those of small size. In the course of his description of the prevailing state of things the author makes some very pertinent statements. He regrets the tendency of over-cautiousness which has hitherto marked the development of electric lighting undertakings. More foresight should, in his opinion, characterise the designs of municipal undertakings of electricity supply, since it is not always possible to keep exactly level with the requirements of the moment. The complaint is often heard that certain electricity works are too small for the requirements which they were intended to meet, but never that they are too large. The vexed question as to who should undertake the supply of electricity in towns is dealt with, and the advisability of a municipality erecting works at the ratepayers' expense, afterwards leasing them to a company, is also touched upon. In theory, every municipality should endeavour to control its own undertaking. It is not admitted that private enterprise must of necessity give better and more reliable results than municipal undertakings. This depends entirely upon the means employed. Speaking generally, the leasing of an electricity supply works to a private concern in Germany is invariably the result of over-cautiousness, and for those who enter into such an agreement, extending, perhaps, over 40 years, the decision is a serious one. No single instance is known to the author in which the concession of such a lease proved itself, as judged by subsequent results, particularly advantageous to the municipality. In conclusion, the writer emphasises the importance of the town knowing the whys and the wherefores of erecting works for the supply of electricity, and whether the circumstances of the particular case in question are favourable to municipal or private enterprise.

Electric Lighting Progress.—On Monday last Bailie MacKenzie read a paper before the Edinburgh Society of Science and Arts on "The Progress of Electric Lighting in the United Kingdom." In it he reviewed the various Acts of Parliament regulating the supply of electrical energy, and also the influence of these Acts on the progress of electrical engineering. At the present time he estimated that an actual capital of some six millions was employed by the electric lighting companies and corporations in London, as against eight millions in the provinces. In London, of course, the companies have the bulk of the lighting in their hands. In Scotland, Bailie MacKenzie stated that the Edinburgh and Glasgow stations, with their distributing systems, represented an investment of practically a million pounds, while the other towns having municipal electricity works had spent about £300,000. In referring to the Bills now before Parliament for the distribution of electricity on a large scale, the opinion was expressed that the opposition of the local authorities was hampering the development of electrical systems in small towns. Bailie MacKenzie clearly explained the advantage of having loads of different characters, such as traction and lighting, supplied from the one station. Thus, if in Edinburgh an electric traction system was supplied from the present mains, he believed a profit of 30 or 40 per cent. could be made if 1d. per unit were charged. Referring to the cost of street-lighting in Edinburgh, the charge made was £14 per arc lamp per annum. This included the current, the maintenance of the lamp, and also the interest and sinking fund on the cost of supplying and erecting the lamps and posts. In Glasgow, on the other hand, the charge was only £13 per annum, but the lamps were burned all night, whereas in Edinburgh a number of them were switched out at midnight. He believed, however, that this charge was not inclusive of the capital items referred to above. The paper was much appreciated by the audience.

Hysteresis.—We have recently had the opportunity of seeing the full text of the paper by Mr. K. Angström in the *Transactions* of the Royal Academy of Science, Stockholm, on the "Objective Representation of the Hysteresis of Iron and Steel." As mentioned in one of our previous issues, the method applied by the author was originally devised by Mr. Braun. It consists of an arrangement by which a fine cathode ray is obtained by the introduction in the tube of a screen with a small hole in it. In this way a brilliant spot of light is produced upon the screen contained in the enlarged end of the tube. This pencil or ray is then deflected by means of magnetic lines of force set up by four coils placed round the tube at angles of 90deg. In the final arrangement two coils were used with their axes vertical with respect to the tube, while two long horizontal coils were placed one on either side of the tube. An alternating current was then passed through the four coils in series, the arrangements being such that the magnetic effect produced in the two small vertical coils was in the same direction, while the two long horizontal coils opposed each other. If iron bars are then introduced in the long horizontal coils, a deflection of the rays is produced in a vertical direction, the deflection being proportional to the induced magnetism. The horizontal deflection produced by the vertical coils is also proportional to the magnetising force. In this way the spot of light traces out the true hysteresis curve. The author gives some interesting photographs obtained in this way, using rods of iron, bundles of soft-iron wire, and, finally, a small bundle of wires surrounded by a brass tube. When the change in magnetisation is produced slowly, the curve obtained is in every case well defined and sharp at the corners. As, however, the frequency of reversals is increased, the curves become more rounded at the corners, and also enclose considerably more area, with the exception of the case in which the bundle of soft-iron wires with the brass tube was used. This, as the author rightly points out, is due to the eddy currents in the body of the bundle, and in the brass tube surrounding the iron wires, as above referred to. An interesting modification of the experiment was made by providing the two vertical magnetising coils with iron cores. The curves then obtained are difference curves, which depend on the varied permeability and hysteresis of the samples, and also on the strength and difference of phase of the eddy currents.

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Units.—Prof. R. A. Fessenden, in the *Physical Review* for February, contributes his second article on the "Determination of the Nature of the Electric and Magnetic Quantities, and of the Density and Elasticity of Ether." Although a certain amount of high mathematics are employed in the article, it is evidently written for the practical man, as the author's conclusions are most clearly expressed in everyday language. The appendix on the property of the atom affords most interesting reading, reviewing the work in this direction which has been carried on during the century. Coming to the electric and magnetic units, Prof. Fessenden again calls attention to the 4π difficulty. He considers, however, that there exists a way in which this difficulty can be got rid of without disturbing any of the legal units. It consists in shifting the 4π from the unit of quantity into the coefficient μ. From the equation curl (Q P) = Work/T. It will be seen that, there being but one curl, there is but one 4π. If the units of mass, length, and time are kept unchanged, the 4π can be got rid of in three ways: (1) By dividing up the 4π between Q and P—*i.e.*, making each $1/\sqrt{4\pi}$ times as large as before. This was suggested by Heaviside. (2) By putting the 4π over on the other side—*i.e.*, making the unit of work 4π times as large as before. This is impracticable. (3) By making one of the two quantities, Q or P, $1/4\pi$ times as large as before. The third method is the practical one. The coulomb cannot be changed, but the unit quantity of magnetism can be taken as equal to the present line, and the unit of difference of magnetic potential as equal to the current turn without creating any appreciable disturbance with the existing order of things. Neither of those quantities has been defined by law, and, as a matter of fact, the ampere-turn is already used by designers as a practical unit of gilbertance. Prof. Fessenden proceeds to follow up these suggestions, introducing new units for specific inductive capacity and permeability. These he calls "capity" and "permity" respectively, which terms he thinks will sufficiently indicate the fact that the quantities are allied to their predecessors. It is further pointed out that the increase in μ will not do much harm, as the permeability of samples of iron varies very largely and has to be tested very frequently. For instance, iron having $\mu = 147$ will under the new system have its $\mu = 1{,}846$.

The Supply of Lamps.—The central stations in America in a large number of instances supply the consumers connected to their mains with incandescent lamps free of cost. It hence becomes important to the electric light companies to select the best grades of lamps, in order that the cost of renewals may be kept down. Also, when consumers give up the supply, a certain number of the lamps are brought back into the central station which have to be either thrown away or used again. In any case, it becomes most necessary for the central station to have a well-equipped lamp-testing department. Mr. Lyman C. Reed, in the current number of the *American Electrician*, describes a few features in the lamp-testing department of the New Orleans Electric Lighting Company. Naturally, the greatest interest centres round the photometric measurements, as it in these that the greatest expenditure of time is likely to take place. We see that in the present instance a Bunsen screen is used for making measurements, and that the electric standard lamp is of the same candle-power as the one to be tested. Mr. Reed advises that the supply to the standard lamp and to the lamp to be tested should be from the same general circuit, so that slight variations may be neutralised. The socket supporting the lamp to be tested is made to revolve in order that the angle of the filament may not affect the results. The socket is arranged with spring sides, so that the lamp can be introduced while the former is revolving. It is found economical to have two operators, one to read the photometer and one to handle the lamps. In this way the operator at the photometer is able to keep up with the quickest handling of the lamps possible by the boy at the revolving socket. In the above company the lamps are divided into two classes, the first class being lamps which have a mean spherical candle-power of 16 and over. In the second class are placed lamps whose candle-power ranges from 13 up to 16. Importance is laid on the point that when lamps come back to the station they should be carefully cleaned before testing. In this way the renewal of lamps due to the fact that the users will not keep them clean, is avoided. In conclusion, Mr. Reed states that when these points are carefully attended to, only those lamps which are actually burnt out and those giving under 13 c.p. need be renewed. As a result of this, the annual renewal account was in one case reduced by quite 20 per cent.

The Pacific Cable Scheme.—On the concluding day of the annual meeting of the Associated Chambers of Commerce on Thursday week it was moved by Mr. Jones, of Liverpool: "That this association recommends that support should be given to the action which the Imperial Telegraph Committee of the House of Commons proposes to take, with the view of placing the important matter of electrical communication between the United Kingdom, India, and the British colonies and dependencies on a footing commensurate with the greatly-altered conditions of inter-Imperial and Colonial relations." In connection with this motion he asserted that French traders had a considerable advantage over their British competitors in the matter of cabling arrangements. In seconding the motion, Sir Edward Sassoon said that a cheap, rapid, and uniform system of communication throughout the British Empire on all-British lines was an admitted necessity, and therefore he urged them to support the Imperial Telegraphic Committee in asking that Parliament should formulate a State policy with regard to the system, which would embrace not only purely British interests, but Colonial, Eastern, and far-Eastern interests. During the last 20 years the nation, including the Colonial Governments, had paid £3,700,000 in subsidies to the cable companies. In the three months ended Jan. 31 last there were breakages and interruptions reported in the cable of the East and South Africa Company over a period of 72 days, or something like 74 per cent., and he thought that this was not properly carrying out the terms of the convention. The charge to Lagos also was 7s. per word, while the French could send to their West African possessions at 1s. 5d. per word. In any future concessions to private companies there should be a well-defined and proper scheme of charges based on the earnings of that company. Mr. Jones proposed a rider to the motion to the effect that the system of granting subsidies without stipulations for effective control, both as regarded the scale of charges for cable messages and as to the maintenance of cables in an efficient state of repair, was prejudicial to the strategic and permanent interests of the country, and calling the attention of Parliament to it with a view to the provision of a remedy. The motion and rider were unanimously agreed to.—We also learn that on Friday last the Canadian Senate adopted a resolution setting forth that any further delay in proceeding with the construction of the Pacific cable would be inimical to the interests of the Empire, and strongly deprecating granting further concessions to the Eastern Extension or any other companies.

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YORK ELECTRICITY SUPPLY WORKS.

York is a city that can boast of having had more names than any other city known to history. At least we have a list of more than 30 before us, of which "York" is the last and least in length. We do not intend to write the history of the city with the multiplicity of names, but intend to refer to what some of us might term the dawn of a civilised era, in that it refers to the initial public lighting of the city. Later on we shall refer to the most recent development of lighting. We have before us a text of an Act obtained in the year 1763, entitled "An Act for the better cleansing and enlightening the streets, lanes, and public ways of the city of York and the suburbs thereof, and of the liberty of St. Peter within the said city, and for keeping the same in repair and free from annoyance; and for regulating the hackney coachmen and chairmen, carmen and draymen, within the same." The text of the Act is somewhat lengthy, and of no great interest to electrical engineers, with the exception of that section dealing with lighting. The number of lamps to be placed in the streets is given in a schedule, and comes to the fairly large total of 389. The Act states that all "lamps shall be bell lamps, and 11in. in diameter, and all as near as possible of the same kind and goodness in all respects, and shall be either fixed with irons against the walls of the streets, lanes, and public ways of the said respective parishes or places, or upon strong posts fit to support the same, and that from and after Oct. 1, 1763, all such lamps shall be lighted at sunset every evening, and kept burning till twilight every morning, from Oct. 1 to March 31 inclusive, in every year and during the week of the annual horse races at or near York; and such number of lamps shall be so provided and kept fixed up as aforesaid in each of the said parishes or places within the said city, suburbs, and liberty, and as particularly specified and expressed in the said schedule hereinbefore referred to as aforesaid." Where the number of lamps was not given in the schedule, the lamps were to be fixed at distances apart not exceeding 40 yards, measuring on one side of the street. Of course they might be placed nearer together, but not nearer than 20 yards. Within these limits the positions were determined by certain officials mentioned. Provision was also made for increasing within limits the number of lamps specified in the schedule. The initial cost, and the cost of maintenance, was to be paid for out of the rates. At the date of this Act the light within the lamp must either be from oil or from candles, probably oil was used. From 1763 to the present time is a period of 137 years; during this period oil has given place to gas, and, as will be seen in the following description, the first steps have been taken by which gas will give place to electricity.

The history of the electric lighting scheme, though, of course, not extending over anything approaching the number of years as that of the city itself, nevertheless holds a unique record both in respect to its length and involved nature. We do not purpose giving more than a very brief outline of this history here, since anything more would require far greater space than stands at our disposal. For 10 long years the question of electric lighting has been before the Corporation, during which period it has passed through many phases, but has proved to possess a vitality which, having regard to the strenuous opposition met with, makes its record a notable tribute to the virtue of steady and untiring perseverance against the heavy odds of conflicting interests. It was in the year 1899 that the Corporation first took the matter up, when it was at once referred to the Streets and Buildings Committee, with the result that a sub-committee was appointed to further deal with the question. This sub-committee decided to recommend the Council to apply for a provisional order, and in August, 1890, such an order was obtained from Parliament, but its stipulation that the city should provide a system of electric lighting within two years of the date of issue was not complied with, although the committee, after studying the best methods of artificial lighting, had decided at an early stage in favour of electricity. A series of visits to various towns and cities was undertaken by the Streets and Buildings Sub-Committee in 1891, and a large amount of useful information so obtained. In May, 1892, it was recommended for the first time that the Corporation should undertake the work of providing an electricity supply themselves. This was eventually agreed to, and tenders were accordingly invited early in the following year. A number of firms responded, but the committee were undecided in their selection of a system, and

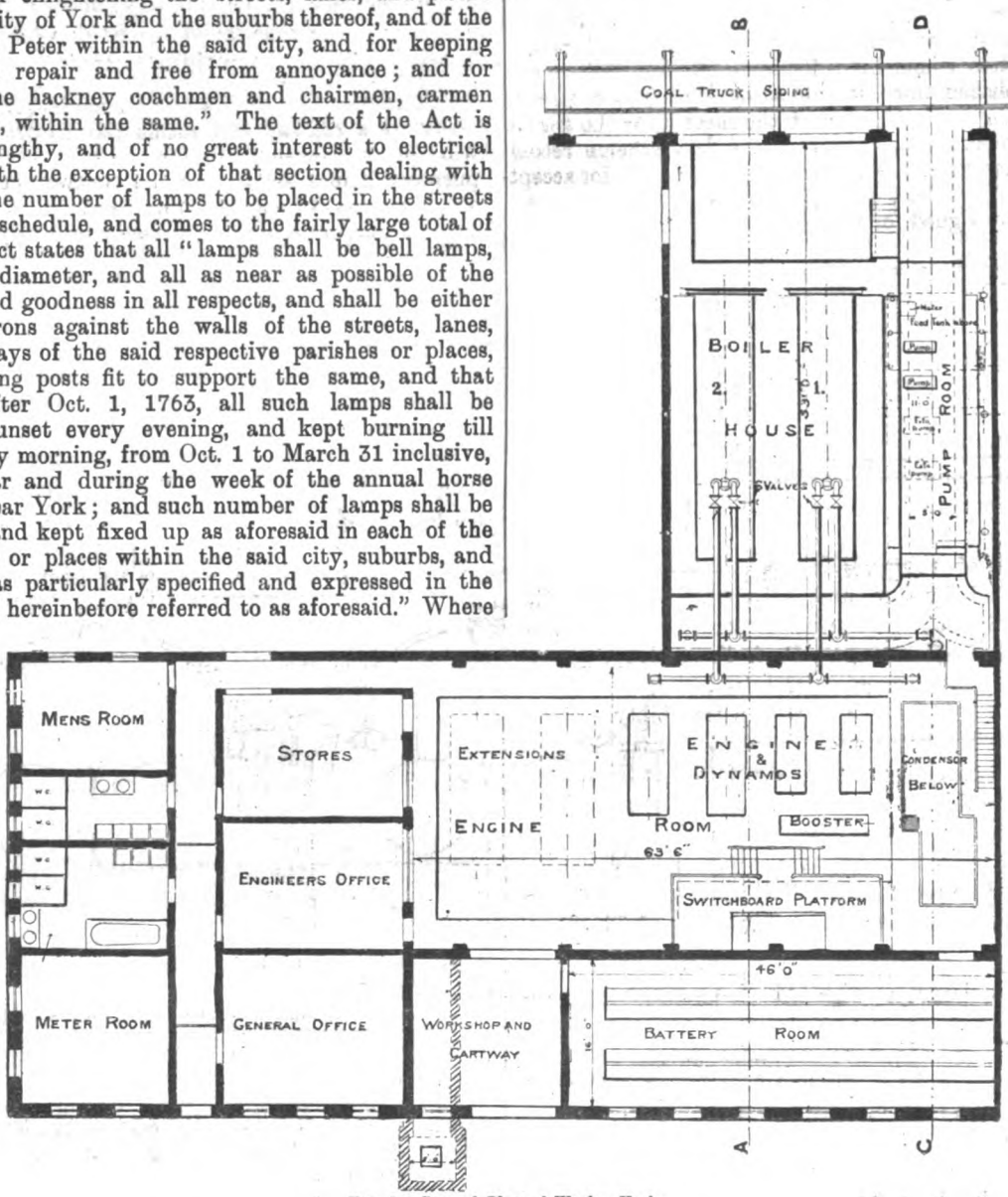

FIG. 1.—Ground Plan of Works, York.

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spent the years 1893-4 in considering the tenders, visiting further stations, etc. However, they reported in April, 1894, in favour of the low-tension continuous-current system of supply. In 1895 a further report was submitted to the Council and duly discussed, but with no definite result. The matter continued to occupy the attention of the committee, and many reports recommending as many different schemes were drawn up for the consideration of the Council, which generally referred them back for further information, until, in May, 1897, the committee finally reported in favour of adopting Prof. Kennedy's scheme and Messrs. Parker and Sharp's contract for the necessary buildings. Further delay, however, occurred, the Council not being able to make up their minds as to the proper course to pursue, with the result that the whole matter was referred to a special committee for further consideration. This committee commenced its work in June, 1897, and soon accomplished much in educating the city on electric lighting matters. In October of the same year the special committee reported in favour of the last scheme recommended by the Streets and Buildings Committee for acceptance, and in 1898 the Council, having adopted the report, contracts were signed for the works herewith described.

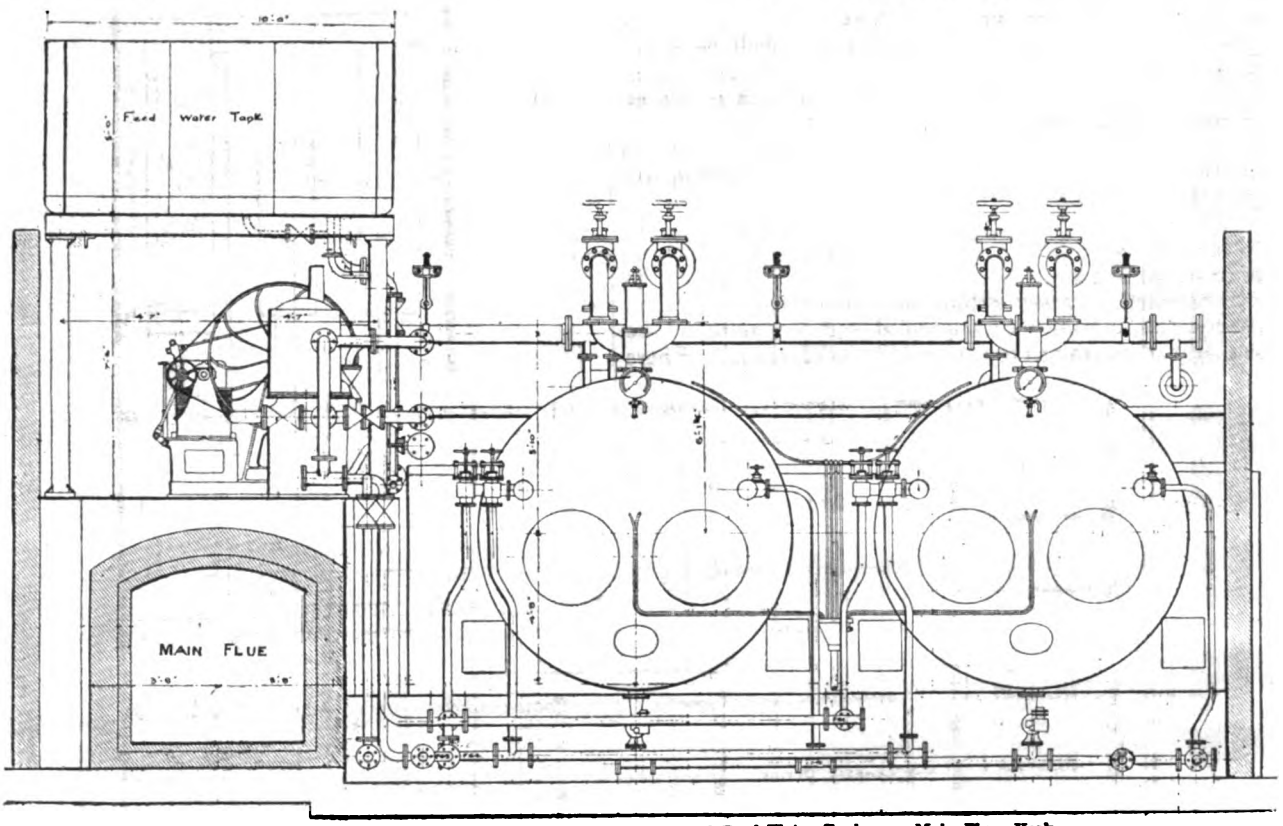

FIG. 2.—Front Elevation of Boilers, showing Feed Pumps and Feed-Water Tank over Main Flue, York.

Before entering into a technical description of the plant installed at York a few remarks may be made with regard to the present position and prospects of the undertaking. One great point in favour of York's future success with electric lighting is its possession of a very progressive and workmanlike Electric Lighting Committee. Alderman E. R. Dodsworth is chairman, and of 12 members it may be mentioned as an interesting feature that seven belong to the legal profession. Of the gentlemen who have taken an active part in furthering the undertaking from the outset, the names Scott and Purnell perhaps shine above all others. Councillor H. V. Scott has taken the greatest interest in the electric lighting question from the time when it was first mooted, and has stuck to it through thick and thin. He, with Alderman Purnell, who possesses technical knowledge which has stood the committee in good stead, are the remnant of the old Streets and Buildings Committee. York possesses some 75,000 inhabitants, and has a ratable value of £349,555, with an area of 3,692 acres. The gasworks belong to a company, the ruling price for gas being 1s. 9d. per 1,000 cubic feet. Though having the merit of exceptional cheapness, the gas supplied to York consumers has not the reputation of very high quality. It is, perhaps, mainly owing to the latter fact that electric lighting, even at this early stage of its supply, bids fair to acquire unusual popularity in York. Although supply to consumers has not yet been regularly started, the lamps connected to the mains already show a goodly total. By the end of the present month it is estimated that the equivalent of fully 10,000 8-cp. lamps will have been connected to the mains, there being application for a total of 12,000 8-c.p. in prospect. The consumers actually connected number about 100, the average number of lamps per consumer reckoned on the 8-c.p. basis reaching the high figure of 60. The above figures do not include street-lighting, which will ultimately be fairly extensive. At present the street-lighting consists of 20 arcs, but a further instalment of 40 is proposed. The public buildings are also being wired. In addition to lighting, the motor load promises to be exceptionally good for a town like York, which cannot be described as a manufacturing centre, but rather as a railway and residential centre. Then there will be a demand on the station plant for traction purposes before long, since the present tramways, which are horse-worked and in the hands of a company, will become Corporation property early in 1901, when it is the intention to convert them for electric traction on the overhead trolley system, at the same time making large extensions. With a view to this work a traction type of generator has been installed at the generating station, it being proposed to supply current from a common station for lighting and traction purposes. Owing to the exceptional and unexpected demand for current, the original instalment of plant has become inadequate before the inauguration of a regular supply. Immediate extensions are, therefore, contemplated which will practically double the capacity of the plant now fixed. But, having regard to the steady stream of applications for a supply which are coming in, it is probable that still further extensions will have to be faced at an early date, for the present plant is capable of supplying only 6,500 8-c.p. lamps, a very small initial capacity for a town of the size of York, though there were, no doubt, special reasons for the comparatively small initial expenditure of £25,560. With regard to the price charged for electricity to consumers, a sliding scale of rates has been adopted, whereby 7d. will be charged per unit for the first hour and 3d. afterwards for demands up to 5,000 units; 7d. and 2½d. for quantities over 5,000 units and not exceeding 10,000;

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7d. and 2d. for quantities over 10,000 units and not exceeding 15,000, while 7d. and 1½d. is charged to consumers requiring a maximum exceeding 15,000 units for lighting purposes. For motive power a flat rate of 3d. is charged, while to churches a special rate of 3½d. has been conceded. In the latter connection it may be remarked that York's famous Minster will probably be lighted throughout by electricity ere long.

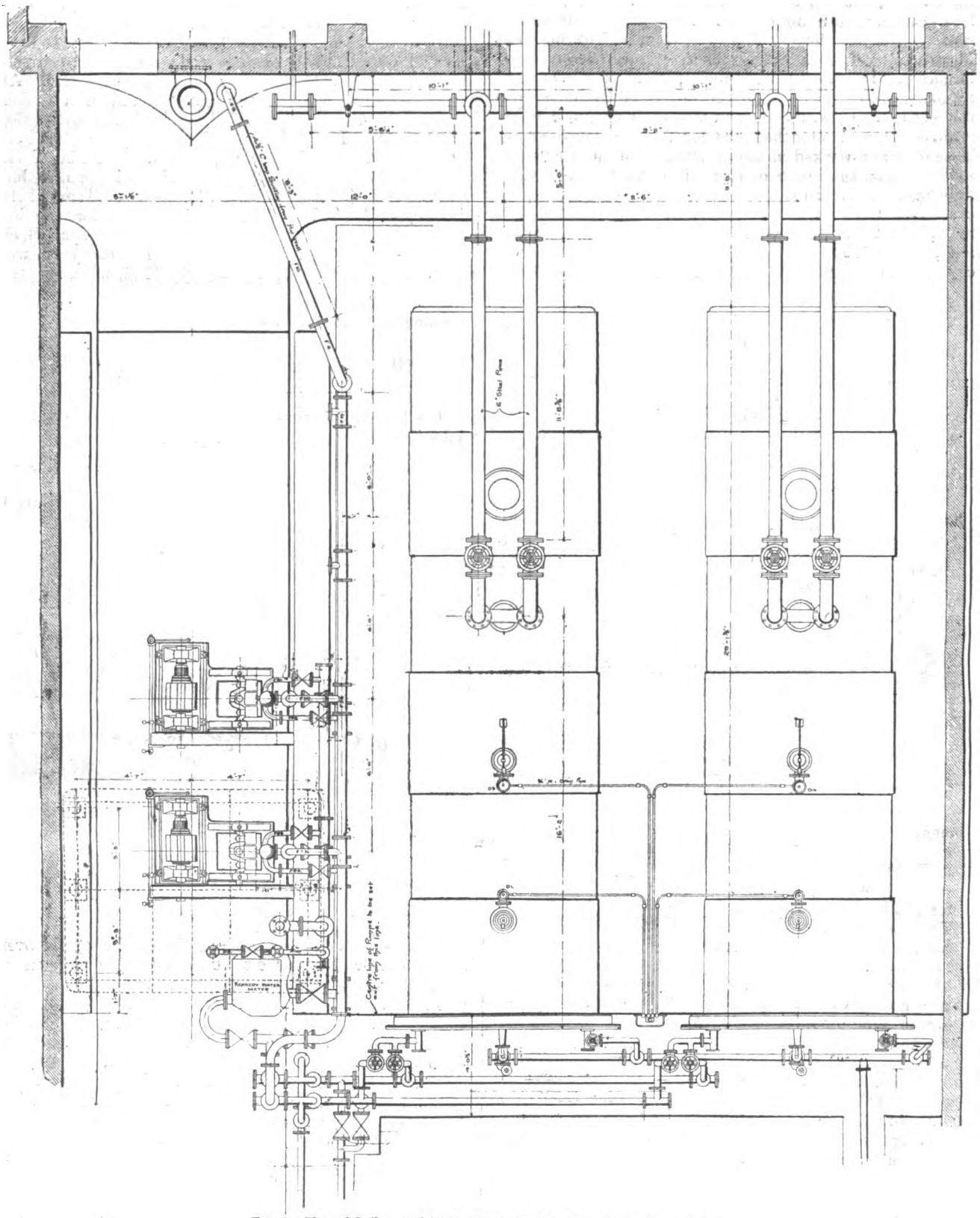

FIG. 3.—Plan of Boilers and Feed Pumps, showing Pipe Connections York.

Coming now to the details of the plant installed at York, it must be mentioned that Prof. A. B. W. Kennedy's scheme which has been carried out provided for a continuous-current generating plant and a low-tension three-wire system of distribution, with a pressure of 230 volts at the consumers' lamps. The site of the generating station buildings is not centrally situated relative to the area of supply, but affords good facilities for coaling and watering. Being situated near the River Foss, ample water is available for condensing purposes, and coal is discharged from a railway siding almost direct on to the stoking floor of the boiler-house. The site also affords plenty of room for future extensions. The station buildings were designed by Mr. A. Creer, the city engineer, and erected by Messrs. Parker and Sharp. They comprise an engine-room, boiler-house, battery-room, workshop, meter-room, storeroom, general and engineer's offices, etc., the general arrangement of which several departments will be seen from the ground plan (Fig. 1). The general design of the buildings is characterised by its compactness, substantiality being also a noticeable feature. Owing to the nature of the site, the ground being "made" to a considerable depth, extensive

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piling was found necessary, especially under the chimney shaft, in order to render the foundations secure. The shaft is a particularly fine specimen of its kind, being 180ft. in height, and of 7ft. 6in. internal diameter at the top. It is octagonal in form, and has a base 11ft. in diameter, the total weight of the shaft amounting to 2,120 tons. Notwithstanding the treacherous nature of the ground and timber foundations, no perceptible movement has taken place. Besides serving the present generating station, and the probable requirements of the same for some years to come, the shaft has been designed to serve a refuse destructor, the foundations for which are now being got in. This destructor will be situated at the back of the present boiler-house, and will consist, we understand, of four cells of the Manlove-Alliott type. The heat generated in the cells will be utilised to raise steam in a battery of Babcock and Wilcox boilers. It is possible that the two steam-raising plants may be eventually worked in conjunction, but, so far as we are able to state, the details of such an arrangement have not yet been decided upon.

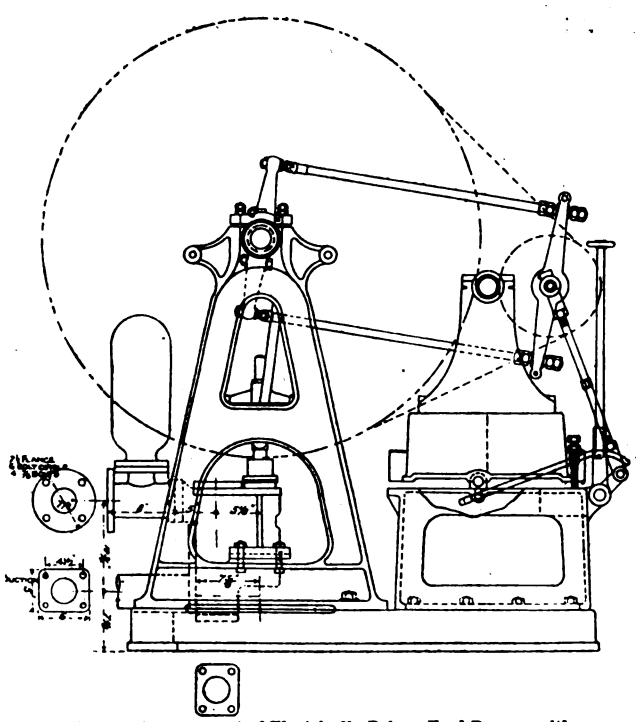

FIG. 4.—Arrangement of Electrically-Driven Feed Pumps, with Horlick's Gear, York.

With regard to the station equipment, it should be mentioned that the contract for the whole of the plant was entrusted to Messrs. Crompton and Co., Limited, the several sub-contractors to which firm will be named hereafter. The present boiler-house provides accommodation for two boilers, both of which have already been installed. They are of the Lancashire two-flue type, by Messrs. Robert Taylor and Sons, Marsden, Huddersfield. Each has a length over all of 28ft. and an internal diameter of 8ft. The internal flues have a diameter of 3ft. 3in., the fire grates being 5ft. 6in. in length. Internal anti-priming pipes, perforated along their sides, are fitted, the boilers being designed for a working pressure of 125lb. to the square inch. They are lagged and mounted with Hopkinson's fittings throughout.

The boiler-feed arrangements are more than usually interesting. Two three-throw feed pumps capable of each delivering at the rate of 1,200 gallons per hour against the full pressure of the boilers, have been provided. These are mounted over the main flue, as shown in Figs. 2 and 3, their weight being carried by transverse girders, and not by the flue. But the unusual interest attaching to these feed pumps centres in the fact that the necessary driving power is transmitted to them through Horlick's gear. The driving power is provided by electric motors, the general arrangement of the gear being better shown in Fig. 4. The motors are first run up to speed, the friction gear being then brought into play by pulling over a lever. This is a novel arrangement of electrically-driven feed pumps, but we understand it has given every satisfaction so far, running quite smoothly and without vibration. The arrangement of feed pipes provides complete duplication from the pumps to the economiser. The pumps draw their supply from a feed tank situated as shown in Fig. 2, which may be fed either from the river, or, as at present, from the town's mains. There is no alternative feed to the boilers, neither in the shape of injectors nor steam pumps.

(To be continued.)

PERPETUAL MOTION.

We received a letter on the above from Mr. C. Clarkson, of Liverpool, just too late for our last week's issue. Mr. Clarkson enclosed a few pages from the January issue of the American journal *Power*, which contained a description of a gravity motor very like one of Mr. Gilbert's design. In fact, save for a few unimportant details, the arrangements were just those of the machine shown in Fig. 1 in our issue of the 9th inst. The description states, however, that the American type was so constructed by its inventor that it would run. From the text, which is written in conversational style, we gather that after it had been running some 10 minutes its inventor used to remember an urgent appointment elsewhere. The motive power was apparently obtained from a spring, and a governor was used to prevent the speed becoming excessive. We are sending the paper on to Mr. Gilbert.

The following communication has also reached us from a subscriber in Italy on the same subject:

Sir,— I have just received the *Electrical Engineer* of March 9, and am afraid it is too late to criticise Mr. Gilbert's designs for obtaining perpetual motion. However,

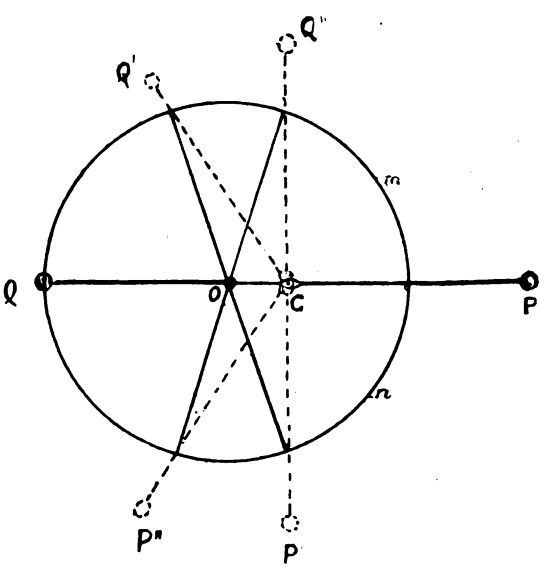

FIG. 1.—Diagram with Two Weights only.

I send you some facts to prove that Mr. Gilbert is mistaken. I was very young when I attempted to use the same ideas forwarded by Mr. Gilbert, and here are the facts which stopped me. When the weights, P and Q (Fig. 1), are disposed as in the accompanying sketch, it is evident that the wheel is not balanced, and P will move towards the position P'. In that way the action of P diminishes, while the negative effect of Q increases by its going off the centre of the wheel till we shall have P' = zero. When P comes under the axis G, Q' then acts considerably in the opposite direction. This unfavourable disposition of the weights supposed to provide power continues. When P' reaches the position of P'', and consequently Q' that of Q'', we shall have Q'' = zero, because it rests upon C, while P'' operates negatively. In fact, the power in the engine as proposed by Mr. Gilbert is only obtainable between *m* and *n*—that is to say, in about one-quarter of a revolution and during the rest of the revolution power is required.

GUISEPPE MUSSO.

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

255. In an alternating-current station with a small day load would it be advantageous to use a motor-alternator in connection with a set of accumulators? What is the usual arrangement when this is done?—A. C. R.

256. In winding the armature of a continuous-current transformer is it necessary for the primary and secondary windings to be wound in opposite directions—*e.g.*, assuming the primary winding to be wound in a clockwise direction looking on the primary commutator, must the secondary winding be wound in a clockwise direction looking at the secondary commutator? This question applies, of course, to a transformer with two windings on a single core.—Z.

ANSWERS.

Question No. 249.—Give a diagram showing the necessary connections for reversing the direction of rotation of a two-phase motor; also of connections for resistances of same.

Best Answer to No. 249 (*awarded* 10*s.*).—A two-phase system may be worked with four leads, in which case the two phases are not interlinked electrically, or it may be worked with three leads, in which case interlinking is present. It matters little for the consideration of the question which system is adopted, as there are only diagrams required. In practice, the two phases are always used with 90deg. phase difference, as this gives a constant angular velocity of the rotatory field, though it has the disadvantage of exciting a field whose strength varies somewhat during its revolution.

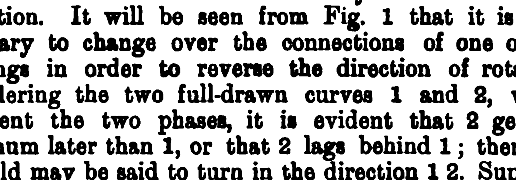

FIG. 1.

For the purpose of the diagram we may consider an induction motor with the magnet winding in two parts, and in the meantime the armature may be left out of consideration. It will be seen from Fig. 1 that it is only necessary to change over the connections of one of the windings in order to reverse the direction of rotation. Considering the two full-drawn curves 1 and 2, which represent the two phases, it is evident that 2 gets its maximum later than 1, or that 2 lags behind 1; therefore the field may be said to turn in the direction 1 2. Suppose, now, that the ends of the winding which gives the curve 2 are reversed. In this case we get the full curve 1 again, but 2 becomes the dotted curve 2′, which is simply 2 reversed as regards its sign. It is evident that 2′ precedes 1 now, and therefore the field turns in the direction 2′ 1. But the winding which gives 2′ is the same as that which gave 2. Hence the field has changed its direction of rotation from 1 2 to 2 1, and therefore the motor is reversed.

Fig. 2 shows how this may be brought about in practice. The magnets are shown as a simple ring, and the two windings are shown, each divided into two parts only for convenience. It is assumed that the power is brought to the motor by three leads. In this case one end of phase 1 is taken direct to a lead. The other end must be joined to an end of phase 2, and the junction point be taken to a second lead. To the third lead is taken the free end of phase 2. The problem is to be able to join an end of phase 1 with either end of phase 2 and with one of the three leads, and at the same time to put the free end of phase 2 to the other lead.

A simple way of doing this would be to have a two-way switch, as shown diagrammatically. The contact bar is special. It has three arms, all insulated from one another, but mechanically connected, the longest of which bridges over from the contact ring connected to the end of phase 1 to one or other of the contact-pieces connected to the two ends of phase 2, while the two short arms have each an end on the inner contact arc which is connected to the main lead only, and are arranged at such an angle to the main arm that when the latter is touching one contact stop one short arm is touching the other contact stop. The reversal

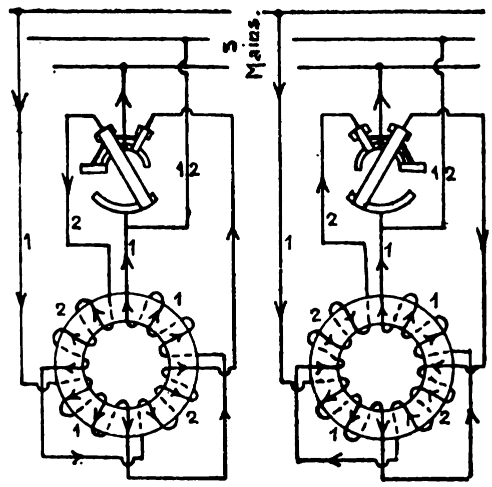

FIG. 2.

occurs by simply switching the long arm from one contact to another. That this is so can easily be seen from an inspection of the arrow heads in the two phases, which are taken for an instantaneous value, and show that phase 1 remains unchanged while phase 2 is connected across the mains in the opposite direction in the two diagrams. The armatures are not shown here, as they do not come into this part of the question. The foregoing explains how to reverse such a motor.

The resistance connections are shown in Fig. 3. The first diagram in the figure shows a short-circuited armature without commutator, and in this case the resistances must be put in the stator circuit. It is again assumed that three leads come from the generator. Two of these go direct to an end of each phase. The other ends of the phases are taken to the resistances, which are shown as liquid type here.

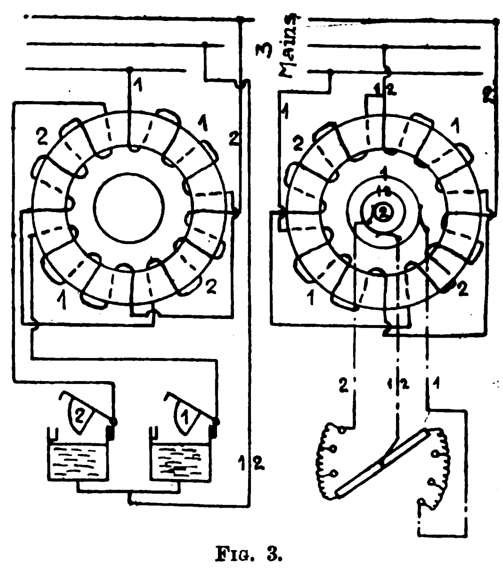

FIG. 3.

These are electrically connected together and the connection is taken to the third lead. The reversing arrangement is not shown here for the sake of simplicity. It could easily be introduced, as all that is necessary is to see that one resistance is in each phase, and that both resistances

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act synchronously, both on cutting out and switching in. As a rule short-circuit armatures are only built for small powers. The torque depends on the current in the armature and the strength of the field. In the case cited, the resistance weakens the field at starting, and so causes the armature current to be excessive at first. To avoid this, the motors for large powers are built with the ends of the armature windings brought out to sliding contacts, which are connected to resistances in the armature circuit. These are gradually cut out, leaving the armature practically the same as before electrically, but during starting they have the advantage of keeping down the armature current, as the field can be at its normal strength from the commencement.

The second diagram in Fig. 3 shows this arrangement. The armature is provided with three contact rings, by which it is diagrammatically represented, one of which joins the ends of the two phases, and is connected to the contact bar of the resistance permanently. The other two rings are connected, one each to a free end of the two phases, and from them leads are taken to the ends of the two resistances, which are here shown capable of being switched out and in by one contact bar, which works quite symmetrically on both. This latter method with resistances in the rotor circuit has a further advantage. In installations with high voltages, the stator field with no resistances can be highly insulated with great ease to stand the voltage. The armature, however, can be wound for quite a moderate voltage, and this makes the resistances cheaper, because they need not be so well insulated as formerly, when they were in the stator circuit, and the resistance to be brought into circuit is also reduced with the reduction of voltage. Hence it is preferable to use the arrangement corresponding to the second diagram in Fig. 3. The foregoing replies to the second part of the question, which is now therefore completely answered.—T. C.

Answer to No. 249 (*awarded* 5*s.*).—In order to reverse the direction of rotation of an ordinary two-phase induction motor it is only necessary to transpose the ends of the winding belonging to one of the phases, leaving the other phase unchanged. This has the effect of reversing the direction of rotation of the rotating field. It can be carried out by means of a simple double-pole switch, as shown in

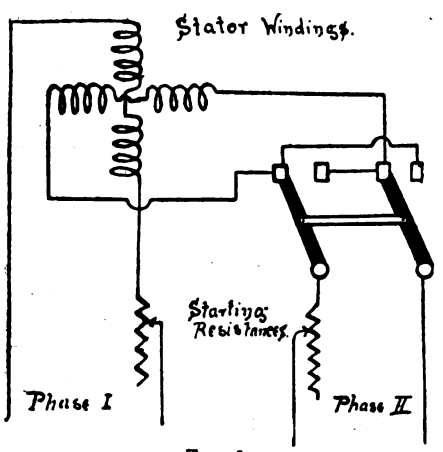

FIG. 1.

Fig. 1 for a four-wire two-phase motor, and in Fig. 2 for a three-wire one. If, when the motor is running at full speed in one direction, the reversing switch is suddenly thrown over, a large rush of current will occur in the rotor and in the stator, and at the same time the rotor will exert a powerful braking action and the motor is almost instantly brought to rest and then starts up in the reverse direction. In the case of railway motors this braking action is desirable, and is therefore usually not reduced by the insertion of resistances anywhere. In the case of small motors also it is often unnecessary to introduce resistances, as the current cannot rise to any very great value. For motors, however, whose output exceeds about 10 h.p., some sort of starting resistance is always supplied. This may be placed in the stator circuits, as shown in Figs. 1 and 2 (the whole resistance being inserted just before reversing and when starting up), but is more usually and with much greater economy placed in the rotor winding. For this latter arrangement the rotor must be of the "wound" type, with slip rings, and not of the short-circuited type. The windings of these rotors are usually arranged in three-phase

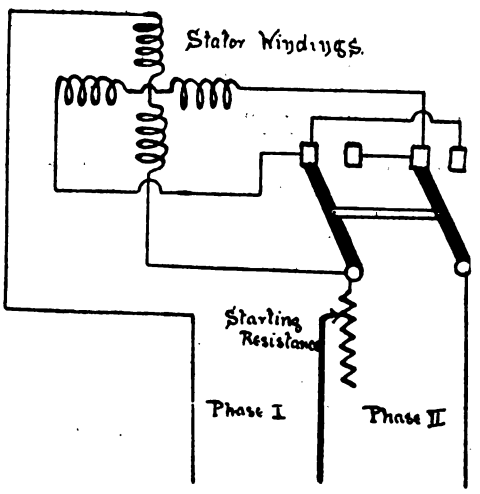

FIG. 2.

star fashion both for two-phase and three-phase motors, and a three-legged resistance is inserted, as shown in Fig. 3, the three legs being controlled by a single handle. When starting up, or when about to reverse, the whole of the resistance is placed in circuit, and is then gradually cut out until the rotor windings are short-circuited. In this way

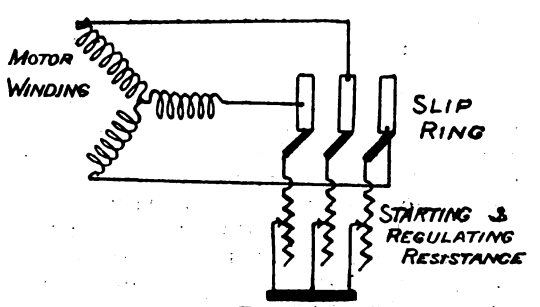

FIG. 3.

the rotor and stator currents are prevented from becoming excessive, whilst a reasonable starting or reversing torque is still exerted by the rotor.—Q.

Answer to No. 249 (*awarded* 5*s.*).—In order to reverse the direction of rotation of a multiphase induction motor it is only necessary to change over one phase of the stator winding, and although it is sometimes considered advisable

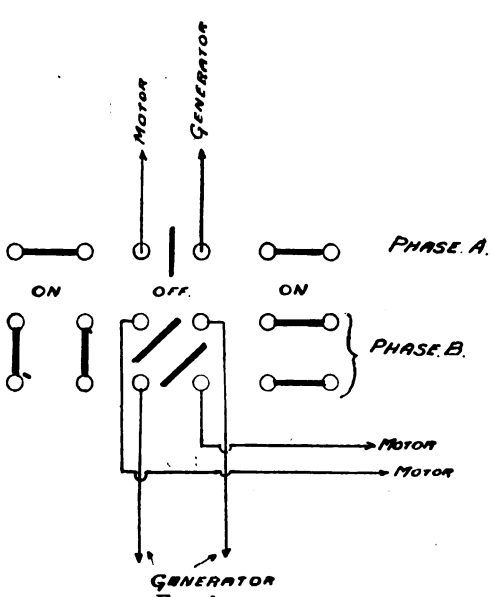

FIG. 1.

to change over all the phases of a three-phase motor, we need not enter into the reasons for this, as the question refers particularly to a two-phase motor. Fig. 1 is a diagram of connections of a switch for performing the

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necessary reversal. It will be seen that six contacts are required, two for the phase whose direction is not changed and four for the reversed phase. The three positions of the switch are shown, the thick lines representing the switch-arms bridging the contacts in each instance.

As regards the connections of a starting resistance, this will depend upon the method adopted for starting the motor, and it will not be out of place to briefly discuss the various arrangements for starting induction motors. When starting, an induction motor behaves as a short-circuited transformer, and consequently there is a big rush of current in both stator and rotor windings. This large current should result in a good torque, but owing to the action of leakage only a very small torque is actually produced, and unless the motor is on a loose pulley, and can thus quickly run up to full speed, there is a great probability of the windings getting damaged. Owing to this fact, and to the effect which it has upon the line voltage, it is advisable, and in the case of large motors absolutely imperative, that means should be taken to prevent, or at any rate greatly diminish, this sudden rush of current. We will consider three different methods of accomplishing this: (1) By means of step-down transformers, by which arrangement

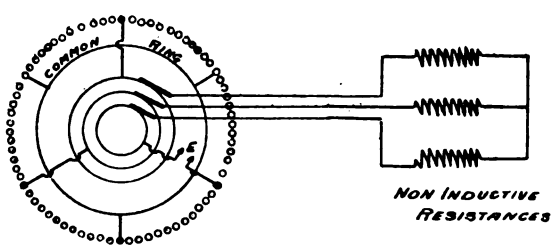

FIG. 2.

the motor can take a large current, but at a low voltage, while only a small current is taken from the line. The transformers are generally provided with a device for gradually short-circuiting the coils, and finally cutting out the transformer all together. (2) By inserting resistance in the stator windings. (3) By means of resistance in the rotor circuit. The advantage possessed by the two first methods is that a simple short-circuited rotor can be used, whereas a wound rotor with slip rings is an essential condition of the third method. By either of the first two arrangements the pressure at the motor terminals is reduced, and as the output of an induction motor is practically proportional to the square of the impressed pressure, consequently only a very small torque is available at starting. For this reason resistance is scarcely ever put in stator windings, but should it be decided to do this, or if transformers are used, the motor must be allowed to start on a loose pulley, for sufficient torque is not produced to start with load on. Now, as to the putting of resistance in the rotor circuit, this is probably the most advantageous arrangement, and may be done in two ways: either the resistance can be placed inside the body of the rotor, or it may be entirely

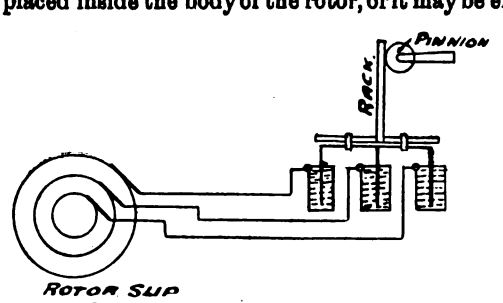

FIG. 3.

separate. By placing the resistance inside the rotor slip rings are dispensed with, but some device has to be provided for short-circuiting the resistance when the motor has run up to speed. In practice it will generally be found advisable to have the resistance on the exterior, as it can then be adjusted to any required value and gradually cut out entirely. The resistance may consist of coils of wire, or may be of the liquid type, but it is necessary that they should be as non-inductive as possible. Fig. 2 shows the connections for a wire resistance, which should be arranged in a cast-iron box, and if this is filled with oil the coils may have a very large current density, especially as they are only required at starting. A very compact and convenient arrangement is to put the starting and reversing switches in one cast-iron case and operate them by means of one handle, the only complication being that three double rows of contacts must be provided on the resistance switch, so that the required resistance is put in circuit when the lever is moved either in the right or left hand direction. Fig. 3 shows the arrangement of Dobrowolsky's liquid starting resistance, and needs no further explanation.—F. A.

Question No. 250.—Explain the three-voltmeter method of measuring power spent in the primary coil of an alternating-current transformer.

Best Answer to No. 250 (*awarded* 10*s.*).—Perhaps the simplest way of arranging what is known as the three-voltmeter method of finding power in any part of an alternating circuit is that shown in the accompanying diagram. A represents the source of supply of alternating current to the circuit; B represents the primary coil of the

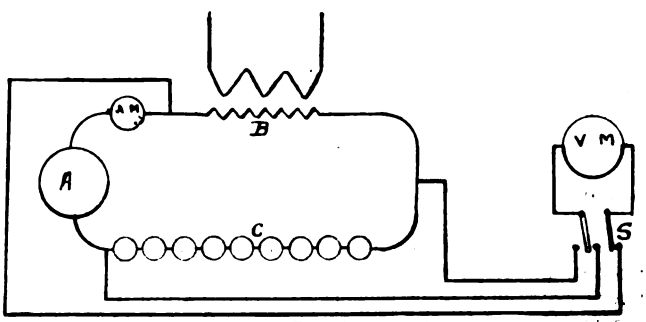

FIG. 1.

transformer under test; C represents a bank of incandescent lamps or some other such non-inductive resistance; A M is an ammeter to measure the current passing; V M (Fig. 1) is a voltmeter.

The usual method is to employ a separate voltmeter for measuring the E.M.F. of each of the three parts of the circuit, A, B, and C. Hence the name of "three-voltmeter" method. The arrangement above, however, enables *one* voltmeter only to be used, which can be switched across the terminals of either the source of supply, the primary coil, or the bank of lamps, by means of a simple switch, S. By doing this we avoid any possibility of error owing to the three voltmeters not reading quite correctly, and, as we shall see, a small discrepancy in one of the measurements affects the result largely.

Let us examine the different parts of the circuit. The bank of lamps has ohmic resistance, but *no* self-induction, hence the current flowing through them and the E.M.F. will coincide in phase, and their relative amounts will be according to Ohm's law. The primary coil of a transformer, on the other hand, has both resistance and self-induction, so that the E.M.F. and the current in this part of the circuit will not coincide in phase. The actual power, however, supplied to the primary is obviously the product of the current passing and that component of the E.M.F. which is in phase with the current.

By means of the voltmeter and switches, measure the effective E.M.F. across the terminals of A, B, and C. We will denote these as follows:

E M.F. across terminals of source of supply A = E;
" " " primary coil B = E_1;
" " " bank of lamps C = E_2.

Since our primary coil has resistance and also self-induction, it is evident that the E.M.F. across its terminals (E_1) will consist of two components, one due to the resistance, which we will call e, and which will be in phase with the current, and one due to the self-induction, which we will call e_1, and which will be 90deg. in advance of the current. Calling the resistance of the primary coil R, and the current flowing C, we have the relation $e = C R$. The accompanying graphic method (Fig. 2) of arranging these measurements, due, I believe, to Mr. Kapp, shows their relationship very simply:

Set out X Y horizontally equal to $e = C R$, and also X Z = E_1, to cut the vertical line through Y in Z. The

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two components, then, of X Z are X O and X Y, and X Y is equal to e, so that X O is equal to e_1, and is due to self-induction. Now set out X V equal to E. This consists of two components, one due to self-induction, but since the lamps have no self-induction, X O will be the component due to this. V therefore will be on the same horizontal

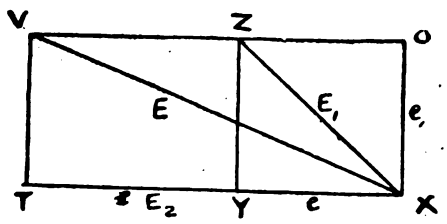


FIG. 2.

line as O and Z. Now, the E.M.F. across the lamps is in phase with the current and also with e. We have then

$$X T = E_2 + e,$$

and we find $$e_1^2 = E_1^2 - e^2;$$

also $$e_1^2 = E^2 - (E^2 + e)^2,$$

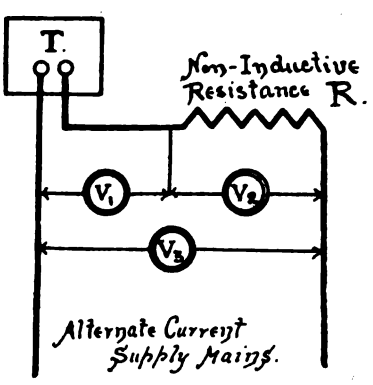
whence $$e = \frac{1}{2}\frac{E^2 - E_1^2 - E_2^2}{E_2}.$$

Now, the energy absorbed by the coil B = e C,

so that $$\text{energy} = \frac{C}{2}\left(\frac{E^2 - E_1^2 - E_2^2}{E_2}\right).$$

It will be seen from the nature of this equation that a small error in one of the readings, E, E_1, or E_2, will have a greatly magnified result, hence the need of eliminating tendency to mistakes by using one voltmeter only. The E M.F. across the primary and the bank of lamps should also be adjusted so as to be nearly the same in each case. Of course, as we must test the transformer at the pressure for which it was designed, it will be seen that the E.M.F. of our source of power must be some 40 per cent. higher than this. This will be obtained either direct from an alternator or by means of step-up transformers.—F. H. C.

Answer to No. 250 (*awarded* 5*s.*).—The connections for this test are shown diagrammatically in the accompanying figure. Simultaneous readings are taken on the three



voltmeters, V_1, V_2, and V_3, and from these readings and the known value of the non-inductive resistance, R, in ohms, the true power absorbed in the transformer or other apparatus, T, is found by means of the expression

$$\text{True watts absorbed in T} = \frac{1}{2R}(V_3^2 - V_2^2 - V_1^2).$$

The truth of this formula may be proved as follows: The voltage, V_1, across T may be considered as made up of two parts—one part, x, in phase with the current, and the other, x_1, in quadrature with the current—so that $V_1 = \sqrt{x^2 + x_1^2}$, or $x_1^2 = V_1^2 - x^2$. Now, since the resistance, R, is non-inductive, the current round the whole circuit is given by $\frac{V_2}{R}$. The true power absorbed in T is therefore $x \times \frac{V_2}{R}$. In the same way the voltage V_3 is made up of a part $(V_2 + x)$ in phase with the current and a part, x_1, in quadrature with it, so that $V_3 = \sqrt{(V_2 + x)^2 + x_1^2}$, or $V_3^2 = (V_2 + x)^2 + x_1^2$. Substituting the value for x_1 found above, we get

$$V_3^2 = (V_2 + x)^2 + V_1^2 - x^2$$
$$= V_2^2 + V_1^2 + 2 V_2 x,$$

or $$x = \frac{V_3^2 - V_2^2 - V_1^2}{2 V_2};$$

and the true power absorbed in T

$$= x \times \frac{V_2}{R} = \frac{V_3^2 - V_2^2 - V_1^2}{2R},$$

which is the required expression.

The test is not an easy one to take. It requires several skilful observers and the repetition of each reading several times if the results are to be at all reliable. It can be shown that the best conditions for accuracy obtain when the values of V_1 and V_2 are alike. Prof. Fleming has found experimentally (*Proceedings*, Inst.E.E., vol. xxi., p. 609, 1892) that though the method may be applied with fair accuracy to the measurement of non-inductive or only slightly inductive loads, it is liable to large errors when used to measure highly inductive loads, such as the watts absorbed by open magnetic circuit transformers at no load. The reason for this is explained by Dr. Sumpner and Prof. Ayrton in the *Proceedings*, Royal Society, London, vol. xlix., p. 434, 1891, where it is shown that if an error of n per cent. is made in the reading of each of the three voltmeters the resulting error in the power will be $n \times \sqrt{\frac{2 + 4(1 + \cos\phi)^2}{\cos\phi^2}}$ per cent., where $\cos\phi$ is the power factor of the load. Supposing $n = 1$ per cent., the error in the power works out at about 5 per cent. with a load whose power factor $\cos\phi = 75$, but becomes as much as 40 per cent. with a power factor of 06, such as occurs in a Hedgehog transformer on open circuit. The three-voltmeter method cannot therefore be recommended for general workshop use.—Q.

MUNICIPAL TRADING.

On Wednesday last a monthly dinner of the London Chamber of Commerce was held in the Empire Room of the Trocadero Restaurant, when the subject selected for discussion was "Municipal Trading." Lord Avebury had arranged to preside at the dinner and to open the discussion, but, unfortunately, he was prevented through ill-health. In his absence the chair was taken by Major Flood-Page, who was supported on his right by Lord Wemyss. After the toast of "The Queen" had been duly honoured,

Major FLOOD-PAGE, in opening discussion, called attention to the way in which the electrical industry in this country had been hampered by legislation introduced with the idea of benefiting the municipal authorities. Instead of England taking the highest place in electrical engineering, we had in consequence to be content with a low position amongst the nations of Europe with respect to electrical work. He wished to call their attention to the fact that other trades were likely to be similarly affected unless some boundary line was drawn as to the scope of municipal trading. The Associated Chambers of Commerce had by a large majority passed a resolution petitioning Parliament to appoint a joint committee to consider the question. This joint committee, which, if appointed, would consist of five members of the House of Commons and five of the House of Lords, would form the highest tribunal to which the question could be referred. He was not an advocate of hurrying the matter, and would be content, if, after taking a certain amount of evidence, which should be disseminated amongst the people largely, the committee deferred reporting for 12 months. Personally he thought that municipal enterprise should be confined to doing everything by which all ratepayers gained and by which no ratepayers lost. In Bills now before Parliament 31 corporations were seeking powers to own patents and 19 were asking for powers to manufacture steam-engines and dynamos. He was strongly adverse to a municipal authority owning patents, which might at any time bring them into a lawsuit involving

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an expenditure of from £10 to £40,000. He also did not see why the Manchester Corporation should build dynamos in competition with the large firm of Mather and Platt, one of their ratepayers. Again, the extension of municipal trading might result in an awful danger from political influence, as politics played a considerable part in our municipal life. He considered that all trades were equally affected, and it must be remembered that in opposing Bills before Parliament they had to oppose the interests of the Association of Municipal Corporations, which had the disposal of a large amount of ratepayers' money. He thought, however, if the country really understood what was intended, the opposition to such measures would be successful.

In Lord AVEBURY'S absence, the following communication from him was then read: "The subject which has called us together this evening is one of great, growing, and, what is known in the House of Commons as, 'urgent public importance.' The indebtedness of our local bodies already much exceeds £100,000,000; but if the present tendency be continued it will reach many hundred millions, and it is, indeed, rapidly assuming gigantic proportions. The following are among the businesses which various municipalities in Bills before Parliament this session ask for powers to undertake: banking, pawnbroking, coal supply, saddlery, telephones, tailoring, manufacture of electrical fittings of the residual products of gas, supply of apparatus for games, Turkish baths, cold-air stores, refrigerators, estate agency, printing, constructing lifts, etc.; and such proposals seem open to many objections. Thus in the first place the municipalities will either make higher charges or lose money, or both. Again, the proposals will involve borrowing on a stupendous scale. In the United States, I understand, the sum invested in electrical undertakings alone already far exceeds £50,000,000; and if the proposals of our municipalities are to be carried out generally, it will involve borrowing to the extent of at least 100 millions of money in this respect alone. It is impossible to say how many hundreds of millions the total will reach. It is undesirable that either the State or the municipalities should be involved in labour problems more than can be avoided, and it will also be a great check to progress. I had the honour of being one of those who introduced the electric light into the country. We had great difficulties to contend with, and were many years without any return, and though the company is now flourishing the dividend is only 6 per cent. I allude to this because my colleagues and I always felt that we had special difficulties in those cities where the municipalities owned the gasworks and looked on us therefore as rivals. We have seen this session also the municipal objection to Bills for providing cheap electrical powers to our manufacturers. The supporters of municipal trading talk a great deal about private 'speculators,' but to my mind there is a wide gulf between useful enterprise and anything which can reasonably be called 'speculation.' If, however, speculation is the right word, then I submit that speculative investments ought not to fall within the limits of municipal duties. Last, but not least, I submit that the action taken by municipalities not infrequently tends to defeat the very object they had in view—taking, for instance, the housing of the poor, which is a subject we all have at heart. Any error, therefore, which would lead to the opposite result is the more to be regretted. It was generally agreed that in many, perhaps most, of our cities, there were slum districts with houses unfit for human habitation. Now, there were two ways of dealing with this state of things. The municipalities had power under the existing law to compel the owners of such property to put it into a proper condition; or, secondly, they might buy the property and build workmen's dwellings themselves. The first seemed to me the true policy, but the second is advocated by many high authorities. Lord Rosebery recently went to Shoreditch to open some workmen's dwellings erected by the Vestry, and he highly commended the Vestry, but his speech, if carefully read, was a crushing indictment of their policy. 'You have,' Lord Rosebery said, 'accommodated 300 families, dispossessing perhaps many more than that.' The number of persons, they were told, who were displaced, were 533, and those who were provided for were 472. This seems a curious way of 'housing the poor,' and dishousing would seem a more appropriate expression. It was evident that the more poor they housed under this system the more would be houseless; but did the 472 who were housed belong to the same class as those who were displaced? Not at all. Lord Rosebery went on to say, 'You build admirable buildings, but the inhabitants of these new buildings are not the people you dispossessed. . . . These buildings are so superior that in some cases they are occupied by a class for whom they were not intended'—that was to say, under this curious plan of housing the poor they turned out 533 poor people and housed 472 people, many of whom were richer and better off. That seemed a curious way of 'housing" the poor. But this was not all. Lord Rosebery went on to say that there would have been in those buildings none at all of the class for whom they were intended 'if the Vestry had not exercised a wise discrimination in refusing tenants who offered much more than the rents which you are prepared to accept.' That was to say, the Vestry was to spend thousands of pounds of the ratepayers' money in building houses, and then to exercise a wise discrimination in letting them below their value. Surely, that offered a wide vista of jobbery and corruption. But that was not all. When the London County Council proposed to adopt a similar policy, I wrote to the great societies which had housed thousands of the working classes, and asked them what would be the effect upon them. They all said that they should erect no more dwellings, and as the municipalities were doing it, they should stop. There was no doubt that if the London County Council and the vestries had not put up any buildings at all, there would be at the present moment many more workmen's dwellings than was actually the case. On the other hand, if what had been done by the vestries was right, it was a vast tinkering with a vast subject. London had a population of 5,000,000, and to house a few thousands of them was really nothing. If it was to be done, it should be done thoroughly, and as it had cost £30,000 to house 500, they would see what a gigantic sum would be required to carry out such a policy. The policy seemed to be one that would be fraught with disastrous results. Lord Rosebery went to bless, but the effect of what he said was to condemn the policy of the Shoreditch Vestry. That policy ought not to masquerade under a false name. It would be less tempting if it were called what it was—a policy, not to house, but to dishouse the poor. Perhaps, then, it would not be quite so attractive. The facts at least, I think, show that the subject requires very careful consideration, and that with the best intentions we may be defeating the very object we had in view. Our municipalities have immense responsibilities and problems to solve, which are enough to tax all their energies. The Government have promised a joint committee to consider the whole question. Surely, therefore, till this committee has reported no extension of powers should be given."

Mr. SYDNEY MORSE said that the tentacles of the municipalities were being drawn round practically all trades, and he considered that the actions of these municipalities would be exceedingly disastrous to the industries of the country. He referred to the bad effects of the Tramway Act of 1870, as there were comparatively few tramways constructed under that Act which had been successful. The short tenure of life, coupled with the fact that at the expiration of the time the municipality could buy the tram way at break-up values, had ruined the tramway industry Any such action did not really benefit the ratepayers. The monopolies in the old days had proved exceedingly disastrous to the country, and he could not conceive that a monopoly controlled by 40 or 50 members ignorant of the technicalities of the undertaking, and influenced largely by their loudest-voiced members, could be commended. He was sure that they would not care to put their money in such an undertaking. He was pleased to note that on Monday last the Committee of the House of Commons had thrown out the Huddersfield Bill, which would have authorised the Corporation to construct tramways largely outside their districts. He thought that the action of the Association of Municipal Corporations, which was practically an association of town clerks, should not be allowed to

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influence the action of members of Parliament in the way now attempted.

Mr. MORRIS spoke in favour of municipal trading if confined to those undertakings in which public property, such as streets, was made use of. He thought that lighting and traction could be done well by the public authorities. He also commented on the fact that when the parcel post was introduced the carriers throughout the country strongly objected, but that public good had resulted from the move.

Lord WEMYSS considered that the corporations should confine themselves to the sewers, sanitary arrangements, and the roads, and leave the supply of public commodities to individual effort It was individual enterprise that had made the nation, and not the municipal authorities. He believed that the Electric Lighting Acts had thrown back the electrical industry very considerably. This was recognised by Parliament, in that the period mentioned in the first Electric Lighting Act had afterwards been doubled. Even if it resulted in higher charges, he believed that private enterprise should be fostered, and predicted that if the present state of affairs was allowed to go and increase there would be no Chambers of Commerce in future, as all the work would be kept in municipal hands.

Other speakers followed in favour of opposition being brought to the extension of municipal trading, and

Major FLOOD-PAGE finally summed up the debate by pointing out that the whole enterprise of the Empire was at stake.

INSTITUTION OF ELECTRICAL ENGINEERS.

Storage Battery Problems.

BY E. J. WADE, ASSOCIATE.

Part I.

Everyone who has given any thought to the principles underlying the chemical storage of electrical energy must at some time or another have been struck by the extraordinary fact that in spite of the theoretical reversibility of every galvanic combination—and their name is legion—yet one and one only out of the whole number is commercially feasible, so that at the present day storage cells may at once be classified thus—practical: lead-sulphuric acid-lead peroxide cells; unpractical: all others. Such, however, being the state of affairs, it appears a fairly safe inference that this special combination must possess distinctive features not shared by any other, or at least by any other whose cost is not prohibitive, and on examination this soon proves to be the case.

Several noteworthy features, each contributing towards its success, might be cited; but the really unique characteristic of the combination as a whole lies in the fact that the electrodes, the active materials, and the compounds produced from them are, under every normal condition of use, all insoluble in the electrolyte employed. In every other galvanic combination with which commercial storage has been attempted one or both of the electrodes or active materials have been soluble, and this solubility has in the long run invariably proved fatal. If a soluble negative is used, and the majority of the attempts made have been in this direction by substituting zinc for lead, the metal can only be redeposited effectively under certain conditions, and for a limited number of times. If the positive is soluble, as, for instance, in the early attempt of Messrs. Thomson and Houston to adapt the Daniell cell to storage purposes, there is the additional trouble that its soluble salt inevitably reaches sooner or later to the negative electrode, where it is also deposited and sets up destructive local action. The latter objection of course applies to all kinds of fluid depolarising agents. For these, amongst other, reasons the difficulties in the way of constructing successful storage cells with soluble electrodes have up to now proved insurmountable; while a second combination, which follows the lines of the lead accumulator and only forms insoluble compounds at both poles, yet remains to be discovered. So advantageous, however, to the electrical industry might be the results attending the introduction of an altogether new type of cell, possessed of greater capabilities than those now in use, and so considerable should be the reward of its inventor that the subject well merits further investigation and experiment in both directions; but I incline to the apparently paradoxical opinion that the solution of the problem (if any) will be an insoluble one. Also, I think that, considering the extent to which the field has already been worked over, success is most likely to be attained by the utilisation of some of the less studied and more obscure reactions into which the metals enter.

On turning our attention again to the lead-sulphuric acid-lead peroxide combination, the storage cell of commerce, a second remarkable fact encounters us. We find that although these cells have now been manufactured and used on a large commercial scale for close upon 20 years, and during that time have been the subject of frequent laboratory investigations, it is not yet definitely settled what are the exact physical and chemical changes taking place in them. Now, this is a most unsatisfactory state of affairs. If, as is not impossible, we may always have to depend on this one combination for all practical electric storage, it becomes of the greatest importance to determine whether its capabilities have already been developed to their utmost limits; or, if not, in what directions further advances are possible; but how can this be done without any certain basis to work from? The last 15 years have witnessed more improvements in lead accumulators than might at first sight be apparent from an inspection of the cells themselves, for they have consisted not so much in any radical alterations of type as in a better understanding of the methods of treatment, the processes of manufacture, and the proper proportions and relations of the various component parts, a general readjustment, in fact, of many details all tending towards one common end, and resulting in an apparatus far better able to meet the requirements of its users. On the other hand, there are indications that empirical experimenting has nearly reached its limits, for I do not think that many of these improvements have been made very recently. It is true that within the last few years there have been numerous attempts, as the Patent Office records bear eloquent witness, to reduce the weight of the cells in order better to adapt them for traction purposes generally, but more especially for use in electric automobiles. Time and trial have already pronounced their judgment on most of them. A few survive, but whether their sum total of usefulness shows any increase over earlier types appears to be doubtful. It has, of course, long been known that weight could be considerably reduced at the expense of life and durability, if circumstances rendered it desirable to do so; but unless the one factor is improved without depreciating the other, that in itself hardly constitutes any real advance. On this question of weight *versus* durability, however, the views of members who have had actual experience with the later and lighter types of cells would be of much use and value.

The preceding considerations must be my excuse for devoting a considerable portion of this paper to a discussion of some of the theoretical and chemical questions connected with lead cells; for if I can help to throw light, or be the means of getting any further light thrown on this part of the subject, I may after all be doing the most practical service possible. Personally, I have no doubt that, as far as any explanation based solely on the results of chemical analysis can help us, the "double sulphation" theory gives the nearest approximation to what does or should take place on discharge. Put shortly, this theory maintains that, on discharge, lead at the negative and lead peroxide at the positive react with sulphuric acid in the electrolyte, and are both converted into normal lead sulphate, water being eliminated at the positive; and the reactions are expressed chemically in the following well-known equations:

At the negative electrode—

$$Pb + SO_4 = PbSO_4 ;$$

at the positive electrode—

$$PbO_2 + H_2 + H_2SO_4 = PbSO_4 + 2H_2O ;$$

and the sum of the reactions at both electrodes—

$$Pb + 2H_2SO_4 + PbO_2 = 2PbSO_4 + 2H_2O.$$

I have advisedly said that this is the "nearest approximation" to the discharge reactions, for the above statements, if taken literally and without considerable mental reservations, especially with regard to the very definite facts embodied in the equations, are probably inaccurate, and certainly open to question in nearly every particular.

In the first place, it is doubtful whether negative active material is simply lead, Pb, using the word and symbol without any qualification and in their usual sense as applied to the ordinary metallic form of that substance. If for a negative electrode of spongy metal electrolytically prepared, we substitute one containing metallic lead in as fine a state of subdivision as it is possible to procure it by purely mechanical means, such, for instance, as lead dust or lead wool, no practical storage capacity can be obtained. The evidence seems to show that the spongy lead at the negative, in addition to its extreme porosity, possesses distinctive chemical properties and is a true allotropic modification which enters into combination somewhat differently to how lead does in its normal condition. M. Darrieus, who was, I believe, the first to propound this view of the nature of the negative active material, has shown that the E.M.F. of various galvanic combinations in which electrolytically prepared lead is employed is ·3 to ·4 volt higher than that obtained by substituting ordinary sheet metal. This proves that the former must be in an abnormally active state, and the same fact is shown chemically by the extreme readiness with which negative active

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material oxidises when exposed to the action of the air, the combination taking place so rapidly that the heat liberated very considerably raises the temperature of the electrode.

Secondly, there is some reason for believing that the positive active material is not normal lead peroxide, PbO_2, if we adapt as our standard for that compound the residue left after treating red lead with dilute nitric acid, which certainly has a proportional composition agreeing with this formula. Mr. Fitz-Gerald drew attention to the point in 1890, the evidence being of a somewhat similar nature to that just adduced in the case of the negative active material—namely, a difference in the E.M.F.'s generated by the two substances. The probability is therefore suggested that the crystalline electrolytically prepared peroxide of a positive electrode is also an allotropic modification and not identical with the amorphous anhydrous peroxide obtained by chemical means; but in this case the matter is complicated by Mr. Fitz-Gerald's further observation that, as far as his experience goes, the electrolytic peroxide is always hydrated. While then, for lack of more definite knowledge, still using the formula PbO_2, it must be considered only provisionally correct.

Thirdly, the usual equations are very misleading as to the nature and composition of the discharge products. Quite apart from the confirmation afforded by analysis, the most casual examination shows that the active materials are never fully sulphated by the time the discharge is completed, no matter under what conditions it is taken nor how small the quantity of active material employed. Even with the merest films of spongy lead and lead peroxide the same fact is patent to the eye.

This is indeed only one aspect of the more general objection which has been urged by Mr. Fitz-Gerald for many years past, that the very definite discharge equation must have some equally definite E.M.F. corresponding to it, no matter what may be its absolute value; whereas the E.M.F. of a discharging cell is a constantly varying one. Even granting that the small but rapid drop of E.M.F. generally observed during the first few minutes of a discharge is the result of special reactions not allowed for in the equation, and that the complete and sudden loss of voltage which ends the discharge is also brought about by causes beyond its scope, yet the fact remains that throughout the normal and useful portion of the discharge lying between these two, the E.M.F. is slowly but steadily falling all the time. Even the assumption of the partial conversion of either of the active materials into normal lead sulphate, $PbSO_4$, under ordinary discharge conditions, is not to be reconciled with their observed behaviour, which is in many respects incompatible with the presence of large percentages of that substance. To instance one. Normal lead sulphate is probably quite irreducible, if not unperoxidisable, in a dilute sulphuric acid electrolyte of the strength ordinarily used in storage cells, provided all the materials are absolutely pure, for the smallest traces of impurities make a remarkable difference in this respect. But however that may be, there is no doubt as to its being acted upon with extreme slowness, under the most favourable conditions, in admixture with other materials of a more conductive nature, and then only with an excessive outlay of energy in proportion to the result obtained; whereas both the active materials can be brought back to their original states of lead and lead peroxide with great rapidity and the expenditure of very little more current than is theoretically necessary. This discrepancy, as well as the almost complete masking of other properties of the normal sulphate, can hardly be explained as due to its state of extreme sub-division and intimate admixture with unaltered active material, for under certain well-known conditions of treatment it does appear in full possession of its distinctive colour and with its non-conductivity and irreducibility aggressively in evidence.

A good deal more might be said as to these and other reasons which forbid our accepting the double sulphation theory in its simplest form except as a purely provisional statement; but without stopping to discuss them further, I will give a very brief summary of what I believe to be the real nature of the various changes that go on in the cells.

Commencement of Discharge.—The active materials of fully-charged negative and positive electrodes consist of lead and lead peroxide respectively, but both in allotropic or polymeric states, and possessed of a molecular structure far more complex than is represented by the formulæ Pb and PbO_2.

Normal Discharge.—On discharge, no molecules of lead or lead peroxide are wholly and directly converted into normal lead sulphate; but, still maintaining their complex molecular structure, they pass through a long series of true compounds containing SO_4 in gradually increasing proportions. In this way no portion of the active materials loses its conductivity, nor is cut off from electrical connection with the remainder, and its easy and rapid desulphation on recharge is thereby provided for.

End of Discharge.—This absorption of SO_4 does not and cannot go on until the molecules are fully sulphated, because at some intermediate stage their electrical resistance, which previously has only been increasing slowly, commences to go up with extreme rapidity. This change is necessarily accompanied by an equally sudden and rapid fall in the cell's potential difference, which soon passes below the usual limiting value; but if the circuit is still maintained the internal resistance goes on rising, and in a short time the potential difference is reduced practically to zero. Most probably the rapid acceleration of resistance sets in when the molecules of active material have attained the respective proportional compositions $Pb_2O_2SO_4$ and Pb_2SO_4.

Reversal.—If the current is kept flowing through the cell by means of an external E.M.F., reversal now commences. No further sulphation of the active materials takes place, the proportion of SO_4 present in the molecules remaining constant throughout this stage, but lead gradually passes over to peroxide at the negative, and *vice versâ* at the positive, until their composition, as given above, is exactly reversed. Here again the change is only effected through a whole series of intermediate compounds, and the molecules retain their complex structure intact.

Recharge.—The recharge of a cell, whether in continuation of the reversal or as the normal charge following on a discharge, consists essentially in the gradual withdrawal of SO_4 from the molecules until allotropic lead and lead peroxide are again reproduced. Other reactions on charge are only incidental, so far as the active materials are concerned.

"*Sulphating.*"—Using this word in its well-understood technical sense, sulphating consists in the breaking up of the complex molecules, containing more or less SO_4, into a number of simpler and independent molecules of normal lead sulphate and of lead or lead peroxide. This rearrangement of structure destroys the continuity and conductivity of the active material, and at the positive, if not at both electrodes, is accompanied by an increase in bulk which may lead to the breaking up of itself and its support. Nothing further is needed to bring about this change than rest on open circuit; but the instability of the compounds appears to be largely proportional to the percentage of SO_4 present either in the active materials or in the electrolyte—that is to say, it increases with the extent to which the cell is discharged and with the strength of acid used in it. Probably local action, due to impurities and other causes, plays an important part in facilitating the same result, and a still more favourable condition is the excessive weakening of the acid electrolyte in the pores of the active materials during discharge.

It will be observed that the foregoing views are entirely based on the possibility of the active materials existing in two distinct molecular states—an allotropic one involving a complex structure, and, although unstable, corresponding to the normal and healthy working condition of the cell, and a simpler and more stable one, but identical with the undoubtedly deleterious condition known as "sulphated." From its very nature direct proof of this assumption is almost impossible, and as the indirect arguments are mostly theoretical, and require a consideration of some of the purely chemical characteristics of the lead compounds, I have dealt with them separately in the second part of this paper. In it I have also traced out in more detail the different changes that must ensue in the cell according to this hypothesis, for the way in which it enables us to furnish a consistent and reasonable explanation of the cell's behaviour in every respect appears to me to furnish one of the strongest arguments in its own support. One obvious objection to the theory may be referred to here. Involving, as it does, the formation of numerous sulphated lead compounds of indefinite composition, it runs counter to the usual text-book chemistry, which draws an absolutely hard-and-fast line between chemical compounds and mechanical mixture. In recent years, however, the rapid advances made in our knowledge of physical chemistry have provided much evidence obtained from very different sources, such as the properties and behaviour of alloys and of aqueous solutions, all tending to prove that substances may exist whose components do not apparently follow the law of combination in multiple proportions, and yet must in other respects be regarded as true molecular and chemical compounds. Of this nature are the compounds normally formed during the discharge, reversal, and recharge of a lead cell.

From this basis of theory we can now proceed to the consideration of some points of more direct practical importance. In the first place, if it is true that the molecules of active material inevitably cease liberating electrical energy when they are about 50 per cent. sulphated (giving on analysis 44 per cent. by weight of unaltered peroxide at the positive, and 40·5 per cent. of uncombined lead at the negative) owing to a sudden and large increase in their electrical resistance at that stage, then the actual performance of commercial storage cells approaches far nearer to the theoretically possible maximum than has hitherto been supposed. If it could be effected electrically, the complete sulphation of 1lb. of lead would liberate 118·5 ampere-hours, and the complete reduction to sulphate of 1lb. of lead peroxide, 102·5 ampere-hours; but I consider that the real standard of perfection should be just half these values—that is, 59·25 and 51·25 ampere-hours respectively. (The figures for the peroxide are based on the assumption that its proportional composition is PbO_2; if it is hydrated, its possible

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output will be slightly less.) The active materials of well-designed and properly-formed Planté-type electrodes do, I think, often approximate to these outputs when discharging at low rates, say in nine to twelve hours; and, judging from the analyses of the positive paste in the E.P.S. cell, tested by Prof. Ayrton in 1890, the active material of Faure-type electrodes is also capable of doing so; but in this special instance the previous treatment of the cell was exceptionally favourable, and as on a 12-hour discharge rate its capacity came out about 33 per cent. above its listed value, it had evidently been worked up to a state of efficiency but seldom attained, still less maintained.

In practice, pasted electrodes hardly ever give more than 30 to 40 ampere-hours per pound of positive or negative active material; while about half these values is probably a more usual figure: for, although the specific output of the active materials in new electrodes is often high, yet in many cases it decreases considerably with use; and if the electrodes are of faulty design or manufacture, or the cells not properly looked after, it may drop to almost any extent. However, with all electrodes, whether of the Planté or Faure type, there is a very considerable falling off in the specific output of the active materials as the discharge rate is increased. The exact amount and curve of decrease varies with every different make of cell, but the best of them do not, at a three-hour rate, give more than two-thirds to three-quarters of their output on a nine to twelve hour rate, while if discharged in one hour their output is only about one-half, or even less. After all, then, there is still some considerable margin left for improvements in the ratio of output to weight, especially when rapid discharges are required, and these are often precisely the cases where a reduction in weight would be of the most importance and use, provided it were not effected at a sacrifice of durability.

It is evident that to obtain the maximum output from any active material the electrolyte must have access to each of its individual molecules so as to include them all in the electrolytic circuit, and its porosity, therefore, must be thoroughly molecular—that is to say, in addition to the spaces that exist between the small visible particles of material, each of these particles must itself be porous throughout. Most negative active material necessarily fulfils this condition, as the electrolytic reduction of the oxide or other insoluble salt employed must leave each molecule of lead surrounded by a space, also of molecular proportions, previously occupied by the other elements in combination with it.

The case of positive active material is somewhat different. If it is prepared from salts, such as lead sulphate or lead chloride, possessing about twice the bulk or half the density of lead peroxide, its molecular porosity is initially provided for just as it is in negative active material; but if it is obtained from litharge or minium or other compounds whose density is about the same as that of the peroxide itself, it is not at first sight evident how it can possess any porosity beyond the spaces between its visible particles, while if it is produced from solid metallic lead by a formation of the Planté type, no porosity of any kind seems to be provided for. In all these cases, however, the materials, before being peroxidised, no doubt pass through an intermediate stage of partial sulphation accompanied by a proportional increase in bulk, so that in this respect the conditions are to some degree the same as if lead sulphate had been the original raw material. That some such growth of the positive active material does take place during its first formation is shown by the expansion of its support which almost invariably attends this process, whether the electrodes be of the formed or pasted variety. But although the pores and spacing are there, they are quite inadequate to contain anything approaching the amount of electrolyte required for the full discharge of the active material surrounding them. Negative active material sufficiently porous to hold its own volume of liquid will have what is sometimes incorrectly called a "density" of 5·7 (half the density of solid lead, 11·4), or, as I prefer to term it, a 50 per cent. porosity; and this is a good average figure for the spongy lead in commercial cells. Lead peroxide being bulkier than lead, positive active material is, as a rule, not nearly so porous, and a good average material will certainly not have more than a 33 per cent. porosity, or a so-called density of about 6·3 (two-thirds that of solid PbO_2, 9·45), and it will only contain one-half its own volume of electrolyte. Now solid lead requires about 24 times and solid peroxide about 16 times their own volumes of dilute sulphuric acid specific gravity 1·200, for their 50 per cent. sulphation with a fall of acid strength to specific gravity 1·150; so that negative and positive active materials of good average porosity can only contain about one twenty-fourth and one thirty-second respectively of the quantity of electrolyte necessary for their complete discharge under these conditions. Even if the whole of the acid were abstracted from the solution in the pores, leaving nothing there but water, then the negative and positive active materials could respectively contain only about one-eighth and one-eleventh of the necessary amounts of 1·200 acid, or about one-seventh and one-tenth if 1·300 acid were employed. These figures show very clearly how entirely the output of a lead cell is dependent on the diffusion of acid from the main body of the electrolyte into the depleted solution in the pores of its active materials. As long ago as 1889 Messrs. Duncan and Wiegand called attention to some of the results that must ensue if proper diffusion were not provided for; and Messrs. Gladstone and Hibbert, in their communication to this Institution in 1892, also indicated some of the effects probably due to this cause. In the latter instance, however, they were considering the matter chiefly in its relations to the E.M.F.'s of cells under various conditions; and I think it yet remains to be recognised how far-reaching are the consequences of defective diffusion, and how many of the faults and shortcomings of the cells may be attributed to it. Rightly to comprehend the scope of its action, it is advisable to consider in some little detail just what takes place in the active materials of a cell when discharging at some rate sufficiently high to bring the effects of imperfect diffusion well into play—that is, at a rate which reduces its output considerably below what can be obtained at slower rates.

It is impossible to say the exact proportions in which the different parts of the active materials will contribute towards the discharge current on first closing the external circuit, for this largely depends on the relative resistances of the electrolyte and the active materials themselves—a very problematic question. Lead in a solid state has only about one-twelfth the conductivity of copper, and in the porous condition its specific resistance is almost certain to be very much higher, but even then it is no doubt considerably less than that of the electrolyte; so, as regards the negative electrodes, the layers of active material nearest to the opposing positives will tend to supply more than their due share of the total current. On the other hand, although lead peroxide is one of the best conductors of electricity of any solid compound substance not entirely metallic, its specific resistance is of the order of a fluid electrolyte, and is probably higher than that of the ordinary acid solution in a cell; therefore, at the positive electrode it is possible that at first the inner layers of active material may discharge a little more rapidly than the others. At both electrodes, however, the distribution of the work is also affected by other conditions, such as the nature and position of the conducting support; and, on the whole, it will be simpler and not much amiss to assume that the initial contribution of every molecule of active material to the discharge is approximately equal, provided that sufficient time has elapsed since the previous charge for the strength of the acid thoroughly to equalise itself throughout the pores. But this state of affairs begins to alter immediately after the discharge has commenced. The diffusion not being sufficiently rapid to supply acid to all parts of the electrolyte as fast as it is being withdrawn by the active material, the solution becomes graduated into a series of layers or strata (assuming the active materials are of uniform porosity throughout) of different strengths; those layers directly adjacent to the surface undergoing practically no alteration, while the innermost layers will be the most weakened.

This change must necessarily be accompanied by a variation in the E.M.F.'s acting at different parts of the active materials, for it has been demonstrated by several researches, notably those of Messrs. Gladstone and Hibbert and of F. Streintz, that the E.M.F. of a lead-lead peroxide couple in dilute sulphuric acid depends on the strength of the electrolyte. Roughly speaking, it slowly decreases from 2·05 volts in 1·200 acid to 1·85 volts in about 1·030 acid, and then drops away rapidly to 1·45 volts, the E.M.F. of the couple in pure water. Consequent in its turn upon the variations in the E.M.F., the relative rates at which the molecules generate current are correspondingly affected throughout the active materials, for only by that means can a uniform potential difference be maintained between every portion of the opposing electrodes. In this way, too, the inequalities in the strength of the electrolyte are prevented from passing certain limits, because just as fast as the acid in solution diminishes, so does the rate of sulphation which brings about this diminution decrease also, until at all points in the active material the absorption of acid and its replenishment by diffusion just balance each other, the net result being that the outer layers supply considerably more, and the inner layers considerably less, than their due share of the current. This unequal distribution of the work is not only maintained throughout the discharge, but becomes more pronounced towards the end, for the conditions which regulate the rate of diffusion are steadily growing worse the whole time. The active materials gradually increase in bulk as they sulphate, thereby reducing their porosity, and it is just those portions through which the whole of the diffusion to the interior has to take place that choke up soonest and most thoroughly. As the discharge proceeds the E.M.F. falls fastest when the sulphation is most rapid, and a more equitable proportion of the work would then be thrown on to the other parts of the active materials were it not that their output is limited by the rate of diffusion, so they can only draw on the surrounding electrolyte till its strength and their E.M.F. is correspondingly reduced.

To be continued.)

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LONDON TRAMWAYS COMMITTEE.

In a good many directions the ways of English legislation are wonderful. They are to go-ahead people crude, extortionate, and dilatory, yet, as Lord Rosebery said of the Boer war, we muddle through all right in the end. But at what a cost! Take the matter of the London tramways as an example. The situation is this. The London County Council, rightly or wrongly, has been allowed to acquire the tramways, but having acquired the tramways it is not permitted to work the tramways by the best methods known to practical science without obtaining further powers. The necessity for further powers is due to the fact that change of system involves further expenditure, and further expenditure is not allowed to any authority when the money has to be borrowed—that is, when it is not paid out of revenue. There may be great wisdom in this paternal supervision of finances, but, as we say, it is costly. It is an ill wind that blows nobody good, so the class yclept lawyers and agents revel in the proceedings for obtaining and opposing Bills. Necessary, therefore, under existing conditions, but, nevertheless, very much of the nature of a farce, are the proceedings this week of the House of Commons Select Committee, presided over by Sir S. Hoare, to consider the Tramways Bill (No. 2) of the London County Council. All that has been said of a vital character for or against the power sought by the Bill could have been said on half a dozen sheets of foolscap, considered by the electrical department of the Board of Trade in the length of a winter's afternoon, and fairly decided by the head of that department at a cost inappreciable compared with that incurred by a Select Committee. So far as we can find, not a single new word has been said and no information added to what already existed. The Council, as we all knew, and as set forth in his opening the case by Mr. S. Pope, Q.C., intends to use a conduit system generally, but wishes to retain the right to the use of an overhead system in suitable districts with the consent of the vestry. Out of forty local authorities in the county of London, only three appeared in opposition to the Bill. According to precedent, the case for the Council was put forward to show its sunniest side, and although it is not expected to do quite as well as Glasgow, it is estimated that with the advent of the use of electric traction a considerably increased profit will be made, estimated at £140,000. To make the required electric installation requires an outlay of £850,000, and allowing £59,000 for interest and sinking fund at 7 per cent. per annum, a profit on the transaction of £81,000 will remain. Of course these figures are all estimates, and we may say at once we have no great confidence in them. What we have confidence in—and the reason for such confidence can be obtained from every forward step through historic times—is that any action taken to increase comfort and convenience for travel has always obtained substantial reward. The supersession of broad-wheel wagons by coaches and of coaches by railways, and of the old-fashioned railways by the newer developments, are all instances

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to the point. Just as in each of these cases time was saved, comfort and convenience increased, with a corresponding increase of revenue, so the supersession of horse traction tramways by electric traction tramways will increase traffic, and that to an extent which fully warrants the change over. Exact figures are therefore unnecessary, and though estimates may be incorrect, the result is bound to come out favourable. Whether we are correct or not in thinking that tramways are an evil and an hindrance to progress is not now in question. We are bound to accept things as they are, and not as the idealist would have them; thus tramways are a transition evil, and must be made as acceptable and useful as possible. The putting of one competent engineer at the head of affairs will ensure uniformity, a result that will conduce to economy as well as convenience. He will ensure by his design that if practicable—and it is practicable—no electrolytic action will trouble the gas or water mains, also that as little disturbance as possible will be made with such mains during the period of change, and, in fact, that the least expense, trouble, or annoyance will be given in any direction. In his evidence he stated that he had allowed £15,000 per mile as the cost of the change over, and any engineer will know that this means as perfect construction as can be obtained. A saving of £3,000 per mile might be made by an overhead system, and £1,500 a mile by a surface-contact system. As regards the latter, although its possibilities are very great, it is doubtful whether any engineer of repute would at the present time pin his whole faith upon any system yet tried. Altogether, the evidence before the committee has been frivolous, not to say vexatious, the whole affair being a sheer waste of time and money caused by our antiquated methods of procedure.

LONDON TRAMWAYS.

The committee appointed by the House of Commons to consider the Tramway Bill (No. 2) of the London County Council decided yesterday afternoon to recommend that the same should be passed, subject to the systems of traction adopted being approved by the Board of Trade.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

DEATH BY ELECTRICITY.

SIR,—In your reprint of my article on the above subject in your issue of Feb. 9, 1900, a comparatively serious error exists, due, undoubtedly, to the typographical omission of a decimal point in the footnote to the original contribution in the New York *Electrical World and Engineer*. This error was corrected by me in a short letter to the editor, and the correction appeared in that journal on Jan. 6, 1900. In the article as it appears in your journal, it seems that I passed *six* amperes at 12,000 volts through a dog without causing permanent fibrillation, or stoppage of the heart-beat. In reality but *six-tenths* (0·6) of an ampere at 12,000 volts were passed through that animal, which, of course, is quite a different matter, and if one considers that many dogs can withstand that intensity, or even a current of considerably greater intensity, for several seconds without the production of the physiological cardiac effect, the failure to kill the animal in the above-mentioned instance was neither remarkable nor very unusual. Many subsequent experiments with properly measured currents at that voltage, and of even less intensity, for instance, 0·3 virtual ampere, have clearly demonstrated that, contrary to the statements of Messrs. Prevost and Battelli, the high-tension currents from transformers and induction coils yielding secondary currents of sufficient intensity produce cardiac fibrillation just as readily as equally strong low-tension alternating or continuous currents do.

Further, if I may extend this brief communication a little more than I had intended to do at the outset, I wish to add that, after numerous endeavours to cause the fibrillating dog heart to resume its normal mode of action by the brief application of a shock from the powerful high-tension transformers employed by me in my experiments, I have not found such shocks at all efficient in causing such hearts to resume their beats in the fashion described by Prevost and Battelli. In fact, similar shocks applied from my electrical apparatus to the normally beating heart *vid* the skin always threw that organ into fibrillation. Possibly the capacity of the machinery employed by me was too great. However, a momentary shock from a condenser of the proper capacity and properly adjusted will often cause the heart to resume its beats, as I have pointed out, an observation that has since been corroborated by Prevost and Battelli in the *Journal de Physiologie et de Pathologie Générale*, No. 1, January, 1900.—Yours, etc.,

R. H. CUNNINGHAM, M.D.

FORTHCOMING EVENTS.

FRIDAY, MARCH 23.

Physical Society.—At 5 p.m., discourse on "An Electromagnetic Experiment," by Prof. S. P. Thompson, F.R.S.; "Some Experiments illustrating Syntony," by Mr. P. E. Shaw; and "An Electrical Micrometer," by Mr. P. E. Shaw.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "The Development of the Modern Locomotive Engine," by Mr. J. W. Cross.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., paper on "Methods of Charging for Public Supply of Electricity," by Mr. W. W. Lackie.

SATURDAY, MARCH 24.

Institution of Electrical Engineers.—At 11 a.m., students' visit to the works of Messrs. Easton, Anderson, and Goolden, Limited, Erith. Train from Charing Cross at 9 50 a.m.

North East Coast Institution of Engineers and Shipbuilders.—At South Shields, general meeting.

Glasgow and West of Scotland Technical College Scientific Society.—At 7 30 p.m., paper on "High-Speed Reciprocating Engines," by Mr. A. Coats, B.Sc.

Royal Institution.—At 3 p.m., Lecture III. of six on "Polarised Light," by Lord Rayleigh, M.A.

MONDAY, MARCH 26.

Society of Arts.—At 8 p.m., Cantor Lecture IV. of four, "Photography of Colour," by Mr. E. Sanger Shepherd.

TUESDAY, MARCH 27.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Discussion on papers on "The Great Central Railway Extension—Northern Division," by Mr. W. F. Bidder, and Southern Division, by Mr. F. Douglas Fox, M.A.

FRIDAY, MARCH 30.

Electro-Harmonic Society.—At 8 p.m., at Café Monico, smoking concert.

Institution of Civil Engineers.—At 1.45 p.m., students' visit to the works of Messrs. John Bazley White and Bros., Limited, Swancombe.

SATURDAY, MARCH 31.

Royal Institution.—At 3 p.m., Lecture IV. of six, on "Polarised Light," by Lord Rayleigh, M.A.

ELECTRIC TRACTION.

At a largely attended meeting of the Gloucestershire Engineering Society, held at Gloucester on Wednesday night, Mr. W. A. Walton, A.M.I.E.E., read a paper entitled "A Glance at Electric Traction, and its Progress in the United Kingdom." After noting the chief advantages offered by electric traction, the lecturer briefly considered some of the methods adopted for harnessing the great unseen force to our tramcars and rolling-stock, and then proceeded to review some typical examples

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of works that had been carried out in the United Kingdom. If, said Mr. Walton, they looked into the various means by which vehicles were electrically propelled, they found systems in great variety, and much ingenuity had been expended on some of them; but for their present purpose it would suffice to group them in the following manner: (1) electricity conveyed by a third insulated rail beside the track; (2) by an overhead conductor; (3) by accumulators carried on the vehicles; (4) by an underground conduit, necessitating a slot in the roadway throughout the track; (5) by surface contacts on the roadway.

The first-named, or third-rail system, as it was best known, was used for overhead or underground railways, or such tracks as were entirely fenced and enclosed. Obviously, level crossings would not be possible, nor could such a system be applied to street traffic. Several very successful examples of the system were in operation in this country, but the completion in 1893 of the overhead electric railway at Liverpool eclipsed all former undertakings. It had been a notable success from the start, and still occupied an unique position in this country. Even the well-known Metropolitan Railway was about to adopt electricity for a section from South Kensington to Earl's Court, £20,000 being voted for the experiment, and it was quite probable that eventually the whole of the Circle would trail behind electric locomotives.

With regard to the accumulator system, such a self-contained arrangement, said Mr. Walton, appeared to have many possibilities, but practical and commercial difficulties stood in the way. In the first place, the accumulators added greatly to the deadweight of the vehicle, and in order to keep the weight as low as possible the batteries had to be worked at high rates of discharge in comparison with their size. High maintenance cost and low efficiency were the result, fully 30 per cent. of the stored energy being lost. For road vehicles, where the tractive force might be 60lb. or 70lb. per ton of load, the deadweight of the accumulators inflicted serious limitations; in fact, they might look upon electric vehicles of this description as a "dream of the future"—from a commercial standpoint, at all events. For tramway purposes, with 30lb. per ton as the tractive effort required, the situation was not quite so bad, but considerations of weight and space prevented power enough being carried to run at satisfactory speeds, an entirely downhill route being somewhat difficult to find. There was an accumulator line in Birmingham about three miles long, and worked by 12 cars. These were being worked with very fair success by chloride cells, but the Birmingham Tramways Company would, however, gladly convert the line to the overhead trolley system next week were it not for opposition on the part of the local authorities.

Coming to the conduit systems, of which, said the lecturer, many had been devised, and a pile of money had been handed over to a considerate Patent Office by sanguine inventors, many practical difficulties beset these systems. Great first cost was unavoidable, and the maintenance, involving so much supervision and repairs, would be heavy. Considerable difficulty was found in preventing leakage from the charged conductor, wet and dirt getting through the slot and causing much mischief. Blackpool had two miles of line on the promenade running for some years, but Mr. Quin, the Corporation engineer, found that with the spray from the sea playing havoc with the insulation, and sandstorms filling the conduit with sea-sand, a change was desirable; in other words, if the trams were to "go" smoothly sentiment must go, too, [and he boldly urged the overhead trolley, which had since been adopted, and considerable extensions to the tramways had been carried out.

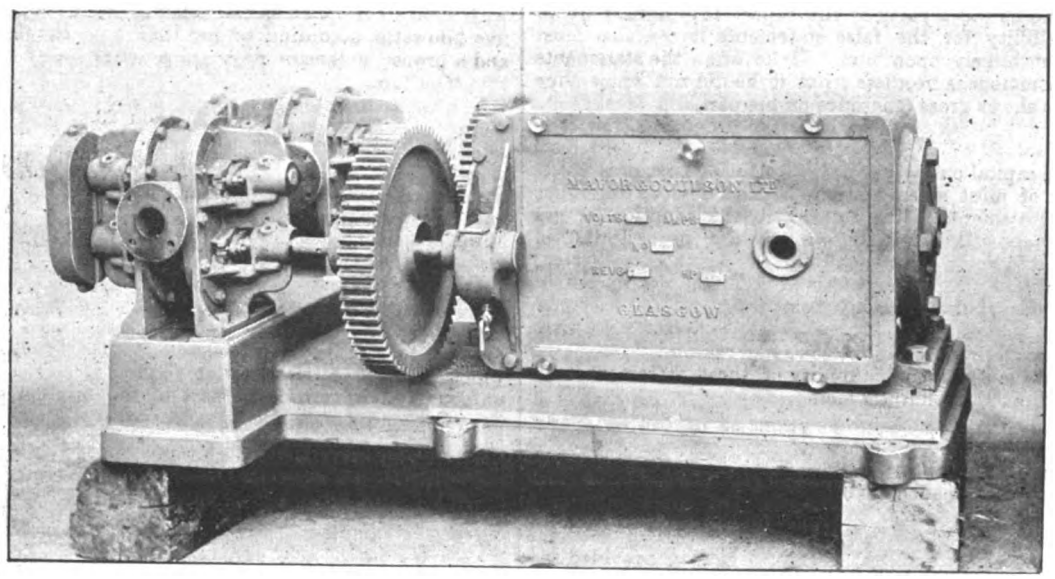
With reference to "surface-contact" systems, like conduits, the first cost was heavy, and upkeep probably heavier. They, like conduits, might at present be considered experimental in this country, but if the practical difficulties of either could be overcome, they would form a valuable adjunct to the overhead system for busy centres of traffic.

Reverting to the overhead trolley system, and after dealing with its practical application and details, Mr. Walton said that, notwithstanding the opposition brought against the overhead conductor, it was making great progress, as the list of tramways adopting it clearly showed. For ease of equipment, moderate first cost, and low maintenance costs, it left all competitors behind. With regard to cost, from data obtained from Mr. Clifton Robinson, the cost of working a well-equipped line should not be more than 5d. per car mile. In several towns, notably Plymouth, St. Helens, Dover, and others, electricity for lighting and tramways were both being supplied from one generating station, but large traction schemes, said Mr. Walton, could best be served by stations exclusively used for the purpose, as at Bristol, Glasgow, and Dublin.

The lecture was profusely illustrated with diagrams, photographs, and specimens of materials used for the construction of electric traction lines.

ELECTRIC OIL-PUMP.

The illustration we give herewith is of an arrangement of oil-pumps designed by Mavor and Coulson, of Glasgow



View of the Mavor and Coulson Enclosed Motor geared to Two Rotary Oil-Pumps.

The two pumps are of the rotary type, and are specially arranged to deal with heavy oils. The gear between the motor and pumps consists of a raw-hide pinion and two cut spur wheels. The arrangement is such as to balance any side thrust on the spindle of the motor which would be felt if one pump only were used. The motor runs at 700 revolutions and the pumps at 250 revolutions per minute. The motor is one of the enclosed type standardised by the makers, with additional bearings cast at one end. A good feature in the photograph is the placing of a two-foot rule on the base-plate, so that an idea of the actual size of the pump and motors can be obtained.

KING'S LYNN ELECTRICITY WORKS.

Gas v. Steam.

As has been mentioned before, the extensions of the King's Lynn electricity works are to be made with steam plant, while the original machinery, laid down under the advice of Prof. Henry Robinson and started last autumn, is driven by power gas. The report adopted by the Council in which the change to motive power was advocated has called forth a counter report from Prof. Robinson, which has again been answered by Mr. John Pilling, the electrical

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engineer of the Council. These two reports, which we give in full below, were discussed at the last meeting of the Council. As matters of personal character were connected with the report, the Council properly went into committee. The result of the discussion was, we understand, in favour of the extension being made with steam plant, as already agreed. Our readers will remember that at the Leyton works the new machinery will be driven by steam. The following is the report from Prof. Robinson above referred to:

Gentlemen,—I heard indirectly only a few days ago that a sub-committee had made a report, which had not been sent to me, containing serious misstatements about the electric light works, which I felt it my duty to protest against in a report presented to the Electricity Committee at their meeting on Feb. 21; and in pursuance of the arrangement made with the Electricity Committee at that meeting, I beg to offer you the following comments on the report of the sub-committee *re* extensions, dated Jan. 29, 1900.

It appears that this committee visited a number of central stations in the London district, including two designed by me, with a view to obtain information to guide them in deciding upon the kind of plant to be adopted for the extensions which are now urgently necessary at Lynn.

Excursions of that kind are useful and desirable, provided that the committee are accompanied by a competent technical expert who is able to direct attention to the important points in the works, and to sift the information volunteered by persons connected with the works, so as to prevent non-technical men from being misled by inaccurate statements made without any due sense of responsibility for the consequences.

I understand that Mr. Pilling accompanied the committee, and I presume he was a party to the report they agreed upon. The responsibility for the false statements it contains must therefore rest largely upon him. If he knew the statements were false, comment is needless; but if he did not know they were false, it shows gross ignorance on his part.

The first point I wish to deal with is the statement that "the great disadvantage of a gas system was the excessive capital outlay. The capital outlay per unit of plant at Leyton is £192, or twice that of most steam stations." The obvious inference from these statements is that, owing to the adoption of gas plant at Leyton, the capital outlay was £96 per kilowatt in excess of what it would have been if steam plant had been used, and that therefore a sum of upwards of £20,000 was wasted in consequence of my advice having been followed. The further inference is obvious also—namely, that a waste of nearly £15,000 has occurred at Lynn for the same reason.

The absolute falseness and stupidity of these statements will be apparent from the following facts:

1. The total costs of the central stations at Leyton and Lynn have been far below £96 per kilowatt.

2. The cost of the central stations is the only portion of the capital outlay which is affected by the type of generating plant adopted.

3. To have saved £96 per kilowatt by the adoption of steam would, of course, mean getting the central station provided for less than nothing.

4. The figure of £192 per kilowatt was arrived at by dividing the total capital outlay at Leyton, including an exceptionally extensive system of mains, to reach the consumers over a large area, and also an extensive system of public lighting, by the number of kilowatts provided in dynamo power.

5. The corresponding figure at Lynn will be under £150 per kilowatt, including a system of mains and public lighting, decided upon by the Corporation, extending far beyond what I advised them to undertake.

6. The corresponding figure for 15 large continuous-current stations in London is £117. These stations belong to the following companies and vestries: Charing Cross and Strand Company, Chelsea Company, Kensington and Knightsbridge Company, Notting Hill Company, St. James and Pall Mall Company, Westminster Company, St. Pancras Vestry, Shoreditch Vestry. The total capital outlay on these undertakings is £2,438,256, and therefore a fair average for large stations can be arrived at. They contain plant of 20,863 kw. Their maximum load is 16,188 kw. Their stand-by capacity is 4,675 kw. The entire cost of these works "per kilowatt of maximum load" is £150, or practically identical with that of the Lynn works, where the stand-by consists of storage batteries.

7. The cost of continuous-current central stations, exclusive of land, is given in the accompanying pamphlet, published by me in 1893, as £2,500+£50 per kilowatt of maximum load delivered to the distributing mains (see marked passages on pp. 11, 12, and 14*). This basis is a little different to the foregoing calculations, as it allows for the loss in the feeders. The Lynn station has a capacity of 176 kw. on this basis, and should therefore cost about £11,300. The actual cost will probably exceed this by about 10 per cent., including all extras. Having regard to the exceptional work on piling foundations and the rise in the price of machinery since the engineers' strike, it cannot be asserted that the discrepancy is large.

8. The corresponding capacity of the Leyton station as carried out by me was 120 kw. in dynamo capacity. The battery capacity, however, was in excess of that necessary as a stand-by to one dynamo, and therefore 150 kw. should be taken in estimating the cost of my 1893 rule, which then shows £10,000 as the cost of a steam station of the same capacity. The actual cost of the Leyton station up to this date was £10,600. It would have been less if the Leyton Council had not, in their fear of there being no demand for the larger plant, decided to carry it out in two stages instead of doing the whole at one time.

9. It will be observed that this cost works out at £71 per kilowatt of maximum load capacity and £53 per kilowatt capacity provided in dynamos and batteries (200 kw. in all). In face of these facts I am accused of having wasted £96 per kilowatt by the adoption of gas instead of steam. Is it possible to conceive a statement more idiotic and false?

10. I must warn you against arriving at false comparisons based upon the estimated cost of the extensions proposed by the committee—namely, one boiler, one engine and 200-kw. dynamo, one engine and 120-kw. dynamo, with economisers, condensers, circulating pump, etc. Without a stand-by boiler this plant only serves as an additional unit of 40 kw., as it would not be safe in an electric light station to rely on one particular boiler always being fit for use. Assume, therefore, that another boiler is added, and that all the plant is properly housed and all accessories properly duplicated, then its working capacity may be reckoned at 120 kw., and not 320, or even 200, for it is an established principle that the largest unit of plant (or its equivalent) must be kept in reserve as a stand-by. One hundred and twenty kilowatts at the station will correspond to about 105 kw. delivered to the distributing mains, compared with 176 kw. supplied by the existing plant. One hundred and five kilowatts, according to my 1893 rule, should cost £5,250, and a proper extension with gas-engines would not cost more than this sum.

The second statement to be noticed is that "the worst feature" of gas plant is that "the capital outlay increases nearly in proportion to the size of the plant, whilst in a steam station this is not so." If the alleged excess of £96 per kilowatt were not a myth, this statement would no doubt be a serious one. No evidence is adduced in support of the statement, however, and I have already shown in paragraph No. 6 on the first question that the cost of the Lynn works per kilowatt is not greater than that of 15 much larger stations in London. I agree that where space occupied is an important factor, and a large output is required, steam power must at present be resorted to, and on these grounds I recognise that the change which is being carried out at Leyton is a wise one, as they unfortunately appropriated part of the original site for other purposes, and have recently had to buy a piece of the adjoining land at a greatly enhanced price. Moreover, the demand at Leyton is increasing at a rate far beyond the expectations of everyone concerned in promoting the original undertaking, and this is undoubtedly due to the extremely low price at which the current is supplied. At Lynn there is no probability of the questions of space ever becoming a difficulty. You will recollect that when the "Walks" site was contemplated I advised a steam plant there, but when the large area of waste land at your present site was adopted I advised gas plant instead.

The third inaccurate statement is that as the plant increases in size the economy in fuel consumption with gas plant vanishes, and that at Leyton, "when 500 h.p. was reached, the consumption was less for steam than for gas." In support of this statement the committee adopt the foolish expedient of quoting the cost of fuel per unit at Leyton during the Welsh coal strike, and in 10 places not affected by that strike, where the actual price of coal is usually from one-fourth to one-half the price which has to be paid in London. The proper way to test the question is to compare different works in the same district.

Referring again to the 15 large continuous-current stations in London, I find from the figures given in *Lightning* on Feb. 15, 1900, that only two companies attained lower fuel costs than Leyton. During the period referred to, however, the South Wales coal strike disturbed the condition and affected Leyton (using anthracite) more than the other stations, where inferior coal was used, and frequently fines were thereby incurred on account of smoke nuisances. In the previous year only one company (the St. James's and Pall Mall) succeeded in equalling the economy attained at Leyton, when the outputs were in the ratio of about 28 to 1. Economy in fuel consumption is extremely important where a large scheme of public lighting is adopted, as the fuel costs in that case form a higher proportion of the "total costs" than in the case of ordinary supply to private consumers.

The fourth point on which great stress has been laid, is that "the maintenance, repairs, and attendance of gas plant are greater than that of steam plant." In reply to this statement I refer to 103 cases given in *Lightning* on Feb. 15. The cost of repairs and maintenance is less than at Leyton in only 15 places,

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equal to Leyton in five places, and greater than Leyton in 83 places. It is therefore clear that the conclusion of the committee is entirely inaccurate. In the instance of Richmond (quoted by the committee) the published cost of maintenance and repairs is 70 per cent. higher than Leyton. As regards attendance, I admit that large steam-engines do not require so much attendance per unit as small gas-engines; but that this item of cost does not counterbalance the other economies can be proved by again referring to the 15 large continuous-current stations in London, where I find that the "total costs" of producing 19,680,774 units was £195,685, which shows an average of 2·38d. per unit, as compared with 2·26d. per unit at Leyton. It is true that at Shoreditch the total costs are only 2·05d. per unit, but this is due to the use of a dust destructor. The St. James's and Pall Mall Company, who supply the cream of the West-end district, and have an output of over four million units per annum, have succeeded in getting their "total costs" down to 1·95d. per unit. In this case nearly all the consumers are within a few hundred yards of the central station, whereas at Leyton they are mostly at double or three times the distance, involving a corresponding additional loss in distribution. Moreover, the "load factor" at St. James's is 14·91 per cent., compared with only 11·60 at Leyton. In non-technical language this means that the demand at St. James's lasts 28 per cent. longer every day on the average than at Leyton, and this is well known to be conducive of economical results. The coal strike raised the fuel costs at St. James's by only 0·03d., against 0·17d. for anthracite at Leyton. All these facts tend to show that under precisely similar conditions the "total costs" per unit would be practically identical in the two stations St. James's and Leyton. I have not referred to any of the alternating-current stations, because the electrical arrangements are so different. If they had been included, the superior economy of the Leyton system would have been still more conspicuous.

In further reference to this question of economical supply, it is interesting to note that the chairman of the Leyton Electric Lighting Committee, Mr. Musgrave, recently stated that the average cost of the current to private consumers was now only a trifle over 3½d. per unit, and "he considered that there was probably no district in the United Kingdom where the consumers had received such great advantages so soon after the opening of a new station." Referring again to *Lightning* of Feb. 15, 1900, I find only nine other places (out of 103) where the private consumers get their current for less than 3½d. per unit, and in all these cases, except two (Edinburgh and Sunderland), the current for public lighting is charged for at a higher rate than at Leyton. Coming nearer to Lynn, to compare with places more similarly situated, as regards coal supply, I find that your fuel cost is already far below that of Cambridge or Yarmouth, and appears to be steadily improving upon that of Norwich, which has some four or five times your present rate of output. The sub-committee say they were much concerned about the gas stations at Morecambe, Coatbridge and Belfast being unsuccessful. As regards Belfast, I believe the fact is that the Corporation Gas Committee were afraid that the introduction of electric light would injure their department, and, therefore, induced the engineer to use their gas for working the electric light station. It is generally recognised that this was a mistaken policy, but it no way reflects upon the wisdom of using producer gas. The engines adopted at Belfast were of a much more complicated design than those at Lynn. Morecambe and Coatbridge are both situated within the area of cheap coal supply, and it is surprising that gas-engines were ever put down there, because cheap coal or slack cannot at present be converted into gas by any process suitable for an electric light station. The North-Western Railway Company, however, have rather a large gas station at Liverpool, and I believe are satisfied with its results. The sub-committee say that "a more satisfactory service can be given by steam plant than by gas plant." I venture to submit that the ordinary consumer is best pleased with a "cheap supply" so long as the pressure is steady. The supply in Lynn is quite as steady as the best steam-engine supplies, and the only failures I have heard of have been due to neglect on the part of the attendants. At regards cheapness, you will find out by practical experience that my advice has been justified by the results.

I have already warned the Electric Lighting Committee that if their scheme of extensions is carried out, it will throw the working of the station into utter confusion next winter. Their scheme involves taking out and selling one of the gas-engines. The loss on this, by the way, will have to come out of the rates for the year. The existing foundations will have to be altered, and new plant erected ready for the autumn load. It requires an extremely sanguine mind to expect the work to be done in the time available, and it would, in my opinion, be a most foolish thing to shift any of the existing machinery. The committee's justification for this ill-advised scheme is based upon a series of utterly false propositions, which I feel it my duty to protest against at once. If the Corporation is content to allow the scheme to proceed, they will not be able in the future, when matters are in a deplorable muddle, to say that I looked on and allowed them to be utterly deceived without offering them a word of warning. It is amazing that people should presume to advise and influence you who show not only absolute ignorance of the subject, but also a most censurable faculty for misrepresenting matters of fact.—I am, etc.,

Feb. 26, 1900. HENRY ROBINSON, M.I.C.E.

* *Extracts Referred to.*—The capacity of the station is stated in kilowatts. One kilowatt is capable of delivering one Board of Trade unit per hour to the lamps. Thus a 300-kw. station means one which can deliver 300 units per hour to the lamps. The cost of central stations is taken to be £2,500+£45 per kilowatt for the alternating-current system. For the continuous-current system it is taken at £2,500+£50 per kilowatt with feeders averaging half a mile long, and £2,500+£46 per kilowatt with feeders averaging one quarter of a mile long.

The following is the report on the same subject from the resident electrical engineer (Mr. J. Pilling):

Gentlemen,—I have gone over Prof. Robinson's comments on the report of the extension sub-committee, and I think the first point which need be noticed is his denial that a gas system of generation is greater in capital cost than a steam system of equivalent power, but more particularly that the capital cost of the works of the Leyton Urban District Council is not excessive. He compares the Leyton and Lynn works with the great London companies, some of which have been working eight to twelve years, and in many cases have spent considerable sums in alteration of works during the time. They have had to expend considerable sums on land, and even purchase buildings and clear sites, while at Leyton and Lynn land has been secured for next to nothing. Large sums have also been expended on items incidental to company finance.

Prof. Robinson refers to a pamphlet published by himself in 1893, but I should think he must admit that the deductions set forth will not hold good to-day. One paragraph states that "the ordinary incandescent lamp can only be worked at pressures not exceeding 110 volts," whereas to-day stations are supplying lamps at 250 volts. This fact alone has greatly reduced the capital cost of works which have recently been laid down, and has altered the arrangement of works and systems to a great extent. The only true comparison of capital cost is with works laid down by local authorities under somewhat similar circumstances. Now Leyton, out of 55 municipal works given in *Lightning* of Oct. 5 last, has the highest capital cost per kilowatt of plant amongst works using a similar system (low-pressure) supply, and is only exceeded by one alternating-current station. These works are all compared on the same basis—*i.e.*, the total capital cost divided by the dynamo capacity in the works. I believe that without exception all the direct-current works in the provinces use batteries, and in many cases have large systems of public lighting included in the outlay. The following are low-pressure municipal works, showing the total capital cost per kilowatt as given by *Lightning* in October last, with the amount of street-lighting as published in March, 1900:

Town.	Total capital cost	Street-lighting Arcs.	Street-lighting Incand.	Kw. of plant.	Cap. cost per kw.
Aberdeen	£61,779	125	200	1,000	£61
Belfast*	96 276	—	—	900	107
Bradford	166 976	51	35	2 769	60
Brighton	237,987	257	1,027	3,210	74
Burnley†	40,619	3	12	304	133
Bury	33 079	32	—	304	108
Chester	54 772	159	—	750	73
Dewsbury	26,691	16	—	280	95
Dundee	45,409	50	—	560	82
Edinburgh	287,465	744	—	3,148	91
Glasgow	339,782	237	—	2 600	130
Hull	94 958	—	—	1,150	82
Lancaster	28,662	29	55	479	59
Leyton‡	47,047	12	267	245	192
Manchester	493 716	29	—	4,860	101
Nelson	10 613	4	—	100	106
Nottingham	127,393	15	—	1 622	78
Oldham	57,110	28	—	1 107	51
Southampton	67,502	62	—	198	96
Stafford	19,177	4	—	790	85
Sunderland	61,931	50	—	860	72
Whitehaven	20,275	10	452	210	96

* First gas plant. † Horizontal and rope driving engines. ‡ Gas.

When the committee visited Leyton, reference was not made in any way to the initial scheme of 140 kw., but to the capital outlay to date, which is certainly excessive when compared with balance-sheets of other similar works. He states that the capital cost is high owing to the large system of mains and public lamps in use there. By their balance-sheet for March 31, 1899, I find that the total cost of the works was £47,047. Of this sum £18,080 had been expended on "cost of mains and laying same," £2,149 on "public lamps," £1,897 on services, and, say, £700 on "engineers' fees, etc.," making a total of £22,826. Now, if you deduct this from the total capital expenditure, it leaves £24,921 for the works, without mains, public lamps, and services, which is equal to over

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£98 per kilowatt of plant. This figure is higher than many steam stations including everything. But it can be further shown that the proportion of expenditure on mains to total expenditure is not greater than at some steam stations—viz.:

Town.	Total expended.	Expended on mains.	Total cost per kilowatt.
Bury	£39,000	£17.000	£199
Chester	61,900	33,500	83
Dundee	45,409	16,888	82
Glasgow	420,000	210,000	77
Leyton*	47,047	22,126	192

* March 31, 1899.

The above are from the *Electrical Review* of March 2, 1900.

Prof. Robinson points out that no evidence is adduced in support of the statement that the capital outlay with gas-engines increases nearly in proportion with the plant. The capital outlay at Leyton in 1898, with 140 kw. of plant, was £201 per kilowatt; in 1899, with 245 kw. of plant, it dropped to only £192 per kilowatt; but in 1900, when the plant has increased to 578 kw. by the addition of more gas and a large steam dynamo, it has dropped to £103 per kilowatt. The expenditure at Leyton is £59,478, per the *Electrical Review*, March 2, 1900.

In a gas system you are compelled to put down engines of comparatively small power, and drive the dynamos by belts (unless you are willing to try experiments). These small sets are comparatively more expensive than direct-coupled steam dynamos, the foundations are larger and thus more expensive, and they occupy considerably more space, thus adding to the cost of buildings. The dynamos being of small size, there is more switch gearing for a given power than with larger steam sets. Prof. Robinson states that they have got a large storage battery at Leyton, which has affected their capital expenditure largely. Other stations have batteries. If the cost of the batteries is taken away there still remains a sum of £80 per kilowatt for the works, without mains, public lamps, services and batteries, which is higher than some works, including everything. The proposed arrangement of steam plant for extensions is criticised. The arrangement of plant was fixed before it was intended to disturb the gas plant. If this were the initial installation of plant I should agree that two boilers would be necessary from the start, but as it is intended to work the steam in conjunction with the gas plant, it would only be on five days a week for a few hours each evening in winter that the boiler would be absolutely necessary for some time to come. I would point out that where Lancashire boilers are used, they, as a rule, have only a sufficient number under steam to cope with the work in hand, and in practice they are as safe as storage batteries, provided the feeding arrangements are duplicated.

The proposed extensions, if No. 5 gas-engine remained in, would give an additional output sufficient for 4,600 lamps of 8 c.p. burning simultaneously, and it would enable 9,200 additional lamps to be connected to the mains, assuming that 50 per cent. of private lamps were in use at the same time. The maximum per cent. of private lamps in use at any one time has been 69 per cent., but this will drop as more lamps are connected. You would also have a stand-by engine and dynamo able to serve simultaneously 5,800 lamps in case of breakdown. The plant would be designed so that a second boiler could be put in when required, and also a third engine of 200 kw. You would then be able to connect an additional 11,600 lamps to the mains, making a total of over 20,000 lamps. This leaves you with a spare boiler and dynamo of 200 kw. The total cost of these extensions would be £13,500, of which £8,000 would be spent within the next 18 months. If 120 kw. of gas plant were put down it would cost £5,250, which is a little under the actual proportion of the cost of your present works. This gas plant would enable you to serve an additional 3,500 lamps, against 4,600 with the steam extensions, and connect up 7,000, agaist 9,200 with steam plant. If a similar complete extension were carried out by gas, at the same rate given by Prof. Robinson, it would cost £15,750. You would then have 13 gas-engines of your present size, only one of which would be a stand-by and altogether insufficient.

It may be said that one large set must be kept as stand-by. That is perfectly true; but it should not be forgotten that if you have a dozen small engines against three or four large ones, it is quite as reasonable to expect two or three of the smaller ones to be out of order at the same time as to expect one of the large sets to be disabled, and this ought to be provided for. It is also contrary to recognised practice to put down a large number of small units when larger sets would cope with the work equally well. He agrees with the change to steam at Leyton on account of the enhanced price of land, so that it may be taken for granted that the large capital cost of the Leyton works is not due to cost of land. In their last balance-sheet the item for land stands at £1,264. The deputation, when at Leyton, were not told anything of dear land, but rather of excessive cost of plant, but I suppose one must give them credit for knowing their own business.

The comparisons of coal consumption in the committee's report were given to show what might be expected by gas and what might be attained by steam stations using a low-pressure system in the provinces, and not a comparison between Leyton and London works. The coal consumption in any works is affected very much by the character of the load, and any works which sell nearly half the current for street-lighting, as at Leyton, ought to show a low fuel bill per unit. This is due to the long and even load on the plant. The cost of Welsh anthracite delivered at Lynn is quite as high as at Leyton. If anything, it appears to be higher, as you were quoted 2s. per ton more by the same agent for an equal quality at the same period. As the economy in fuel consumption is the sole reason for the adoption of gas-engines in an electric light works, it may interest to know what is being done in other works. Out of 21 works, municipal low pressure, given in *Lightning*, Leyton is only exceeded by Southampton, whilst the average cost per unit is only 0·51, against 0·68 at Leyton. Many of these works work non-condensing, not being so favourably situated for water as yourselves. In one paragraph Prof. Robinson states that he "has not referred to any of the alternating works, because the electrical arrangements are so different," and yet on the next page he compares the coal consumption of Lynn with Yarmouth and Cambridge, which are both alternating stations. In comparing Norwich, which has a coal bill of 0·7d., he did not state that the load factor was only 9·71 per cent., against 12 or 13 per cent. at Lynn. The railway rate from Derbyshire is also 7s. per ton to Norwich, against only 5s. to Lynn.

It is extremely difficult to gather data as to repair and maintenance of plant. In the first place, you cannot compare works which have only been in operation a short time with works that have been running for years. As a rule, when plant is first laid down, the contractors maintain the same in repair for some months, as in your own case, where the contractors are still maintaining the plant. The accounts in *Lightning* mentioned include repairs and maintenance of buildings, engines, boilers, dynamos, machinery, instruments, tools, accumulators, mains, meters, switches, etc. It is therefore difficult to say how much is due to the engines without a detail balance-sheet before you. It is generally admitted, however, by persons who have had practical experience that breakages of parts are much more frequent than in steam-engines. At Leyton, we are informed that they had begun to put aside a sum of money annually to meet this repair item. In some stations they employ fitters to carry out repairs, and in such cases the wages may be classified as "repairs" or "wages." Prof. Robinson admits that large steam-engines do not require so much attention per unit as small gas-engines.

I cannot see what is gained by comparing the "total costs" of the great London companies with either Leyton or Lynn. However, adopting the same method of comparison, I find that of 19 municipal low-pressure works outside London, in *Lightning* of Feb. 22, 1900, the average "total cost" per unit is 1·93d., against 2·26d. at Leyton. I also find that the average "rent, rates, and taxes" paid by the 19 works of 0·21d. per unit, against nothing, or, rather, £1, at Leyton. Therefore, add 0·21d. per unit to the Leyton figure and it becomes 2·47d. I also find that the average "load factor" of these works is only 10·54d. per cent., whilst at Leyton it is 11·6d. per cent., which is the most important factor for reducing costs. The cost of coal at Leyton last year was 0·68d. per unit. Now, take the cost of coal from the "total cost" of 2·47d. (which it would have been if the average rates had been paid), and it reduces the cost per unit without coal to 1·79d. Nine municipal low-pressure works can afford to give them their whole coal bill and yet show better results, as follows: Bradford, 1·43d.; Brighton, 1·68d.; Burnley, 1·74d.; Chester, 1·3d.; Edinburgh, 1·21d.; Manchester, 1·53d.; Nottingham, 1·36d.; Oldham, 1·66d.; Whitehaven, 1·6d. Prof. Robinson refers to a statement made recently by the chairman of the Leyton Electric Committee that "the average cost of current to private consumers was now only a trifle over 3½d. per unit," but he omitted to state that the undertaking made a loss, after paying interest and repayment, during the first year of £737, and during last year of £928. I find that for the year ending March 31, 1899, 104,593 units were sold for street-lighting at an average price of 1·7d. per unit, and 144,312 units to private consumers at 4·02d. Let the price of 1·7d. per unit for street-lighting remain as it is (which is also the price recommended by him for Lynn), and divide the loss of £928, equal to 1·54d., amongst the units sold to private consumers, and you get 5·56d. per unit. This demonstrates what I have several times pointed out to you—viz., that you should get rather more than 1·7d. for public lighting. If this is not done, you will require much better results than those of Leyton, which Prof. Robinson says are excellent. Prof. Robinson says: "It is surprising that gas-engines were ever put down at Morecambe or Coatbridge, as they are both within the area of cheap coal." As a matter of fact, neither of them discarded gas on account of the high fuel bill. The Morecambe Company went into liquidation, I believe, due to an order to remove their works for nuisance, and the Coatbridge Company discarded the engines owing to frequent breakdowns and their unsuitability for driving alternators.

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With the steadiness of running of gas-engines I will not deal here, as it is entirely a technical question. The committee has been advised by me strongly, as by Prof. Robinson, that nothing must be done to the existing plant calculated to interfere with the supply during the next autumn, and I also advised that the Local Government Board may require the loss on the gas-engine, if sold, to be taken out of revenue. On this advice the committee understood that it should not be done if found impracticable. As it was intended to fix the two steam-engines in the room occupied by one gas-engine, the committee expected that more would be saved on the extension of buildings than would be lost on the sale of the engine.

Nothing is said on the noise and vibration set up, which have been one of the reasons for the committee's recommendation, and which would increase if extensions were carried out by gas. I cannot understand how Prof. Robinson can feel so much surprise at the committee's recommendation, as I told Mr. Leigh Robinson some two months ago that in all probability extensions would be carried out by steam power, if the noise and vibration was not stopped.—Yours, etc.,

March 7, 1900. JOHN PILLING, A.M.I.E.E.

LEGAL INTELLIGENCE.

THE ATTORNEY-GENERAL v. THE NATIONAL TELEPHONE COMPANY.

In a Queen's Bench Divisional Court on the 16th inst., composed of Justices Grantham and Phillimore, the case of the Attorney-General *v.* the National Telephone Company, Limited, was mentioned.

The **Attorney-General** said he was there for the purpose of moving for an interim injunction against the Telephone Company for breaking up the streets. The case raised an important question of law as to whether they could do this without obtaining the license of the Postmaster-General, and also that of the County Council. His learned friend, Sir Edward Clarke, Q.C., who represented the Telephone Company, was of the contrary opinion. Unless some decision were come to as to rights the streets might be broken up indefinitely.

As the Court could not sit long enough to hear arguments on both sides, it was arranged that the motion should be taken on Thureday, April 5.

ACETYLENE GAS GENERATORS.

Mr. J. J. Blight, electrical engineer, Falmouth, sought at the Falmouth County Court on the 17th inst. to recover £36 from Thomas and Son, Penryn, for an acetylene gas generator and fittings.

Mr. W. J. Terrill, for the defence, said his clients were the victims of a misrepresentation.

Plaintiff denied that he induced defendants to to take the apparatus on the grounds that it would be much cheaper than coal gas. They did not manage the generator properly, and when it was tested by witness it did its work satisfactorily. Mr. Thomas wrote that it cost him three times as much as ordinary gas, and he reverted to the old illuminant.

Defendants stated that the plaintiff persuaded them to take the generator by the statement that it would give a better light than coal gas at half the cost. They agreed to give it a trial on those conditions, but the thing was a failure.

Mr. J. M. Thomas, a member of the Institute of Gas Engineers, said acetylene cost six times as much as coal gas used through a Welsbach burner, at the price of gas at Penryn. Acetylene was only used in isolated cases.

Plaintiff said New-street station, Birmingham, was lit with it. It was absolutely untrue that he told the defendant acetylene would only cost half as much as coal gas.

Judge Granger said the misrepresentation need not be fraudulent, but if it induced defendants to enter into a contract, that contract was void. It was extremely foolish of defendants not to have had the whole contract put into writing. He must believe the defendants' version of what occurred, and thought there could be no doubt that plaintiff did represent that acetylene was half as cheap again as coal gas. There must be a judgment for defendants with costs, plaintiff to have the generator and fittings back.

ELECTRICAL COMPANY INTERESTS.

An application was made to Mr. Registrar Hope, at the London Bankruptcy Court, for an order of discharge on behalf of John Charles Howell, 24, Queen Victoria-street, E.C., who during the last six years has been connected with the following companies—viz.: John Charles Howell, Limited, B. Howell and Son, Limited, Porous Accumulator Company, Limited, Crompton-Howell Electrical Storage Company, Limited, John Charles Howell, Limited (No. 2 company), Epicycle Company, Limited, Epicycle Manufacturing Company, Limited, and the Pontypool Electric Lighting Power Company, Limited.

The **Official Receiver** reported that the bankrupt failed last November with liabilities of about £12,682 and assets valued at £11,433, of which £11,393 represented an estimated surplus from shares held by creditors as security for their claims, the realisable value of which was very problematical. The other assets were expected to realise £30. The bankrupt commenced business on his own account in 1881 as an electrical engineer, at Llanelly. Nine years later he took offices in London, and in 1892 he converted the business into J. C. Howell, Limited, with a capital of £25,000. As vendor he received £10,000 in shares, and remained as managing director, at a salary of £800 a year, until 1895, when the company went into liquidation. For many years past the bankrupt had been connected with a firm of engineers, chiefly as agent for the investigation of processes and inventions; but his connection with them was severed in 1896, to which severance and subsequent action of the firm, who obtained judgment against him in August, 1897, the failure was chiefly ascribed. As offences the Official Receiver reported (1) insufficiency of assets to pay 10s. in the £ to the unsecured creditors, and (2) trading with knowledge of insolvency.

Mr. Devonshire, on behalf of creditors, asked for the bankrupt's discharge to be suspended until the creditors had received 10s. in the £.

Mr. F. Cooper Willes, who appeared for the bankrupt, resisted that appeal; but the learned **Registrar** made an order in those terms, observing that the assets consisted of shares in various companies the success of which depended very largely on the bankrupt's efforts. The discharge was granted subject to that conditional order.—*Financial News.*

GUINNESS v. THE RIVER PLATE ELECTRIC LIGHT AND TRACTION COMPANY, LIMITED.

This case came before Mr. Justice Cozens-Hardy on the 17th inst. on a motion for judgment in a debenture holder's action.

Mr. Vernon, for the plaintiffs, said there had been default in the payment of interest on the debentures, and the company appeared and consented to judgment.

Judgment was accordingly entered in the usual form in a debenture holder's action.—*Financial News.*

COMPANIES' MEETINGS AND REPORTS.

BURY, ROCHDALE, AND OLDHAM TRAMWAY.

The twenty-third ordinary general meeting of this Company was held on the 16th inst. at the Grand Hotel, Manchester, Mr. J. Coomer, the chairman, presiding, when the report (published in our last issue) was adopted.

The **Chairman** said the miles worked during the year were 2,953, the passenger mileage 459,529, as against 442,113 in the corresponding period of last year, and the number of passengers carried was 3,837,336, against 3 657,464 for the half-year ending January, 1899. The total receipts from all sources had been £23,460, and the total working expenses £20,478.

Mr. James Byrom, the retiring director, was re-elected, as was also Mr. W. S. Lewis, the auditor.

BARCELONA TRAMWAYS.

The twenty-seventh ordinary general meeting of this Company was held on Wednesday at Winchester House, Mr. E. M. Underdown, Q.C., presiding.

The **Chairman** said the number of electrical cars running was now 73, and it was hoped that within a short time 125 would be in full operation. The Board hoped that later on they might be able to submit a project for converting the Ensanche lines from animal to electric traction. Some of the directors were going to Spain to study that question on the spot. For January and February of this year the receipts had exceeded by £4,522 (equal to 31 per cent.) those for the same period of 1899. The diminution in working costs resulting from electric traction had been enormous. In addition to the preference dividend at the rate of 5 per cent. it was proposed to pay a dividend at the rate of 2 per cent. per annum on the ordinary shares.

The report and the payment of the dividends therein recommended was adopted.

IMPERIAL TRAMWAYS.

The annual meeting of the proprietors of the Imperial Tramways Company was held on Saturday at the Grand Hotel, Bristol, Mr. George White, chairman of the directors, presiding, and the directors' report and statement of accounts for the year 1899 (published in our last issue) was submitted.

The **Chairman** pointed out that the receipts were slightly better than those for 1898, which, coupled with some savings made, enabled them to earn 6 per cent., against 5 per cent. in 1898, upon the Corris Railway ordinary stock. The Reading tramways receipts also compared favourably with any former period, and the dividend earned upon the share capital in that company was 8 per cent. for the whole year, against 6¼ per cent. in 1898. He thought that the opening of the London United Company's tramway would be as nearly as possible coincident with the opening of the Central London Electric Railway, which terminated at the commencement of their new electric tramways. With

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regard to the steps taken during the past 12 months to obtain powers for still further extensions, he said that they had gone to Parliament as directed by the Commissioners, and had renewed the arrangements with the local authorities excepting one, Teddington. With regard to the Uxbridge-road portion of their system, they had arrived at an agreement with the councils of Ealing, Hanwell, and Acton, so that by filling in this gap of about three miles in their authorised system a through line of electric tramways of about 12 miles in length would be secured on the main road from London to Oxford, commencing at the Central London terminus at Shepherd's Bush, and terminating in the town of Uxbridge. At Darlington the profit realised on the year's working was in excess of any previous similar period. On the Middlesbrough, Stockton, and Thornaby electric tramways operations had been conducted with the greatest regularity and smoothness. They had carried between eight and nine millions of passengers at very low average fares, and had made a profit of £14,611. The proposed powers for certain extensions referred to in the report were favourably entertained by the Light Railway Commissioners, but as yet an arrangement had not been arrived at with the owners of certain toll gates. They were about to carry out an extension from the centre of Middlesbrough to the Clarence Ferry. The result of the year's trading was a net profit of £30,251 on their investments in the various undertakings.

The directors' report and statement of accounts was adopted, and dividends agreed to as follows: on the preference shares at 6 per cent. per annum, and on the ordinary shares at 8½ per cent. per annum, for the half-year ended Dec. 31 last.

Mr. Godfray was re-elected a director, and Messrs. James Fraser and Son were reappointed auditors, and the proceedings terminated with a vote of thanks to the chairman.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING.

Directors: Right Hon. Lord Rathmore (chairman); J. B. Braithwaite, jun. (deputy chairman); Frederick W. Reynolds; Aymor H. Sanderson; Francis E. Savory; Joseph Shaw, R. Percy Sellon. Chief engineer: Charles P. Sparks, M.I.C.E. Secretary: H. B. Renwick.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the sixth ordinary general meeting of the Company to be held at Winchester House, Old Broad-street, E.C., on 26th inst., at 12.30 p.m.:

The capital expenditure during the year, on account of the Company's London districts, amounted to £155,608. 12s. 9d., making the total expenditure in respect of those districts up to Dec. 31 last £718,195. 18s. 11d. This expenditure was met by the issue in January, 1899, of £200,000 4½ per cent. debenture stock at a premium of £8 per cent. The premium received from the above-mentioned issue has been applied as follows: reduction of general preliminary expenses, £10,000; writing off costs in connection with applications for provisional orders, £2,000; amount placed to reserve for depreciation, repairs, and renewals, £4,000—total, £16,000. The balance from last account, after payment of the final dividend on the preference shares for the half-year ended Dec. 31, 1898, less income tax, amounted to £5,775. 18s. 6d., and the balance from revenue account, after payment of directors' fees, rent, rates, taxes, general establishment charges, wages, and proportion of salaries, to £45,417. 8s. 6d., making a total available revenue of £51,193. 7s.; from which must be deducted interest on debenture stock, including interest on instalments paid in advance, £5,032. 11s.; interim dividend on 20,000 6 per cent. preference shares for half-year ended June 30, 1899, less income tax, £5,800; amount placed to reserve for depreciation, repairs, and renewals, £6,500; leaving for further distribution £33,860. 16s. The directors recommend (*a*) that payment of the interim dividend on the 20,000 6 per cent. preference shares for the half-year ended June 30, 1899, less income tax, be confirmed; (*b*) that a further dividend on the 20,000 6 per cent. preference shares for the half-year ended Dec. 31, 1899, less income tax, be declared; and (*c*) that a dividend on the 40,000 ordinary shares for the year ended Dec. 31, 1899, at the rate of 4 per cent. per annum, less income tax, be declared, and that the same be paid to all proprietors registered at March 13, 1900. This will absorb £21,266. 13s. 4d., and leave a balance of £12,594. 2s. 8d. to be carried forward. The Company's interest in the Richmond (Surrey) Electric Light and Power Company, Limited, has been disposed of to the Bournemouth and Poole Electricity Supply Company, Limited, at a profit. The directors, having accepted in November last Mr. A. J. Lawson's resignation as engineer and manager, have appointed Mr. Charles P. Sparks as engineer to the Company. The retiring directors are Mr. J. B. Braithwaite, jun., and Mr. A. H. Sanderson, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

London Stations.

St. Luke and Clerkenwell, Eastern Holborn and Western Holborn, and St. Giles.—The balance to credit of revenue for the 12 months ended Dec. 31, 1899, amounted to £8,707. 7s. 9d. In these districts the total applications to Dec. 31 last, including power, represented the equivalent of 80,923 8-c.p. lamps, of which 61,188 were then connected to the mains. The applications for the year represented an increase of 37,324, and the connections an increase of 24,886. At the same date 84 users of motors, aggregating 381 h.p., were supplied from the Company's mains, showing an increase of 253 h.p. for the year, and further applications have since been received, raising the total to 125 users, representing 686 h.p. The special plant erected for the generation of continuous current for power purposes is capable of supplying 2,000 h.p. A supply of current in the Western Holborn and St. Giles district was commenced in the summer of last year. The local authorities have not yet given their consent for the commencement of the compulsory works under the provisional orders held by the Company for Mile End Old Town, St. George's-in-the-East, and the district of the Limehouse District Board of Works.

Wandsworth District (including the parishes of Putney, Wandsworth, Clapham, Streatham, and Tooting). *Camberwell and St. George-the-Martyr, Southwark.* — The balance to credit of revenue for the 12 months ended Dec. 31 last amounted to £11,136. 10s. In these districts the total applications to Dec. 31 last represented the equivalent of 56,876 8-c.p. lamps, of which 54,647 were then connected to the mains. The applications for the year represented an increase of 24,240, and the connections an increase of 25,733. The work of laying mains throughout the compulsory area, and some additional streets in the Camberwell district has been completed, and a supply of current was commenced in July of last year. A supply is also available in the district of St. George-the-Martyr, Southwark.

St. Olave.—Work is in hand for this district.

Investments in Provincial Electricity Supply Companies.

Bournemouth and Poole Electricity Supply Company, Limited.—This company has made satisfactory progress during the past year. The directors have recommended the payment of a dividend on the ordinary shares of the company at the rate of 5 per cent. for the year ended Dec. 31, 1899, less income tax, as compared with 4 per cent. for the previous year.

Dover Electricity Supply Company, Limited.—This company has now reached a dividend-earning stage. The balance from revenue account for the year ended Dec. 31 last, after providing for interest charges and reserve for depreciation, has allowed the payment of a dividend on the share capital of the company at the rate of 3 per cent. per annum.

Dr. General Revenue Account.	£	s.	d.
Directors' fees, rents, rates, taxes, insurance, wages, and proportion of salaries	6,757	17	0
Printing, stationery, and postage	550	10	6
General charges and travelling	1,002	17	8
Legal expenses	229	9	8
Trustees' fees	105	0	0
Auditors' fees	105	0	0
Bad debts	236	1	5
Depreciation of office furniture	134	10	6
Interest paid on temporary loans	1,923	12	4
	11,044	19	11
Balance carried to net revenue account	45 417	8	6
	£56 462	8	5

Cr.	£	s.	d.
Gross profits derived from interest on investments, rents, discounts, and administration of associated companies	1,892	4	7
Transfer fees	106	18	6
Dividends receivable, less income tax	2,346	5	7
Profits on investments realised	32 273	2	0
Balance from revenue accounts	19,843	17	9
	£56,462	8	5

County of London (North) Electric Lighting Order, 1892.

Dr. *Revenue Account.*	£	s.	d.
Generation of Electricity—			
Engineers' salaries and wages	1,540	12	1
Coal and other fuel	3,489	7	3
Oil, waste, water, etc.	600	14	7
Stores and works expenses	159	15	1
Repairs: buildings, £167. 11s. 3d.; engines and boilers, £1,266. 9s. 7d.; accumulators, £58. 18s. 10d.; dynamos, £43 18s. 11d.; other machinery and tools, £131. 1s. 9d.	1,668	0	4
Distribution of Electricity—			
Engineers' salaries and wages	339	9	7
Repairs	28	7	1
Rents payable	896	9	9
Rates and taxes	1,110	19	4
Insurance	56	16	6
Stationery and printing	151	8	1
Audit fee—Board of Trade	51	0	0
General charges and travelling	253	13	0
Legal expenses	25	4	10
	10,371	17	6
Less repairs and renewals	1,696	7	5
	8,675	10	1
Balance carried to general revenue account	7,449	17	9
	£16,125	7	10

Cr.	£	s.	d.
Gross receipts from sale of current, £19,369. 12s. 4d.; less abatements under sliding scale, £4,137. 14s. 5d.	15,231	17	11
Rental of meters	523	19	2
Rents receivable	366	17	9
Testing fees	2	13	9
	£16,125	7	10

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COUNTY OF LONDON (NORTHERN EXTENSIONS) ELECTRIC LIGHTING ORDER, 1897.

Dr. *Revenue Account.*

	£	s.	d.
Generation of Electricity—			
Engineers' salaries and wages	235	8	6
Coal and other fuel	533	13	0
Oil, waste, water, etc.	91	15	7
Stores and works expenses	24	6	4
Repairs: buildings, £25. 12s. 2d.; engines and boilers, £193. 14s.; accumulators, £8. 19s. 4d.; dynamos, £6. 12s. 7d.; other machinery and tools, £20. 0s. 4d.	254	18	5
Distribution of Electricity—			
Engineers' salaries and wages	141	6	5
Rents payable	137	0	4
Rates and taxes	216	15	8
Insurance	8	11	7
Stationery and printing	13	16	4
Audit fee, Board of Trade	7	16	0
	1,665	8	2
Less repairs and renewals	254	18	5
	1,410	9	9
Carried to general revenue account	1,043	3	10
	£2,453	13	7

Cr.

	£	s.	d.
Gross receipts from sale of current, £3,255. 16s., less abatement under sliding scale, £895. 14s.	2,360	2	0
Rental of meters	93	11	7
	£2,453	13	7

HOLBORN AND ST. GILES ELECTRIC LIGHTING ORDER (No. 1), 1898.

Dr. *Revenue Account.*

	£	s.	d.
Generation of Electricity—			
Engineers' salaries and wages	36	4	5
Coal and other fuel	82	2	0
Oil, waste, water, etc.	15	0	0
Stores and works expenses	3	14	10
Repairs: buildings, £3. 18s. 10d.; engines and boilers, £28. 18s. 4d.; accumulators and dynamos, £2. 7s. 11d.; other machinery and tools, £3. 1s. 7d.	38	6	8
Distribution of Electricity—			
Engineers' salaries and wages	41	12	2
Rents payable	21	9	11
Rates and taxes	35	5	8
Insurance	1	6	4
Stationery and printing	18	9	1
Audit fee—Board of Trade	1	4	0
	294	15	1
Less repairs and renewals as above	38	6	8
	256	8	5
Balance carried to general revenue account	214	6	2
	£470	14	7

Cr.

	£	s.	d.
Gross receipts from sale of current, £693. 16s. 10d.; less abatements under sliding scale, £231. 18s. 8d.	461	18	2
Rental of meters	8	16	5
	£470	14	7

CAMBERWELL ELECTRIC LIGHTING ORDER, 1896.

Dr. *Revenue Account.*

	£	s.	d.
Generation of Electricity—			
Engineers' salaries and wages	79	0	1
Coal and other fuel	162	9	3
Oil, waste, water, etc.	35	12	9
Stores and works expenses	5	13	11
Repairs: buildings, £5. 6s.; engines and boilers, £68. 11s. 2d.; other machinery and tools, £2. 13s. 7d.	76	10	9
Distribution of Electricity—			
Engineers' salaries and wages	13	15	1
Repairs	3	17	7
Rents payable	20	14	4
Rates and taxes	22	14	6
Insurance	2	11	6
Stationery and printing	25	17	3
Audit fee—Board of Trade	3	0	0
General charges	3	8	8
	455	5	8
Less repairs and renewals	80	8	4
	374	17	4
Balance carried to general revenue account	566	14	9
	£941	12	1

Cr.

	£	s.	d.
Gross receipts from sale of current, £1,214. 3s.; less abatements under sliding scale, £299. 9s. 8d.	914	13	4
Rental of meters	26	18	9
	£941	12	1

WANDSWORTH ELECTRIC LIGHTING ORDER, 1892.

Dr. *Revenue Account.*

	£	s.	d.
Generation of Electricity—			
Engineers' salaries and wages	1,501	2	2
Coal and other fuel	3,086	16	2
Oil, waste, water, etc.	680	2	0
Stores and works expenses	108	4	0
Repairs: buildings, £90. 13s. 9d.; engines and boilers, £1,304. 12s. 5d.; dynamos, machinery, tools, and roadway, £50. 17s. 10d.	1,446	4	0
Distribution of Electricity—			
Engineers' salaries and wages	808	14	9
Repairs	68	11	1
Rents payable	77	4	0
Rates and taxes	355	6	1
Insurance	48	17	11
Stationery and printing	128	4	9
Audit fee—Board of Trade	57	0	0
Legal expenses	125	18	5
General charges and travelling	222	9	2
	8,714	14	6
Less repairs and renewals as above	1,514	15	1
	7,199	19	5
Balance carried to general revenue account	10,569	15	3
	£17,769	14	8

Cr.

	£	s.	d.
Gross receipts from sale of current, £19,221. 18s. 7d.; less abatements under sliding scale, £2,140. 16s. 4d.	17,081	2	3
Rental of meters	639	10	11
Rents receivable	47	1	0
Testing fees	2	0	6
	£17,769	14	8

BRUSH ELECTRICAL ENGINEERING.

The ordinary general meeting of this Company was held on Monday last at the Cannon-street Hotel, E.C., Mr. J. B. Braithwaite presiding.

The **Chairman** stated that during the half-year an issue of £125,000 4½ per cent. perpetual second debenture stock had been made, of which £75,000 were offered to the public and £50,000 reserved to enable holders of the existing second debenture stock to exchange their holding for the new stock at par. The £75,000 offered to the public was over-subscribed for and allotted. Compared with last year, the great features of the report were that the item of creditors amounted to £49,344, against £55,222, while, on the other hand, debtors showed an increase, and stood at £129,930, against £123,380. The depreciation reserve fund was £15,000, against £10,000 owing to an increase of £5,000 made on the last occasion. The Board would ask the shareholders on this occasion to place a proportionate amount for the half-year to that fund, which was invested outside the business. Turning to the profit and loss account, it would be seen that the profit from all sources amounted to £28,347 for the half-year, and, though they were dealing with the lean half-year, that profit was a little in excess of half the total profits of the year ended June 30 last. A considerable sum had been spent during the half-year in maintenance of buildings and plant, and that was really equivalent to a further sum placed to depreciation. He told them in September last that the Company would be forced to continue its capital expenditure on a considerable scale, and a large sum had been spent during the six months, while a very fair amount of work was in progress or contracted for. That further capital expenditure the Board proposed to provide for by an issue of a portion of the unissued ordinary and preference shares, and they proposed to issue a sufficient amount to provide for all capital expenditure for a considerable time to come, and to provide sufficient working capital for the proper carrying on of the business. The directors would issue 30,000 shares of each class, which would be offered to existing shareholders, the preference and ordinary shares being linked together, so each class must be taken up proportionately. The Board did not need the money immediately, and they would so spread the instalments on the shares that they would not have to pay dividends on the new capital until the new works were profit producing. The instalments would be paid in four parts, ranging from April up to March, 1901. The new inductor alternator had been largely taken up, and had fully realised their expectations of it. The prospects of the business altogether were very encouraging.

The report was seconded by **Mr. A. H. Sanderson** and adopted, a dividend at the rate of 6 per cent. per annum on the ordinary shares for the half-year being approved.

WIRELESS TELEGRAPH AND SIGNAL.

An extraordinary general meeting was held last week, Major S. Flood-Page presiding.

The resolution passed on the 23rd ult., changing the name of the Company to that of Marconi's Wireless Telegraph Company, was unanimously confirmed. A resolution was also confirmed fixing the remuneration of the directors at £1,000 per annum, with the addition, in any year in which the dividend on the ordinary shares should be in excess of 7 per cent., of £500 for every extra 5 per cent. paid, but limiting the entire remuneration in any year to £3,000.

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BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

The annual general meeting of this Company was held on Thursday of last week at Winchester House.

Mr. H. R. Beeton, who presided, referred to the fact that there was a slight reduction in works' costs and total costs, notwithstanding the higher price of coal. The number of lamps and the consumption of current had been larger than in any previous year. A large expenditure had been incurred in renewing machinery and mains. In order to provide the net cost of that plant, the directors proposed, after calling on the revenue account for £4,500 as a current contribution for wear and tear, to appropriate £2,800 out of profits and £7,000 from depreciation account, leaving a balance of £14,202 to be dealt with in the future, when the profits would, of course, benefit from the operation. Shareholders might reasonably anticipate an enhanced dividend in the near future.

The report was adopted, and the payment of the dividends approved.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY.

The general meeting was held on the 19th inst., Mr. A. H. Sanderson presiding.

The **Chairman** said the whole of the undertaking of the Bournemouth and District Electric Supply Company had now been vested in the Company, and the agreement for the purchase of the interests of the County of London and Brush Provincial Electric Lighting Company in the Richmond (Surrey) Electric Light and Power Company had been carried out.

The report, published in our last issue, was adopted, and a dividend on the ordinary shares at the rate of 5 per cent. for the year was agreed upon.

DIRECT SPANISH TELEGRAPH.

The report for the year 1899 shows, after providing for interest on, and redemption of debentures, a balance to the credit of revenue of £9,325. After adding the usual sum of £5,000 to the reserve fund, the directors recommend a dividend of 4 per cent., free of tax, on the ordinary shares for the year 1899. The traffic receipts show a decrease of £6,352, as compared with the year 1898, when they were exceptionally large owing to the Spanish-American war. The ordinary working expenses are £598 in excess of those for the year 1898. On Oct. 11, 1898, the Falmouth-Bilbao cable broke at a distance of about 200 knots from the English landing. It was repaired on Oct. 18, and the cost of the repairs—viz., £1,743—has been taken from the reserve fund.—*The Times.*

LONDON ELECTRIC SUPPLY.

Directors: Lord Wantage, V.C., K.C.B. (chairman); the Earl of Crawford, K.T., F.R.S., LL.D.; Sir W. H. Preece, K.C.B., F.R.S.; R. Stewart Bain, Esq., C.A. (managing director). Consulting engineer: H. R. J. Burstall, M.I.C.E. Engineer-in-chief: G. W. Partridge, A.M.I.C.E. Superintendent engineer: C. J. Barley, M.I.M.E. Secretary: H. C. Carter.

Directors' report (with abstract of accounts) for the year ended Dec. 31, 1899, to be submitted to the shareholders at the ordinary general meeting to be held at the Cannon-street Hotel, E.C., on March 28, at 12 noon:

The number of lights at Dec. 31 was 173,906, an increase of 18,587 for the year. The directors are of opinion that this increase would have been more than doubled, but owing to the default of the contractors in delivering the additional plant ordered in 1898, to meet the requirements of last winter, some of which has not yet been completed, they were only able to accept a very few orders during the last six months. The strain thrown upon the existing plant through this default, the great increase in the price and the difficulty in obtaining an adequate supply of Welsh coal, have all tended to increase the cost of generation, and to temporarily impair the efficiency of the service. A new 900-h.p. plant has been added during the year. New trunk mains amounting to 3,889 yards, and new distributing mains to 18,362 yards, have been laid, the total length of mains now laid being over 106 miles. The lease of the offices and distributing station in Cockspur-street was purchased on advantageous terms. The plant and machinery have been entirely maintained out of revenue. Additional capital being required for the further development and extension of the Company's works, the shareholders will be asked, at the ensuing meeting, to pass a resolution authorising the directors to raise such capital as they may, from time to time, deem desirable in the interests of the Company. The profit on the working for the year is £21,547. 16s. 6d., to which has to be added interest on deposit £589. 0s. 6d., and the amount brought forward from last year, £3,275. 9s. 7d., making a total of £25,412. 6s. 7d. Out of this, the interest on the debentures to Dec. 31—viz., £8,000—and an interim dividend at the rate of 6 per cent. per annum on the preference shares to June 30, 1899, amounting to £7,476, has been paid, leaving £9,936. 6s. 7d. now to be dealt with. The Board propose to deal with this amount as follows: by payment of a dividend, at the rate of 6 per cent. per annum on the preference shares, for the half-year ending Dec. 31, 1899, £7,476; provision for special rebates, £1,000; and to carry forward, £1,460. 6s. 7d. The directors regret that their colleague, Mr. Roger de Q. Quincey, resigned his seat on the Board during the year on account of age, and, in accordance with article 76 of the articles of association, they have elected Sir W. H. Preece, K.C.B., F.R.S., to fill the vacancy. The retiring director is the Right Hon. the Earl of Crawford, K.T., F.R.S., who is eligible for re-election.

Revenue Account.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£21,550	19	8			
Oil, waste, water, and stores	3,420	16	4			
Salaries of engineers, etc.	1,092	10	0			
Wages and allowances	6,148	1	6			
Repairs and maintenance: buildings, £363. 3s. 6d.; engines and boilers, £4,227. 19s. 11d.; dynamos and exciters, £330. 14s. 10d.; other machinery and tools, £756. 10s. 7d.; transformers and accessories, £47. 8s. 8d.	5,725	17	6			
				37,938	5	0
Distribution of Electricity.						
Salaries of superintendents, etc.	1,352	17	1			
Wages and allowances	1,436	9	8			
Repairs and maintenance of mains	1,172	2	8			
Repairs and maintenance of transformers, etc.	1,001	13	2			
Repairs to buildings	186	7	9			
				5,149	10	4
Rents, Rates, and Taxes.						
Rents payable	788	4	6			
Rates and taxes	1,924	5	6			
				2,712	10	0
Management Expenses.						
Directors' remuneration (£2,000—half relinquished)	1,000	0	0			
Salaries of manager, secretary, etc.	3,105	4	7			
Salaries of canvassers and meter readers	407	19	6			
Stationery and printing	238	8	4			
General establishment charges	660	14	5			
				5,412	6	10
Law and Parliamentary Charges.						
Law expenses	56	7	9			
Board of Trade audit	85	0	0			
				141	7	9
Balance carried to net revenue account				21,547	16	6
				£72,901	16	5

Cr.	£	s.	d.
Sale of current per meter less discounts and allowances	66,594	5	4
Sale of current under contracts	1,850	14	2
Rental of meters, transformers, etc.	3,282	13	7
Transfer fees	61	0	0
Sundry receipts, including discounts, etc.	1,113	3	4
	£72 901	16	5

General Balance-Sheet.

Dr.	£	s.	d.
Capital account—amount received	792,070	0	0
Sundry tradesmen and others due on construction of plant and machinery, fuel, stores, etc.	16,410	5	0
Sundry creditors on open accounts	8,096	4	3
Net revenue account	9,936	6	7
	£826,512	15	10

Cr.	£	s.	d.
Capital account—amount expended for works	789,256	18	5
Cash at bankers and in hand	11,670	13	11
Sundry debtors for current	22,261	18	1
Other debtors	691	9	0
Stores on hand: coal, £206. 5s. 10d.; oils, waste, etc., £314. 18s. 3d.; general, £1,110. 12s. 4d.	1,631	16	5
	£825,512	15	10

SOUTH LONDON ELECTRIC SUPPLY.

Directors: George Ellis, Esq., J.P. (chairman); Captain E. Ironside Bax (managing director); Bennett Fitch, Esq., M.I.C.E.; W. W. Phipps, Esq.; Algernon Turnor, Esq., C.B. Engineer-in-chief: F. A. Nixon, Esq., A.M.I.C.E. Consulting engineers: Messrs. Kincaid, Waller, and Manville. Secretary: Sidney H. Webster, Esq.

Report of the directors (with abstract of accounts) for the year ending Dec. 31, 1899:

In making their annual report the directors have to state that the extensive works at Bengeworth-road, Loughborough Junction, are, with the exception of one large steam alternator and certain thermal storage arrangements, now complete, and that the various contracts are practically concluded. Mains have been laid in all the compulsory streets, as also in a number of other streets, throughout the area of supply where a demand for current was likely to arise. The remaining large steam alternator has now been delivered, and is in course of erection. The thermal storage plant has been somewhat delayed in order to benefit by the experience derived from the use of similar arrangements elsewhere, and to take advantage of improvements in design. The directors are glad to record that the work at the station has been well carried out, and that, with some minor exceptions, the machinery is proving satisfactory. When the works were approaching completion in the early autumn of 1899, the directors were able to commence taking over the electrical load, and on Nov. 28, 1899, to terminate

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the contract under which energy was being obtained from a neighbouring company. The Corporation has therefore been relying on its own resources for three months, and the commencement of this year may be regarded as the date from which the real business of the Corporation begins. At the present time electricity is being supplied to the equivalent of 26,688 lamps of 8 c.p., and applications have been signed for 3,185 more. In addition to this, current is being supplied temporarily to a supply company in an adjoining district. The Board have applied to Parliament for powers to supply electricity in that portion of Lambeth north of and including the Westminster Bridge road, that part of the parish, in fact, which was not included in the Lambeth lighting order of 1892. A petition for admission into that district of this Corporation's system has been signed by many of its residents, and the decision of the Board of Trade is shortly expected. This area, comprising, amongst others, Westminster Bridge-road, Waterloo-road, Belvedere-road, York-road, and Commercial-road (Lambeth), can readily be supplied from the existing station, and if powers are obtained the new area should prove a valuable additional source of revenue. There appears to be a growing demand for current to be used for motive power. At present there are a number of motors on circuit, and applications are to hand for more ranging from ¼ h.p. to 16 h.p. The dust destructor has been at work some 10 weeks, but the full quantity of ashbin refuse which it is capable of consuming has yet to be supplied under the Lambeth Vestry's contract, which comes into operation at the end of this month. No difficulty has been experienced in destroying all the refuse obtainable. A reference to the accounts will show that they have been drawn up in the form prescribed by the Board of Trade, the net revenue account exhibiting a profit of £295. 0s. 6d., which has been carried into the general balance-sheet.

REVENUE ACCOUNT.

Dr. Generation and Distribution of Electricity.	£	s.	d.
Electricity purchased	3,258	7	7
Coal, including cartage of ashes, etc. £1,369 14 2			
Oil, waste, water, and engine-room stores 191 16 8			
Proportion of salaries of engineers and officers 217 18 4			
Wages at generating station 282 12 10			
Wages in distribution of current 139 14 10			
Repairs and maintenance: engines and boilers, £8. 7s. 5d.; machinery, instruments, and tools, 11s.; meters, £3. 8s. 8d. 12 7 1			
Maintenance of mains 127 1 6			
Disconnecting temporary supply 52 1 0			
Other miscellaneous expenses 18 6 9			
	2,411	13	2
Rents, Rates, and Taxes.			
Rents payable 97 10 11			
Rates and taxes 49 17 4			
	147	8	3
Management Expenses.			
Proportion of directors' remuneration 900 0 0			
Proportion of salaries 937 0 5			
Canvassing and advertising expenses 109 15 11			
Stationery and printing 119 4 8			
General establishment charges 213 8 4			
Auditors of Company 31 10 0			
Auditor of Board of Trade 27 0 0			
	2,337	19	4
Law expenses	5	18	6
Insurance	67	19	6
	£8,229	6	4

Cr.	£	s.	d.
Sale of current per meter	7,365	5	3
Meter rentals	228	7	4
Transfer fees	24	5	0
Sundry fees	0	16	0
Discount on purchases	3	17	5
Balance carried to net revenue	606	15	4
	£8,299	6	4

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	311,325	0	0
Sundry contractors and others	11,717	1	11
Sundry creditors on open accounts	478	1	8
Contractors for repaving the streets	100	0	0
	£323,620	3	7

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	219,284	14	5
Cost of acquisition of provisional order, etc	46,649	0	0
Sundry debtors for amounts paid on account	1,806	4	4
Stores on hand: coal, £42. 10s.; oils, waste, etc., £85. 3s. 8d.; general, £1,381. 17s. 11d.	1,509	11	7
Sundry debtors for current supplied and other debtors	3,664	15	7
Deposit with Vestry	5,100	0	0
Suspense account	109	9	0
Cash at bankers and in hand	44,946	1	10
Preliminary expenses	549	9	10
	£323,620	3	7

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Waasmes (Belgium).—The Municipality are open to receive tenders for the electric lighting of the district. Tenders by May 31.

Keighley.—The Corporation invite tenders for wiring the new municipal offices now in course of erection. Tenders by March 31. Details in our advertisement columns.

Maidstone.—The Corporation invite tenders for the supply and erection of steam and water pipes and valves. Tenders by April 3. Details in our advertisement columns.

Halifax.—The Tramways Committee of the Corporation invite tenders for the supply of a wheel press for tramway purposes. Tenders by 31st inst. Details in our advertisement columns.

Edinburgh.—The Corporation invite tenders for the supply of steam coal, arc lamp carbons, and cast-iron pipes, pavement box frames, etc. Tenders by April 7. Details in our advertisement columns.

Salford.—The Corporation invite tenders for the supply and delivery and erection of ash conveyor and two electrically-driven travelling cranes. Tenders by April 9. Details in our advertisement columns.

Doncaster.—The Corporation invite tenders for lighting the corn exchange by electricity. Specification may be obtained at the office of the Resident Electrical Engineer, 3, Priory-place. Tenders by 28th inst.

Sunderland.—The Corporation invite tenders for the supply of I.R. covered cables, W.I. and C.I. piping, box frames, and covers, stoneware casings. Tenders by March 30. Particulars in our advertisement columns.

Southampton.—The Harbour Board invite tenders for supplying and fixing a motor-transformer, with accessories, upon the Board's premises, Town Quay, Southampton. Tenders by April 7. Details in our advertisement columns.

Mexborough.—Tenders are to be obtained shortly by the Urban District Council for a dust destructor, which is to be utilised for the purpose of creating heat and providing power for the proposed electric lighting installation for the town.

Morpeth.—The Visiting Committee of the County of Northumberland Lunatic Asylum, near Morpeth, invite tenders for a complete electric light installation for their asylum. Tenders by April 7. Details in our advertisement columns.

Campo de Criptana.—Installation and working for 20 years of public and private electric lighting. Applications to be made to the Municipality of Campo de Criptana (province of Ciudad Real, Spain), or to the L.G.B.—*i.e.*, the Ministerio de Gobernacion, in Madrid, where specifications may be obtained. Open till March 26.

Manchester.—The Tramways Committee of the Corporation invite tenders for the execution of general builder's work at the intended electric car shed, Queen's-road, Cheetham. Particulars may be ascertained from Mr. J. M. McElroy, general manager, Tramways Department, Town Hall, Manchester. Tenders by 26th inst.

Stockholm.—Tenders are invited by the Administration of Royal Swedish Telegraphs, not later than noon on the 29th inst., for the supply of certain telephone cables. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 5 p.m.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and erection of the following: boilers and accessories—viz, six Lancashire and four water-tube boilers and two economisers; polyphase generators—viz., two 1,000-kw. and two 500-kw. low-speed generators. Tenders by April 26. Details in our advertisement columns.

Cardiff.—The Corporation invite tenders for the wiring and fitting up for electric light the new fish market in the Hayes, Cardiff. Plans may be seen and specifications and particulars obtained at the office of the Electrical Engineer, Eldon road, Cardiff, after the 15th inst., on deposit of £1. 1s., which will be returned upon the receipt of a bona fide tender. Tenders by April 3.

Blackpool.—The Corporation invite tenders for the construction and delivery of 15 tramway cars. The drawings of type of car required can be seen and specification forms obtained on application to Mr. John Lancaster, tramway manager, Blackpool. Tenders to be sent in, addressed to the Chairman, Tramway Depôt, Blundell-street, Blackpool, and endorsed "Tender for Tramcars," by 10 a.m. on 27th inst.

Corunna (Spain).—Tenders are invited by the Corunna Electric Co-operative Society for the supply of a complete set of electrical machinery of 400 h.p., and capable of supplying 12,000 lamps of 10 c.p. All necessary information can be procured from the secretary, Senor Dr. Enrique Sors, 81, Calle Real, Corunna. Tenders should be addressed to the president, Senor Dr. Manuel Baifa, Calle de Zafateria, No. 5, Corunna, before April 15.

Dartford.—The Urban District Council invite tenders for the supply and erection of the following plant: Lancashire boilers, with fittings, economiser, feed pumps, etc., pipework, etc., in engine and boiler house, surface-condensing plant, two steam dynamos (vertical enclosed high-speed engines) and motor boosters, storage batteries, main switchboard and connections, six-ton overhead engine-room travelling crane, underground

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mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed type) and posts, station lighting. Tenders by 27th inst. Details in our advertisement columns.

RESULTS OF TENDERS.

St. Annes.—The tender of Messrs. Moore Bros., St. Annes-on-the-Sea, has been accepted for the building of the new electricity works.

Leeds.—The Corporation have accepted the tender of Messrs. S. Dixon and Son, Swinegate, Leeds, at £75, for wiring for the electric lighting of the crypt of the town hall.

Southport.—An offer from Messrs. Dick, Kerr, and Co., Limited, to lay rails for the tramway extension from London-square to Kew-gardens, and in East Bank-street to Chapel-street, has been accepted.

Inverness.—The Town Council have accepted the tender of the Brush Electrical Engineering Company, Limited, for the installation of electric light. The contract, excluding the boilers, amounts to £21,000.

Sunderland.—The Corporation have accepted the following tenders: Wearmouth Foundry Company, Limited, Sunderland, steam, exhaust, and feed pipes; Dutihl-Smith, McMillan, and Co., Great St. Helens, E.C., steam-driven induced-draught fans.

St. Annes-on-the-Sea. — The following tenders have been accepted by the Urban District Council: Tudor Accumulator Company, Dukinfield, Manchester, battery; Venner and Co., London, meters: Reason Manufacturing Company, Brighton, demand indicators.

Stoke.—The following tenders have been accepted: Lancashire Dynamo and Motor Company, Manchester, engine-house plant, comprising Alley and Maclellan's engines and dynamos of their own make, at £1,600; Mr. G. Margetts, Manchester, wiring and accumulators, at £1,126.

Newington.—The Vestry have accepted the tender of Messrs. Babcock and Wilcox for the supply and erection of two additional boilers at the station, feed pump, ironwork, and the extensions to the steam and water mains, including chain-grate stokers and superheaters, for the sum of £9,461.

Bournemouth.—The Corporation have received the following tenders for cables, arc lamps, wiring, switchboards, fittings, etc., for the electric lighting of pleasure grounds: Brush Electrical Engineering Company, Limited, £460; C. Cooper and Co., Bournemouth, £395. 10s. (accepted).

Liverpool.—The Electric Power and Lighting Committee have agreed to recommend the Council to give the contract for the erection of the sub-station to Messrs. Morrison and Sons, builders, Wavertree, on the same terms as those on which they are erecting the electric power station in Lister-drive. The total cost will be about £5,000 to £6,000.

Bath.—The following tenders have been accepted: Callender Cable Company, cables (high and low tension), £7,357; Lucy and Co., arc lamps, posts, and accessories (British Thomson-Houston lamps), £2,763; British Electric Transformer Company, transformers, £458. 8s.; Cowans, Limited, sub-station switchboards, £236; Westinghouse Company, main works switchboards, £1,918. 18s.

Newcastle.—The tender of the British Thomson-Houston Company has been accepted, at £75,776. 10s., for 130 electric cars. This tender was the lowest, and was made up as follows: cars £35,608, equipment £31,666. The following tenders have been accepted for material for bonding the rails of the new car line: Blackwell, London, at £95 per 1,000 for one section of the tram-line, and F. Danvers and Co., at £94. 10s. per 1,000 for the other section.

Perth.—The Electric Lighting Committee have accepted the following tenders for work at the electric lighting station: for mason and brick work, Owen and M'Kearney, Falkirk; excavator and concrete work, Joanes. Smith, and Co., Dundee; plumber work, A. and J. Davidson, Perth; plaster work, J. Peebles, Perth; slater work, J. Buchan, Perth; glazier work, Stalker and Boyd, Perth; ironwork, A. Mather and Son, Edinburgh; joiner work, Leith and Lumsden, Perth.

Shoreditch.—The Vestry have accepted the tender of Babcock and Wilcox, Limited, at £1,650, for the supply of two extra boilers for the electric lighting station, and the tenders of the Edison and Swan United Electric Light Company, Williamson and Joseph, Limited, and Johnstone, Benjamin and Co., for yearly supply of electrical sundries. The tender of Mr. J. O. Richardson, at £5,196, for the erection of the chimney shaft at the new electric lighting station, has been recommended for acceptance.

Aberdeen.—The following tenders have been received by the Tramways Committee of the Town Council for the supply of four electrically-equipped tramcars and other materials:

Macartney, McElroy, and Co., Limited, 53, Victoria-street, Westminster, London, S.W. (accepted)	£3,900	0	0
British Westinghouse Company, Limited, Norfolk-street, Strand, W.C.	4,110	0	0
British Thomson-Houston Company, Limited, 83, Cannon-street, London, E.C.	4,185	15	0
Siemens Bros. and Co., Limited, 4, Queen Anne's-gate, Westminster, S.W.	4,280	0	0
R. W. Blackwell and Co., Limited, 39, Victoria-street, Westminster, S.W.	4,365	3	2
Dick, Kerr, and Co., Limited, 110, Cannon-street, London, E.C.	4,380	0	0

Hastings.—The tender of the General Electric Company, Limited, of Queen Victoria-street, London, to supply 10 and 25 ampere meters at £5. 5s. each has been accepted; also the quotation of the Tudor Accumulator Company, Limited, of 16, Victoria-street, Westminster, to supply a 540 ampere-hour battery, with all accessories, etc., as specified in their quotation at £345, and to maintain the battery in satisfactory working condition for the period of two years from the first charging of the same free of expense to the Corporation; and the quotation of Cowans, Limited, Salford, Manchester, to supply the switch-gear, etc., and to fix the same at such times as may be arranged with the electrical engineer, having regard to the other extensions being carried out at the work, at a total sum not to exceed £500.

Brighton.—The Town Council have received the following tenders for the supply, delivery, and erection, at the electricity generating station, North-road, Brighton, of a combined feeder and dynamo switchboard:

Lowden and Co., Temple Electric Works, Dundee	£500	0	0
Edison and Swan United Electric Company, Limited, 36 and 37, Queen-street, Cheapside, E.C.*	502	0	0
Veritys, Limited, 31, King-street, Covent Garden, W.C.	536	15	7
Electric Construction Company, Limited, Wolverhampton	660	0	0
Crompton and Co., Limited, Mansion House-buildings, E.C.	673	0	0
General Electric Company, Limited, 69 and 71, Queen Victoria street, E.C.	680	0	0
Fowler-Lancaster, Limited, Graham-street, Birmingham	743	0	0
Nalder Bros. and Thompson, Limited, 34, Queen-street, E.C.	840	0	0

* Recommended for acceptance.

Ilford.—The following tenders have been accepted by the Council in connection with the proposed establishment of electricity supply works: Babcock and Wilcox, water-tube boilers with fittings, economiser, feed pumps, etc., £3,471; Babcock and Wilcox, pipe work, etc., in engine and boiler house, £1,296; General Electric Company, two 200-kw. and one 100-kw. steam dynamos and motor boosters (vertical enclosed high-speed engines), £5 324; Electric Power Storage Company, storage batteries, £1,750, and maintenance of the batteries for three years at £405 (the Council to reserve to themselves the right of option to change it to five years for £675); James White, main switchboard and connections, with marble panels, £1,387. 11s. 6d.; Southgate Engineering Company, one 15 ton engine crane, £317. 10s.; Henley's Telegraph Works Company, underground mains, conduits, and road work for public and private lighting, £24,636. 10s. 5d.; Verity's, Limited, arc lamps and posts, £2,671; L. G. Tate, £83. The total of the accepted tenders amounts to £41,341. 11s. 11d.

BUSINESS NOTES.

TRACTION.

Lincoln Corporation Tramways Bill.—This Bill has been referred to the Committee on Unopposed Bills.

Surrey.—By the recent action of the County Council the county light railways scheme is now practically defunct.

Brownhills.—The Urban District Council are satisfied with the proviso made for their protection in the Walsall Corporation Tramways Bill.

Folkestone.—The Town Council intend to petition in opposition to the Bill being promoted by the Sandgate and Hythe Electric Company, Limited.

Norwich.—The Town Council have confirmed the appointment of Mr. G. M. Chamberlin as director of the Norwich Electric Tramways Company.

Glasgow District Tramways Bill.—Notice of opposition to this Bill, now in the House of Lords, has been given on behalf of the Corporation of Glasgow.

Grimsby.—It appears that a number of ratepayers have decided to poll the town on the old paper system, at their own cost, with regard to the tramway question.

Stockport Tramways Bill.—The House of Commons Committee presided over by Sir S. Hoare have declared the preamble proved, and the Bill has been reported to the House.

Birkdale.—Notices appear in the local Press of intended transfer of the undertaking authorised by the Birkdale Electric Lighting Order, 1898, to the British Electric Traction Company, Limited.

Pewsey.—The surveys for the light railway line being finished, the Great Western Railway staff are now engaged getting out plans, specifications, etc., preparatory to submitting the work for contract.

Warwick.—The General Purposes Committee will confer with the directors of the Warwick and Leamington Tramways Company upon the proposals made by them, and the Council do not propose to oppose their provisional order.

Airdrie and Coatbridge Tramways Bill.—The Court of Referees of the House of Commons has decided that there was a clear competing *locus* for the North British Company, and in the circumstances they also gave a competing *locus* to the Caledonian Company.

South Staffordshire Light Railway (Extensions) Order.—The Light Railway Commissioners have submitted to the Board of Trade for confirmation an order made by them for the construction of light railways in the urban districts of Bilston, Willenhall, and Coseley, in the county of Stafford.

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Lambeth.—The Vestry have refused to give assent to the introduction of the London County Council's Tramways Bill No. 1 unless the Council would agree to strike out of the Bill any power to put electric power "on" or "over" any roads, the Bill being then confined to underground work only.

Middlesex Light Railways.—After two days' sitting the enquiry as to the expediency of granting the application of the Middlesex County Council and the Metropolitan Tramways and Omnibus Company, Limited, for an order to authorise the County of Middlesex Light Railways, has been adjourned to the 26th inst.

Barnet.—The Light Railway Commissioners will, on the 28th inst., hold a public enquiry at the town hall as to the expediency of granting an application of the Herts County Council and the Metropolitan Tramways and Omnibus Company, Limited, for an order authorising them to construct the Hertford Light Railways (No. 2).

Brussels.—The Brussels correspondent of the *Daily Chronicle* states that a project is announced for an electric tram service to connect Brussels and Antwerp without intermediate stoppages. The distance from station to station, about 24 miles, would be covered in 20 minutes, or, including the local service to the centre of each city, in 35 minutes.

Wolverhampton.—At the last meeting of the Wolverhampton Trades Council the following resolution was passed: "That we, the Trades and Labour Council of Wolverhampton, desire to congratulate the Town Council on the municipalising of the tramways, making special reference to the valuable services rendered by the town clerk and the borough surveyor."

Ayr.—A deputation of the Tramways Committee has left Ayr to visit various towns in England with a view to reporting as to the best method of traction for the system of tramways proposed to be introduced to Ayr, and for which parliamentary sanction has already been obtained. Amongst the places proposed to be visited are Preston, Manchester, Liverpool, and Blackpool.

Leeds.—The members of the Tramways Committee, accompanied by a number of Corporation officials, have inspected the route of the proposed new electric tramway from the Leeds boundary to Meanston, with branches to Horsforth and Yeadon The wish of the inhabitants of the three places is that the Leeds lines should be extended from the Kirkstall terminus. A report will be submitted to the City Council shortly.

Leith.—The amended offer in connection with the proposed leasing of the tramways in Leith, in the event of the undertaking being purchased by the Leith Town Council, to the Edinburgh Corporation tramway lessees (the Edinburgh and District Tramway Company) is to the effect that the company is prepared to pay the uniform rate of 6 per cent. on the capital expenditure involved—probably £120,000.

Sedgley.—At the last meeting of the District Council a letter was read from the British Electric Traction Company asking the Council to consider the reduction of the use of granite setts, owing to their being somewhat handicapped by the great request that was being made for such setts. They asked for the use of granite setts to be reduced from 1 in 40 to 1 in 30. The Council decided to adhere to their former resolution.

Ackworth, Hemsworth, and Rothwell Light Railways.—The Light Railways Commission have held an enquiry into applications for orders to construct light railways in the Ackworth, Hemsworth, and Rothwell districts, at the end of which the Chairman announced that the Commissioners would be prepared to recommend the order on condition that certain clauses were agreed to protecting the property of the interested parties.

Leicester.—The Corporation are about to take over the tramways of the borough, and are considering the question of adopting some other traction in place of the present horse system, and are sending deputations to various cities to enquire into the working of the tramways there. Several members of the Borough Tramways Committee have paid a visit to Sheffield and Leeds, and they are also to inspect the tramway systems of Glasgow and Edinburgh.

Mersey and Wirrall Railway Co.—A special general meeting was held on Friday last at Worcester House, Walbrook, to consider two Bills now pending in Parliament: (1) to authorise the working of the Mersey Railway and the lines connected with it by electricity and to regulate the capital of the Company; and (2) to authorise the Wirral Railway Company to work the traffic on their railways by electrical or other motive power. A resolution approving the Bills was passed.

Birkenshaw.—At a recent meeting of the District Council, a petition to the Light Railway Commissioners was adopted, embodying eight objections to the Spen Valley light railways extension scheme promoted by the British Electric Traction Company. The principal objection was that the Council had requested the Bradford Corporation to extend their system into Birkenshaw, and that the Corporation was the proper body to whom the power should be given as far as the township was affected.

Blackheath.—The objections to the application of the London County Council to the Light Railway Commissioners for a provisional order relating to Blackheath in regard to the proposed light railway between Deptford, Shooters Hill, and Woolwich have now been formulated on behalf of a committee of resident ratepayers and freeholders of Blackheath and the vicinity appointed for the purpose. These will be urged by counsel at the local enquiry, which it is expected will be held shortly after Easter.

Baker-street and Waterloo Railway.—The engineers of this line have estimated that the proposed extensions for which parliamentary sanction is being sought this session will cost £945,000. The expenditure includes these items: Paddington extension, £378,000; Westminster Bridge extension, £31,000; New Kent-road extension, £228 000; Elephant and Castle extension, £263,000; subway at Newington to the Elephant and Castle station of the City and South London Railway, £9,000; and subway at Paddington, £14,000.

Portsmouth.—The clause in the proposed basis of agreement between the tramway company and the Corporation to which most exception has been taken is that requiring the payment of £10,000 by the Corporation for the concessions made by the company. Mr. A. W. White, manager of the tramway company, is now willing to amend this clause as follows: "In consideration of the foregoing concessions being made by the company to the Corporation, the Corporation to agree for the arbitrator to include in his award for such concessions a sum to be mutually agreed upon, or, failing agreement, by reference to an arbitrator."

Limerick.—At the last meeting of the Corporation a report was read from Mr. Hassard, C.E., on the effect which the carrying out of the proposal of the electric power syndicate would have upon the water supply of the city. After some discussion it was decided to provide clauses in the Bill of the Shannon Water and Electric Power Company fully safeguarding the interests of the Corporation with regard to the waterworks, as well as with regard to the electric and gas lighting of the city, and further consideration of the petition was adjourned pending the terms of such clauses being submitted and considered by Council, and agreed to by the Corporation and the promoters.

Aberdeen.—The Tramways Sub-Committee have made arrangements for meeting the opposition to the Tramways Bill which has been intimated by the War Office in respect of the Links tramway; by the Post Office Department as regards the double line of rails in Crown-street; and by traders and others who object to the double track in Market-street, Upper-quay, and Palmerston-road. On the 19th inst. an open-air demonstration was held at Coutts' Corner, Victoria-road, Aberdeen, to protest against the opposition to the proposal of the Town Council to extend a double line of electric tramways from the top of Market street to Torry, under the Corporation Tramway Bill.

Ipswich.—The Bill promoted by the Corporation for the working of an electrical tramways system in the borough has been before a committee of the House of Lords. The Great Eastern Railway Company were the only petitioners against the Bill, and negotiations have been proceeding between the town clerk (as representing the Ipswich Corporation) and Mr. Moore (solicitor for the railway company) towards an amicable settlement. The company's petition was withdrawn on the understanding that their position should not be prejudiced if, by reason of the negotiations falling through, they should wish to oppose the Bill when it comes before the committee of the House of Commons.

Cambridge.—At a recent special meeting of the Town Council a letter was read from the Cambridge Street Tramways Company offering to reopen negotiations in conjunction with the British Electric Traction Company with the Corporation with a view to the extension and future working of the tramways. The proposed extensions mentioned would be in the direction of Romsey Town and Chesterton, and would be effected under the Light Railways Act. The system of electric traction by overhead wires is proposed. An offer is also made to pay £200 towards the cost incurred by the Council in plans, etc., if the Corporation will support the proposal. The communication was referred to the Tramways Committee.

Newcastle.—It was explained at Wednesday's meeting of the City Council that the reconstruction of the tramway lines in the city, prior to the installation of the electric system, would commence at the end of this month. In connection with the estimate of the Tramways Committee, which was adopted, it was stated that the committee had entered upon the work of providing 44 miles of electrical tramways in the city, and, having obtained a loan of £400,000—with the prospect of having to borrow £200,000 more—proposed to spend £300,000 during the incoming year on capital works, with £7,375 in addition in repayment and interest in respect of the £400,000 loan. The Council had previously added £50,000 to the capital expenditure.

Loughborough and District Light Railway Scheme.—Application having been made for an order under the Act of 1896 for the construction of lines in Loughborough and district, the Light Railway Commissioners have held an enquiry at the Police Court, Town Hall-passage, Loughborough, as to the expediency of granting the same. The scheme is being promoted by the Loughborough and District Electric Traction Syndicate, Limited, with the support of the Brush Electrical Engineering Company, Limited, Falcon Works, Loughborough. The proposed lines are to run from Hathern through Loughborough and Quorn to Mountsorrel, with a cross line in Loughborough from the Falcon Works. The enquiry was adjourned to an indefinite date.

Clydebank.—Three communications with reference to the proposal to lay electric tramways in the burgh are before the whole Commissioners in committee. The first is from the Glasgow Corporation asking if the Commissioners had come to any decision as to the proposal of Glasgow to extend their service to Clydebank, and asking the Commissioners to meet with the Glasgow Tramways Committee. The others are from Mr. B. Cumming, as clerk to the Third Ward Committee and Amalgamated Wards Committee respectively, stating that it had been agreed at meetings of these bodies to ask the Commissioners not to have anything to do with private companies, but to go in with the Glasgow Corporation or get a provisional order for themselves.

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Southport Extension Bill.—During the hearing of evidence on this Bill by the House of Commons last week it was stated that in the order of the Ormskirk Light Railway Company there was a provision which anticipated the extension of the borough in the direction of that place, and in such event the Corporation had the power to purchase so much of the light railways as came within the borough. Physically speaking, there would be no distinction between a tram and a train of the light railway. It would be the same gauge as the tramway, and to all intents and purposes it was a tramway. The Corporation had got a source of electric supply that would serve the whole district. There was opposition on behalf of the Birkdale authorities, but finally it was announced that Southport and Birkdale had come to an agreement.

Carlisle.—After a long discussion on the tramways at the Town Council meeting last week, a resolution was carried in the following form: "That the attention of the County and Rural District Councils be directed to the fact that the Carlisle Tramways Company do not intend to carry out the scheme of tramways as provided by the order in certain respects outside the city, and that they be urged to call upon the company to carry out their obligation in this respect, and if default be made, to appeal to the Board of Trade with a view to the company being compelled to carry out the scheme in its entirety. That the Council join with the County and Rural District Councils in any action which it may be thought desirable to take with a view of the tramways company being compelled to carry out the scheme of tramways as provided by the order."

Dublin.—The electric service on the Dublin and Lucan line has been started. The power station is at Fonthill, a little over five miles from Dublin. It contains two high-speed compound horizontal engines of 200 h.p. each, coupled direct to the generators and working at a speed of 260 revolutions per minute. The engines were manufactured by the Ball and Wood Company, New York. The two boilers are of the Lancashire type, and were made by Messrs. Galloway and Co., Manchester. Special pump motors and machinery have been laid down in the pump-house on the bank of the Liffey 600 yards from the power station. The cars are mounted on Brill patent bogies, each driving axle carrying a 20-h.p. motor. They will commence running at eight o'clock in the morning on every weekday, and make the journeys between Dublin and Lucan at intervals of 45 minutes until a quarter-past ten at night.

Bath.—The Bath Road Car and Omnibus Company have entered into negotiations with the Corporation with the view of obtaining their co-operation in an application for an order to enable them to run electric cars in the city and outlying districts. The British Traction Company and Messrs. Brash Wheeler, Umney, and Chambers have made similar applications. These communications having been considered at a recent meeting of the Electric Traction Committee, it was agreed to ask the several applicants to state whether they would be prepared to co-operate with the Council in obtaining an order upon the existing application of the Council for routes to Bathford, Lower Weston, Twerton, and Devonshire Arms, the Council granting a lease to them embodying such of the terms mentioned in their letters with any other necessary terms to be agreed upon by the Council, and also asking what guarantees they offer to insure the execution of the works undertaken by them, and the payment of the costs.

Southampton.—At the last meeting of the Town Council it was stated that the receipts from the new electric section had been so satisfactory that it was hoped the 'bus service would be a feeder to the trams, and any loss on the 'bus service would be recouped from the electric service. With regard to the hours of labour of the tramways employés, the committee had resolved that their hours of labour be 60 a week, and that the wages be fixed as follows: motormen (permanent) 5d. per hour for the first 12 months' service and 5½d. per hour after that period, motormen (under instruction) 23s. per week until qualified, conductors now in the first and second classes 4½d. per hour, in the third and fourth classes 4d. per hour, in all other classes 3½d. With regard to uniform for motormen and conductors, it was resolved that a blue reefer coat, pair of trousers, and a cap be supplied to every employé once in each year, and that one overcoat be supplied every second year; that a second pair of trousers be supplied at net contract price; also sou'-wester caps and oilskins be kept at the respective depôts for the use of the motormen. The chief inspectors' pay was increased from 37s. 6d. to 40s., and the second inspectors' pay increased from 27s. 6d. to 30s. per week. Various increases were also made in the salaries of the office staff.

Paisley.—At a special meeting of the Town Council the Glasgow District Tramways Bill was further discussed. The proceedings were private. The agreement between the Town Council and the Glasgow District Tramways Company is rather a lengthy one. The twentieth clause sets forth that the Corporation agrees to lease to the Company the right to lay and electrically equip tramways within the burgh, and to run cars therein for 42 years, with breaks at the end of 25 years and 35 years respectively, from the time when the lines are open for public traffic. The Corporation may purchase after 25 or 35 years on paying the then market value as a going concern. The company is to pay to the Corporation an annual rent or wayleave of £400 per annum for the first five years, and £500 per annum thereafter; or, alternatively, the company shall pay to the Corporation, instead of an annual rent or wayleave, either (1) the sum of £17,500 sterling at the end of 25 years, and £500 per annum thereafter to the termination of the lease; or (2) the company shall pay to the Corporation the sum of £26 600 at the end of 38 years, and £500 per annum thereafter to the termination of the lease; or (3) the company shall pay to the Corporation at the end of 42 years the sum of £40,000 sterling. If any of the latter alternatives is decided upon, a sum will be set aside by the company annually to meet that claim, and be invested in security of same.

Hull.—The *Leeds Mercury* says: "The delay in opening the Holderness-road section of the Hull electrical tramways is causing much disappointment and annoyance to the dwellers on that road. They have been expecting with some confidence that the new service would be ready during March, or at any rate by Good Friday, but so far as present appearances go there will be considerable delay. A few weeks ago it was found in the thoroughfare known as Witham that a portion of one line had to be taken up and relaid, through a miscalculation, a loss to the ratepayers being thus entailed, as the work is being done by the Corporation. During the present week the section at the north end of Savile-street has had to be taken up, as the curve is not correct for effecting a junction with the lines in George-street. There are also two points on the Holderness-road section which the Government inspector has declined to pass, owing to the fact that there is not a sufficient space between the nearest rails and the footpath. To overcome this difficulty the Corporation find it necessary, until certain property can be acquired, to connect the track at these two points into a single line. This will entail not only delay but an additional expense. There is a general feeling in Hull that the Corporation should have known before they put in a double line what space would be required by the Government inspector, and, as there has been no alteration in the position at the north end of Savile-street, what curve would take the line round into George-street."

Rochdale.—At a special meeting of the Town Council resolutions confirming the propriety of including in the parliamentary Bill provisions for conferring upon the Corporation certain traction powers were passed as follows: "To construct and adapt for mechanical (including electrical) traction the tramways in the borough when acquired by the Corporation, and to construct additional tramways within and without the borough; to enable the Corporation and any local authorities, companies, and persons to agree for the purchase, sale, lease, working, use, management, and maintenance of any tramway within or without the borough, which will form continuations of tramways, for the time being of the Corporation, and for the making of any necessary junctions; to enable the Corporation to work all or any tramways for the time being owned, leased, or run over by them by means of animal or mechanical power (including electric energy), and to purchase or take on lease the necessary rolling-stock and plant therefor, to make such alterations and reconstructions or any of such tramways as may be necessary to adapt them to such use, and to place and erect in, on, and under streets, posts, brackets, channels, and electric lines, and to attach the same to buildings; to empower the Corporation to produce electric energy and to use it for traction on the tramways and generally for motive power, and to supply the same to any local authority, company, or person for traction on tramways, and to use the lands of the Corporation, formerly occupied by premises known as 'Bridge Mills,' as a station for generating such energy; to enable the Corporation to acquire certain tramways in the urban district of Wardle, or in lieu thereof to exercise running powers thereover."

Greenock.—The Law and Finance Committee of the Police Board, which consists of the entire membership, have adopted the report of the special committee appointed to deal with the tramways question. The report recommended the acceptance of the offer of the Greenock and Port-Glasgow Tramways Company for the leasing of the line within the burgh. The price of electricity is to be 1½d. per unit for a minimum of 500,000 units, the charge for additional quantities to be fixed when necessary. At a subsequent meeting of magistrates, a petition was submitted asking that a meeting of the ratepayers be called to consider the tramway question. The *Greenock Herald* says: "The tramways company's offer is now as good as any reasonable body of men could expect. A rent of £1,200 per annum for 14, 21, or 28 years is about double the income hitherto derived from the Corporation's tramway lines, and this of itself shows that the lengthy discussion of the question has had a good result. In addition to this assured income, the town will have a profit from the sale of its electricity to the company, as well as reaping the advantage of having the streets in which the lines are laid kept in repair free of cost. If this is not a much safer course than the dubious experiment of the Corporation working its own tramways, with all attendant worry and anxiety as to the result, then we must have a clearer statement as to the benefits of municipalisation than we have yet obtained. And then, after all, if we should discover that we have handed over an Eldorado to the British Electric Traction Company, we can take it from them 14 years hence." At the monthly meeting of the Greenock Police Board on the 20th inst. the offer of the Greenock and Port Glasgow Tramways Company for leasing the lines within the burgh owned by the Corporation was accepted. A notice of a rescinding resolution was submitted with the view of municipalising.

LIGHTING AND GENERAL.

Luton.—Application has been made for an electric lighting loan of £26,000.

Beckenham.—The electric lighting is to be extended to the Cator roads.

Colwyn Bay.—Sanction has been obtained for a loan of £5,100 for electric lighting.

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Ilford.—Sanction has been received for the electric lighting and tramway depôt scheme.

Maidstone.—The Council are asking for an additional loan of £10,000 for electric lighting.

Tunbridge Wells.—Sanction has been obtained to a loan of £24,680 for lighting extensions.

Teddington.—The District Council have decided to apply for a provisional electric lighting order.

Hornsey.—The District Council have decided to oppose the North Metropolitan Electric Power Supply Bill.

North Metropolitan Electricity Supply Bill.—The Harrow Urban District Council have petitioned against this Bill.

Willington Quay.—The District Council have decided to grant an interview to the representatives of the Tyneside Electric Power Company.

Macclesfield.—It is proposed that a valuer be appointed to value the Alderley and Wilmslow electric supply for the Alderley Edge district.

Ryde.—The Council have decided to apply for £30,000 to carry out the electric supply scheme prepared by Messrs. Kincaid, Waller, and Manville.

Ambleside.—The Urban District Council have concluded an arrangement with the Windermere Electric Supply Company for the supply of current.

Nuneaton.—Colonel W. R Slacke, R.E., has held an enquiry into the application of the Council to borrow £16,000 for the purposes of electric lighting.

Bermondsey.—The Vestry have granted the loan of the town hall for the purpose of holding a town's meeting at which the electric lighting scheme might be discussed.

Aron Electricity Meter, Limited.—The transfer books of the preference shares will be closed from 26th to 31st inst., both days inclusive, for the preparation of dividend warrants.

Margate.—With regard to the electric lighting scheme, we learn that the arrangements for the generating station and plant are being completed, and it is hoped to get it forward at an early date.

Dundee.—The amount of electricity rental paid in February was £170. 19s. 8d., making a total for the 10 months of the current year of £6,033. 16s. 7d.—an increase on the previous year of £1,107. 6s 11d.

Stirling.—Out of several candidates for situations at the power station, Mr. J. A. Roberteon has been appointed assistant engineer. The Council have agreed to insure the boilers at the electric lighting station for £3,000.

Adams's Electrical Generator, Limited.—This Company has been registered with a capital of £5,000, the object being to acquire certain patents relating to improvements in apparatus for generating electrical pressure, etc.

Brighton Corporation Bill.—The Select Committee of the House of Commons, presided over by Mr. Schwann, on Wednesday rejected the proposals made by the Hove Corporation, and passed that part of the preamble relating to electrical energy.

Deptford.—The hearing of the summons against the London Electric Supply Corporation, Limited, for penalties in respect of the alleged defective lighting of the Dover Castle public-house, Broadway, Deptford, has been adjourned until the 30th inst.

Skipton.—The Skipton Traders' Association have decided to ask the Urban District Council to take into consideration the advisability of making application during the next session of Parliament for a provisional order to supply electric light to the town.

Whitechapel.—The Board of Works will be officially represented at a conference to be held at Whitehall Gardens on the 29th inst. upon the application for provisional orders, under the Electric Lighting Acts, made by Mile End Old Town, Limehouse, and St. George's-in-the-East.

Wandsworth.—The Vestry have agreed to a notice from the County of London and Brush Provincial Electric Lighting Company under the Wandsworth Order, 1892, of intention to lay low-tension mains along portions of Ullathorne-road (each side) and West-drive (east side).

Personal.—Mr. G. W. Webb has been appointed manager of Messrs. Fry and Co.'s showrooms at 19, Farringdon-avenue representing Messrs. Joyner and Co., manufacturers of gas and electric fittings, etc.—Mr. R. M. Carr has been appointed assistant electrical engineer to the Bexhill-on-Sea Urban District Council.

Harrogate.—The report of the Electric Light Committee contains a number of recommendations to erect new lamps and rearrange existing ones. The report was adopted last week, and it was also resolved that the borough surveyor be authorised to engage a clerk of works for these extensions when he considers it necessary.

London Gazette.—Mr. R. T. Tatham, 9, King-street, Maidstone, has been released of his trusteeship *re* Mr. H. W. Thane, 32, The Hill, Northfleet, Kent. A first and final dividend of 4s. 8d. per £ has been declared *re* B. Wild and J. H. Clerk, trading as Wild, Rothwell, and Co., Atlas Works, 63, Virginia-street, Southport, Lancs., payable at offices of Yates and Scrampton, 4 and 6, Wood-street, Bolton.

Huddersfield.—The salary of Mr. A. B. Mountain, the borough electrical engineer, has been increased by £100 per annum. The Electricity Committee, in their minutes, expressed satisfaction with the statement referring to the cost of the extensions carried out at the electric supply station. The total amount of the contracts was £6,949. 15s. 6d., and the amount expended £7,222. 16s. 3d., with a balance for extras of £273. 0s. 9d.

Greenock.—The engineer's last report states that during the month ended March 9 18,400 units of electricity were generated, and the estimated number sent out was 11,400. Up to the present the number of lamps applied for by private consumers is equivalent to 4,247 8-c.p. lamps, and this, together with the arc lamps, brings the total up to 5,151, or an increase of 795 8 c.p since last report. The number of consumers is now 72, as against 60 last month.

Paisley.—The minutes of the Electric Lighting Committee laid before the last meeting of the Town Council showed that Mr. Teague had reported to the Electric Lighting Committee with reference to the three steam alternators supplied by Messrs. Ferranti, Limited. The alternators will require to be taken out, and Mr. Teague recommends the Corporation to accept in their place engines of the type supplied by the firm to the Wallasey Corporation works, which have been found satisfactory.

Appointments Vacant.—The Vestry of St. Mary require a fully qualified mechanical draughtsman, also mechanician. Full particulars of this and other appointments appear in our advertisement columns. There are vacancies for an improver and draughtsman, a trained expert manager for a new accumulator manufacturing department, and others.—An electrical engineer is required for the Sheffield Corporation at £500 per annum.—An assistant engineer is required at Hanley.—The Glasgow Corporation want an assistant manager for their telephone exchange.—A mains superintendent is also required for the electricity department at Cardiff.

City of London Electric Lighting Co.—An extraordinary general meeting of this Company will be held at Winchester House, Old Broad-street, E.C., on March 30 at 12 noon, when the following resolution, which was passed unanimously at the general meeting of the Company held on March 15, 1900, will be submitted for confirmation as a special resolution: "Resolved that the Company approves the Bill as introduced into Parliament intituled 'a Bill to empower the City of London Electric Lighting Company, Limited, to acquire lands and work generating stations and for other purposes,' subject to such additions, alterations, and variations as Parliament may think fit to make therein."

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to: Buenos Ayres and Belgrano Electric Tramways Company, Limited—£120,000 5 per cent. second debenture stock, and National Telephone Company, Limited—£500,000 4 per cent. debenture stock; and a further issue of 100,000 ordinary shares of £5 each. The committee have further been asked to allow the following securities to be quoted in the official list: Edmundson's Electricity Corporation, Limited—£75,000 4½ per cent. first mortgage debenture stock, and Electric Railway and Tramway Carriage Works, Limited—shares of £5 each, fully paid. The committee have also ordered the British Electric Traction Company's further issue of 20,000 6 per cent. cumulative preference shares of £10 each, fully paid, Nos. 90,001 to 110,000, to be quoted in the official list.

Steam.—We have received a copy of the first English edition of the volume entitled "Steam," issued by Messrs. Babcock and Wilcox, Limited, of 147, Queen Victoria-street, E.C. This edition is issued simultaneously with the thirtieth edition of the volume published in America. The details of the Babcock and Wilcox boilers are now so well known that any further reference is almost unnecessary, but the historical description given in this volume will be most interesting to all engineers. In addition to information respecting the design of water-tube boilers, a large amount of general information is added on the subject of fuel, its combustion, and the general design of steam-raising plant. The question of superheating is also gone into more fully than in previous editions, and the advantage of superheating is further supported by a number of tests which have been made by experts of renown. We are glad to see opposite the preface an illustration of the boiler-room of the City of London Electric Lighting Company's station. The illustrations elsewhere in the book are mostly taken from installations outside Great Britain. The photographs, however, of the Renfrew works of the company remind us that placing orders for Babcock-Wilcox boilers does not mean the engineering work is sent out of the country.

The Speed of Electric Cars.—The Liverpool city coroner (Mr. T. E. Sampson) held an inquest at the Coroner's Court, Dale-street, recently on the body of a child named George Roberts, aged two years and seven months, son of a cotton porter, Poyntz-street, Kirkdale-road, who was killed by an electric tramcar in Kirkdale-road. Evidence showed that the car was proceeding about five or six miles an hour. It went some little distance before it stopped after deceased was knocked down. Mr. E. T. Pugh, assistant superintendent, said that the lifeguard attached to these particular cars were of a new type, approved by the Board of Trade, which it was thought would prevent the possibility of accident. There were only 2½in. between the lifeguard and the ground, and he could not conceive how the child got under it. The Coroner, referring to the general question of speed of the electric cars, said that the frequency of these accidents forced him to say that extreme care must be taken by drivers of cars, especially in crowded thoroughfares, and they must exercise due caution in order to prevent the recurrence of these accidents. With regard to the lifeguard, he hoped some attention would be given to it by the tramway authorities. The jury returned a verdict of "Accidental death," but expressed the strong opinion that drivers of cars should be very careful about the rate of speed at which they travelled.

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Fifeshire.—At the last meeting of the Lunacy Board it was stated that the proposal to introduce electric light into the asylum had been caused by the Cupar Gas Company asking the Board to erect a new gasometer. The institution could be lighted very much cheaper by the electric light. The matter was remitted to a committee with powers.

Leeds.—The City Council have decided in reference to Electric Power Distribution Bills to join in and support the opposition of the corporations specially affected by these Bills, "all of which contain provisions which are prejudicial to the interests of corporations, both as to the supply of electricity and in the interference with the streets."

Wealdstone.—The Board of Trade have informed the Council with respect to the Harrow Electric Light and Power Company that, as the undertaking authorised in the order of 1894 had been transferred by the local authority to a private company, the Board did not appear to have any power to amend the area prescribed by the order at present applied for.

Bridgwater.—The Town Council have entered into an agreement with Mr. Trentham as consulting engineer for the electric light installation. Mr. Trentham is to be allowed two months in which to prepare plans, specifications, etc., and 12 months for the execution of the works. The name of Lord Kelvin has been substituted in place of Mr. Wright as referee.

Southend.—At the last meeting of the Southend Town Council it was decided not to appoint an electrical engineer in succession to Mr. Mitchell, but to appoint temporarily an assistant to the borough engineer's department having experience in electrical matters. It will be remembered that at Southend both electric lighting and light railway schemes have been proposed.

Heswall.—At a recent meeting of the parishioners it was decided not to consent to the proposed scheme of the Heswall Lighting Company, Limited, to effectually light the parish, and to enable the company to obtain a provisional order from the Board of Trade for powers to carry out the necessary works. A resolution in favour of adopting the Lighting Act was carried unanimously.

Barnard Castle.—The Urban District Council recently passed a resolution with regard to the purchase of the electric supply company's undertaking that 30 years be the terms of purchase under the Act of 1888, with 15 per cent. on the capital expenditure, but the company insisted upon 31 years with 20 per cent. The Urban District Council have decided now to agree to the company's terms.

Leamington.—The Electric Light Committee have submitted a report recommending that if the suggested clauses and amendments filed by the Corporation were accepted by the Midland Electric Light and Power Company, Limited, and embodied in the order they were applying for, the Corporation should abandon the order obtained by them in 1899, and withdraw their opposition to the company's order.

Bacup.—The Electricity and the Health Committees have visited Darwen, and appear favourably impressed with the electricity and destructor works. The system proposed to be adopted by the Corporation for the supply of electrical energy is the three-wire low-tension continuous-current system, as recommended by Mr. Taite. It has been decided to proceed with the appeal to the House of Lords in the Wallasey case.

Southampton.—The Electricity Committee have reported that the statement of income and expenditure for nine months, submitted by the borough accountant, showing income and expenditure, including assets and liabilities, also including proportion of accumulation of deficit for the first three years, but not including supply of power to the tramways, showed no loss, and which the committee considered satisfactory.

Aberdeen.—At a meeting of the Town Council on the 19th inst. it was remitted to the Gas and Electric Lighting Committee to consider and report upon the existing arrangement as to charging for electric light under the indicator system, the mode in which the calculations are made, and the effect it has on the accounts of those consumers who use electric light all the year round. Forty additional lamps are to be provided in the streets at a cost of £1,272.

Bankruptcy.—A meeting of creditors was held last week at the offices of the Leeds official receiver relating to the affairs of Frederick Metcalfe, electrical engineer, late of White Horse-street, Boar-lane, and residing at White House, Cookridge, and now of 6, Tenter-lane, Swinegate, and residing at 4, Ashville-terrace, Cardigan-road. The liabilities are £125. 16s. 10d., and the assets £6. 7s. 7d. The debtor attributes his failure to loss on contracts.

General Electric Co.—We have received from this Company a fresh sheet for pasting in their catalogue. The sheet in question deals with a special pipe vice, small-power motors for fan driving, etc. These motors are of $\frac{1}{10}$ h.p. and $\frac{1}{4}$ h.p., and are constructed for continuous currents from 100 to 200 volts. The speeds vary from 1,500 to 1,850 revolutions per minute. A patent sealing-wax heater manufactured by the Company is illustrated, and also the Byng telephone and microphone.

Inverness.—At a meeting of the Town Council last week, Mr. E. G. Craven, electrical engineer, submitted a report on the tenders for the installation of electric lighting in the burgh, and it was unanimously resolved to accept the offer of the Brush Electrical Engineering Company, Limited, London, the question of the particular kind of boilers being reserved. The contract, excluding the boilers, amounts to £21,000. The work of construction will be proceeded with at once.

Walsall.—The total number of consumers supplied on Feb. 28 last was 158. After the 25th inst. the charge for the supply of electric current for motor purposes will be at the rate of 2½d. per unit for the first four hours at the maximum load, all additional units are to be charged for at the rate of 1d. per unit, and the 10 and 12½ per cent. discounts to all large consumers are to be abolished in so far as current for motive power is concerned.

Lowestoft.—The Town Council have passed the following resolution: "That this Council will support the English Industrials, Limited, of Manchester, in their application for a telephone license, and that wayleave facilities may be afforded the same company on conditions to be hereafter mutually arranged." The charges proposed are 50s. per instrument, with ½d. per call, and a maximum of £6 5s. A letter from Messrs. Bush and Dryburgh, containing proposals as to the free wiring of houses for electric lighting, is being considered by a sub-committee.

Ashton.—The Council have resolved that the price of current for lighting purposes be 4½d. per unit instead of 7d. and 2d., the change in price to take effect from the beginning of the present quarter, and that electricity for power purposes be charged at 3d. per unit. The question of installing additional generating plant as per the report of Mr. Vincent has been considered, and a sub-committee has been appointed to visit and inspect electricity works with Mr. Vincent in order to ascertain the best make and description of plant for adoption, and to report thereon.

Bath.—At the meeting of the Town Council on the 20th inst. it was proposed that a sub-committee be formed to enquire into the cost of producing the electric light in Bath, contending that the cost as compared with most other corporations was not favourable. A long discussion ensued, it being pointed out that the committee were already endeavouring to reduce the expenditure, and finally the motion was withdrawn. A report was submitted by the Electric Lighting Committee which recommended the acceptance of tenders for carrying out extensions for public and private lighting at a cost of about £13,000.

West Riding.—The County Council have adopted a report of the Highways Committee stating that they had concluded a general agreement with the National Telephone Company, Limited, relative to the laying of electric cables under main roads, the control of which is vested in the West Riding County Council, providing for payment by the company of an annual acknowledgment of 2s. 6d. per furlong or part of a furlong of cable, and a charge of 10s. per annum for each large box, and 2s. 6d. per annum for each small box, and for the due reinstatement of the road and removal of the wires and apparatus on notice.

Jarrow and Hebburn Electrical Supply Bill.—This Bill came before the Court of Referees of the House of Commons on the 20th inst. upon a question of *locus standi*, the petitioners against the scheme objected to being the Electrical Power Distributing Company, Limited, and the County of Durham Electrical Distribution Company, Limited. The committee decided that the petitioners had an obvious *locus* within their petition. A request has been lodged at the Private Bill Office of the House of Commons that the petition of the Hebburn Urban District Council praying to be heard by counsel may be withdrawn.

Grimsby.—The Corporation have issued a prospectus with regard to the supply of electrical current to the public for lighting purposes. The current will be supplied at a pressure of 230 volts. The Corporation in all cases lay the service mains between their own mains and the consumers' premises, and will supply, fix, and keep in repair a suitable meter on the consumers' premises on the house side of the main fuse. For this meter a rent will be charged half-yearly at the following rates: meters for registering up to 25 8-c.p. lights, 6s. per half-year; 50, 6s. 6d. per half-year; 100, 7s. per half-year; 200, 7s. 6d. per half-year.

Glasgow.—At the last meeting of the Council the Electricity Committee's minutes were approved after some opposition. The committee propose that the system of charging by demand indicator should be abolished, so far as householders are concerned, at the beginning of the financial year. It was stated that the use of the electric current in households had not been popular hitherto, and the committee wished to change this and to have a fixed rate. The maximum load in private houses came on at a different hour from that of offices and warehouses, and the committee thought it would be an advantage to cultivate this trade in private houses.

Spennymoor.—The Urban District Council have passed the following resolution: "That consent be given to the Northern Counties' Electric Supply Company to apply to the Board of Trade for a provisional order to establish works and to supply electricity in the district upon the conditions as stated in the company's letter, dated Oct. 16 last; and also further distributing mains from the Four Lane Ends to the Five Lane Ends, as shown on the plan deposited with this Council; and also further upon condition that within four years (if not earlier required under Section 21 of the Electric Lighting (Clauses) Act, 1899, or other Acts or orders) the company shall lay down suitable and sufficient distributing mains for the purposes of general supply throughout every street or part of a street within the urban district, where public street lamps are at present erected." A committee has been appointed to further consider the matter.

Kandy, Ceylon.—We learn from the columns of the *Ceylon Standard*, a copy of which business-like paper has been forwarded to us, that the recent completion of the Kandy electric lighting scheme was the occasion of an interesting ceremony, when the services of the resident electrical engineer, Mr. J. E. Addyman, under whose supervision the whole of the work has been carried out, met with gratifying recognition from the employés of the Kandy branch of the Colombo Gas and Water Company, Limited,

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who presented him with a handsome gold watch, engraved with the monogram "J. E. A." on the back, and inside, "Presented by the employés of the Kandy Branch, Colombo Gas and Water Company, Limited." The address which accompanied this memorial congratulated Mr Addyman on the successful manner in which the work of lighting the town had been carried out, and was in itself an ample tribute of the esteem in which Mr. Addyman is held by those under him.

Govan.—The last report of Mr. James Brown, the resident electrical engineer, states that up to Feb. 28 he had received 12 applications from private consumers. The total of these applications amounted to an equivalent of 865 16 c.p. lamps. In addition to this, about half a dozen more shopkeepers had signed their names on the official application form as consumers, but the actual number of lights to each was not yet fixed. The total of these would amount, roughly, to another 300 16 c.p. He also reported on the extension of mains in Woodville-street, which would cost about £400. This was in connection with an application of a firm who are about to erect new brassworks in Woodville-street. With regard to charges, it has been agreed that where the current was used for less than five hours per day the charge would be as for light, 6d. per unit for first hour and 2d. per unit thereafter, but where the current is used for five hours and upwards the charge would be 2d. per unit over all.

Ayr.—The last monthly report of the burgh electrical engineer, Mr. Arthur J. Fuller (adopted by the Council), states that the output for the past three months shows a very considerable advance over the corresponding period of last year, the figures being as follows: winter. 1898, units generated, 140,000; winter, 1899, 188,000; increase for 1899, 48,000. The maximum load at any one time this winter worked out at 256 kw., as against 200 kw. of the previous winter. The sub-committee have inspected several new lamps for side street-lighting, and have been very favourably impressed with the increased candle-power which it is proposed to give next winter—viz., 32 c.p. as against 16 c.p. lamps now in use. The price at present charged is £2 10s. per annum for each 16 c.p. lamp, and this price will be now adopted for the double candle-power lights. The engineer is also considering the advisability of reducing the price charged for the arc lamps and also of the cost of the current to the ordinary consumer.

Paisley.—The electric lighting authority, having applied for further borrowing powers, the Under-Secretary for Scotland wrote for their information that under the statutes the Council could only borrow with his consent for the purpose of their undertaking to the extent of the unexercised margin of the borrowing powers conferred by their local Gas Acts—that is to say, the borrowing of the burgh for gas and electricity together must not exceed the total amount authorised to be borrowed under the local Gas Acts. It was reported that the unexhausted borrowing powers under the Gas Acts would, at May next, amount to £13,000, and it was decided to apply for authority to borrow for electric lighting purposes to that extent in the meantime, and make application for a provisional order authorising borrowing to the extent of £20,000 for electric lighting purposes, on the understanding that, should the order be obtained, the right to exercise their borrowing powers to the extent of £13,000 would revert to the gas corporation.

West Ham.—The following extensions of the electric light have been adopted: No. 1 extension—from the electricity works along Stephen's-road, Plaistow-road, High-street, Plaistow, and Balaam-street to Barking-road, one main in High street, Plaistow, one in Balaam-street from Newman-street to Barking-road; No. 2 extension—along north side of Barking-road from Balaam-street to Green-street, and one low tension main to supply Plaistow hospital; No. 3 extension—from the corner of Upton-lane and Plashet-road along Plashet-road to Gipsy-lane, and in Gipsy-lane from Glenpark-road to Chester-avenue; No. 4 extension—along Romford-road from Richmond-road to Balmoral road. The report of the electrical engineer on the question of electricity charges has been adopted advising the committee not to entertain any idea of instituting a uniform charge. He suggested that the rebate be given quarterly instead of half-yearly; that when a new consumer is connected his maximum demand be calculated only from the date on which he is connected to the mains; that the scale of charges be reduced as follows: lighting purposes from 7d. and 3d. to 7d. and 2d., power purposes from 5d. and 2d. to 5d. and 1½d.; that the following scale of quarterly discounts be adopted: accounts amounting from £10 to £30 2½ per cent., from £30 to £50 5 per cent., from £50 and upwards 7½ per cent. The committee approved of these suggestions.

Brighton.—The Town Council have adopted a report of the Lighting Committee recommending a modification of their agreement with Mr. Wright by which he would be relieved of the superintendence of details, but remain consulting engineer at the same salary as at present. Mr. Wright bound himself for five years, while the Corporation might determine the agreement by a three months' notice. Mr. Joyce is to be acting manager of the electricity works during the absence of Mr. Fowler in South Africa. The balance-sheet of the electricity works for last year shows that 3 815,743 units of electricity were generated during the year, of which 2,604,039 were consumed in private use, 602 584 on the public lamps, 160,630 in the works, and 448 470 not accounted for. There were 257 public arc lamps and 1,027 incandescent. Including £229,687. 15s. 1d. due to capital, the liabilities at the close of the year were £308,295. 0s. 1d. The cost of generating the electricity was £17,269. 11s. 9d., and of distribution £11,745. 14s. 6d. Sales to the public realised £35,321. 3s., while the charge against public lamps was £8,546. 16s. 11d. To a profit on the year of £16,700 must be added £6,802. 0s. 7d. brought forward from the previous year, making £23,502. 0d. 7d., of which interest consumes £7,146. 0s. 5d., and sinking fund £8,099. 1s. 5d. The sum of £2,135 was applied in aid of district rate; £179. 2s. 10d. transferred to reserve fund; £4,496. 17s. 9d. paid to loans fund; and £1,454. 18s. 2d. carried forward.

Sale of Machinery.—We are enabled to give the following particulars of the forthcoming sale by the Northampton Electric Light and Power Company, Limited. The plant consists of two compound vertical engines, cylinders 11½in. and 18in. by 15in. stroke, 120 i.h.p., speed 200 revolutions per minute, steam pressure 120lb. per square inch. The engines are fitted with Pickering governors and a Boys and Cunningham's steam separator, and a 7ft. flywheel for rope driving; the engines were made by Messrs. Scott and Hodgson, of Guide Bridge; a sight-feed lubricator is also fitted to each engine. Two Crompton shunt-wound dynamos; output, 510 amperes at 130 volts; speed, 680 revolutions per minute; pulley-wheel for ropes. One compound vertical engine, coupled direct to a Crompton shunt-wound dynamo; engine cylinders 11½in and 18in., stroke 15in., 120 i.h.p., speed 200 revolutions per minute, steam pressure 120lb. per square inch. The engine is fitted with a Pickering governor and a Boys and Cunningham's steam separator; the dynamo is a four-pole shunt-wound; output, 600 amperes at 130 volts. Three 600 ampere automatic knock-off switches, three 600 ampere ammeters, three shunt resistances. Three Daniel Adamson steel Lancashire boilers, 20ft. by 6ft., capable of evaporating 3,000lb. water per hour; working pressure 120lb. per square inch. Each boiler is fitted with duplicate feed valves, a blow-off cock, safety valves, also quite recently fitted with Bennis mechanical stokers and Hotchkiss cleaners.

Guildford.—In reply to the resolution recently adopted by the Council enquiring of the Guildford Electricity Supply Company, Limited, as to whether they are willing to sell their undertaking to the Corporation, and, if so upon what terms, the directors have decided to recommend the shareholders, subject to the necessary sanction of the Board of Trade, to dispose of the whole undertaking of the company for £25 000. A small committee of the Town Council is to meet the directors and discuss the matter with them. In the meantime the directors have tendered for street-lighting on the following terms: For 16 c.p. incandescent lamps with reflectors, giving an equivalent of about 25 c.p. If the town authorities provide standards, lamps, and all other equipment, including erection, but cleaning, lighting, and extinguishing to be done by the company, £3 per lamp per annum. If the company is required to provide standards, lamps and fittings, £3. 10s. per lamp per annum, for a term of not less than five years. The company is prepared to supply and fix in a suitable place, at their own expense, an electric lamp of a pattern that they would recommend, keeping the same in order, provided the Corporation pay for the current consumed. They suggest a three-way reflector lamp (with three 16-c.p. lamps) at the weighbridge in North-street, and are willing to let it be on show for three months. For arc lamps the company is not prepared to quote for these without further particulars as to the number and position of the lamps required. Arc lamps must be connected and supplied in pairs. To supply a single arc lamp at a distance from any other would be impracticable. Arc lamps are not recommended for street-lighting in a town of this size. The company's offer to erect a lamp has been accepted.

Catalogues.—We have received from the Electrical Company, of 122, Charing Cross-road, a copy of their price-list for "Luna" arc lamps. Illustrations and prices are given of shunt, differential, and inverted lamps for use on direct-current circuits, and of an enclosed arc lamp for alternating-current work. Prices are also quoted for choking coils, resistances, etc.—We have also received from Messrs. R. W. Blackwell and Co., of Victoria-street, S.W., a copy of their catalogue No. 24. This catalogue is profusely illustrated, and is printed on exceptionally good paper. A novel feature in connection with it is that the various articles listed are divided up into sections, and the book may be immediately opened at any one of these by means of the thumb index given. Amongst the immense number of articles appearing in the catalogue we notice various types of rails and rail bonds. Motor trucks are dealt with in one section, together with automatic couplings, air-brakes, etc. Trolleys have a section devoted entirely to them, as have trolley poles and trolley wagons. This trolley wagon is a very convenient arrangement for working on trolley wires. Insulators and lightning arresters occupy other sections, while switches and circuit breakers are dealt with at length. Lamps (both arc and incandescent), meters, and transformers are described, and prices given and information as to the use of the "Keystone" arc light voltmeter and ground detector, and also of the polarity indicator, are to be found in this section. A short section then deals with roller bearings, and a longer one with the Allis types of engines. The last section deals with valves, pipes, tools, fittings, etc. Altogether the book is a good work of reference for an electrical engineer, as giving the average prices to be paid for practically all his requirements.

Westinghouse Switchboards.—The British Westinghouse Electric and Manufacturing Company have forwarded us two catalogues of switch gear. The first of these is devoted to switch gear for polyphase circuits working at pressures of from 1,100 to 2,200 volts, while in the second instance the switchboards are designed for pressures of from 100 to 600 volts. So much information is given in these that it is difficult to go into detail over any particular features of the switchboards. What impresses us most is the fact that the company has standardised such a large number of panels containing the whole of the instruments required for generators and feeders. In this way if an engineer is content

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to take standard types which he knows have been prepared from long experience, he can at once ascertain the exact size his switchboard would have to be, and also, we presume, that he will, in consequence of the standardisation, be able to obtain the panels he requires in a much shorter time than if they had to be designed *de novo*. The panels in question can be obtained for either single-circuit running or for working a number of generators in parallel. In the high-tension circuits they are standardised for three currents as a rule—*i.e.*, 60 amperes, 100 amperes, and 200 amperes respectively. The panels required for high-tension feeders are arranged for a much wider range of output. In every case a distinction is made as to whether a board is required for three or two phase work. The low-tension switchboards are made much in the same way as the high-tension, except that a diffrent type of switch is used. In this case the switch is placed on the face of the panels, whereas with the high-tension switchboards the handle only is in front of the board and the switch is placed behind the board, where it cannot be accidentally touched.

The Allan Accumulator.—We have received from Messrs. Allan and Adamson, of Clun House, Surrey-street, Strand, their price-list for the Allan types of accumulators. The grids of these accumulators are specially designed to enclose the active material in an envelope, so that the paste is well supported by the grids. For this purpose two open grids are used, one of which comes on each surface of the plate. The section of the grid is of a V-shape, with the point inwards. The points of intersection of the strips forming one grid are arranged to come in the middle of the points on the opposite grid. By special casting arrangements these grids are cast in one piece and connected round the edges. The section of the edge of the plate has thus a channel through which holes are made to allow any gas to escape which may collect in it. The firm are now manufacturing these accumulators in four different types. The first is used for small work, such as driving medical apparatus, electric ignition for gas-engines, and for telegraph and telephonic purposes. The next type is intended to be used for motorcar work, while the F. O. type is adapted for house-lighting and for driving electric launches. The remaining type, called the H. V. type, is employed for central-station work, house-lighting etc. As regards the traction type of cell for use with motorcars, the list states that a cell weighing 33lb. has a capacity of 125 ampere hours at a five hours' discharge rate. This cell can also give 50 amperes for 1½ hours without any damage resulting. Ebonite boxes are used to support these traction cells, but they can also be supplied in wooden boxes lead-lined, which will certainly be found more serviceable. The firm also specialise in connection with these accumulators for traction an ebonite vent which allows the escape of gas while preventing the acid from spilling.

PROVISIONAL PATENTS, 1900.

MARCH 12.

4639. Improvements in overhead electric railway trolleys. William Harley and John Duggan, 15, Water-street, Liverpool.

4672. Improvements in the terminals and insulators of the holders of electrical incandescent or glow lamps, which improvements are also applicable to other electrical terminals. William Walker, jun., 7, Staple-inn, London.

4680. Improvements in electric accumulators. Adolph Müller, 46, Lincoln's-inn-fields, London.

4685. Improvements in or connected with electricity meters. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

MARCH 13.

4706. Improvements in electric switches, principally for high-voltage circuits and also applicable to switch lamp-holders. John Lightfoot, 15A, Cooper-street, Manchester.

4709. Improvements in or connected with electric cable joint-boxes. George Hinde Nisbett, 15, Water-street, Liverpool.

4719. Improvements in electric motors. James Marr and William Cranswick Laidler, 3, St. Nicholas's-buildings, Newcastle-on-Tyne.

4720. Improvements in and relating to the electric lighting of railway carriages, cars, ships, and the like. George Macculloch Brand, 96, Buchanan-street, Glasgow.

4774. An improvement in switchboards. Arthur Ford-Lloyd, Boswell-court Works, Devonshire-street, Theobald's-road, London.

4784. Improved magnet winding for continuous-current machines and converters for effecting simultaneously a sparkless commutation and a pressure regulation. Max Déri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4785. An alternating-current motor. Max Déri, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4795. Improvements in the distribution of electric current and apparatus therefor. Julien Dulait and Otto Garbe, 322, High Holborn, London.

4803. Improvements in incandescent lamps. Reginald Aubrey Fessenden, 24, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, Sec. 103, Aug. 25, 1899, being date of application in United States.) (Complete specification.)

MARCH 14.

4818. Improvements in and in the means of supporting electrodes or plates of electrical accumulators, and in the manufacture of such electrodes and tools or appliances for use in such manufacture, and a method of constructing such tools or appliances. Edwin Thorley Parker, Prince's chambers, Wolverhampton.

4829. An improved method of suspending, raising, and lowering electric lamps and other articles. Joseph Gullen Booth, 132, Rochdale-road, Bury, Lancs.

4831. A patent asbestos application to wires and insulated wires for electrical purposes. Arthur Connor Richardson, 6, Lombard-street, Newcastle-upon-Tyne.

4832. Improvements in and relating to motors of the steam-turbine type. James Murrie, 264, St. Vincent-street, Glasgow.

4842. An electric firedamp detector or indicator. William Outterson Wood, 77, Chancery-lane, London.

4844. Improvements in obtaining metals from their fused ores, oxides, and salts by electrical action. José Baxeres de Alzugaray, Suffolk House, Laurence Pountney-hill, London.

4848. Improvements in telephone divided multiple-board system. William Aitken, 2, Oxford-court, Cannon-street, London.

4859. An electric mechanism for operating a clutch in connection with electric motors. Joseph Gershom Childs, 145, Farringdon-road, London.

MARCH 15.

4885. Improvements in electrical instruments for measuring current, pressure, and power in electric circuits. George Dudley Aspinall Parr, the Yorkshire College, Leeds.

4892. Improved electric furnace. John Joly, 12, Northbrook-road, Dublin.

4921. Improved electrical method for securing uniform time in clocks. John Grant, 13, Prospect-terrace, Aberdeen.

4926. Improvements in automatic time switches. Archibald John Howard, Corporation Electricity Works, Newport, Mon.

4932. Improvements in or connected with electric motors and generators and other electric apparatus and instruments. Valère Alfred Fynn, 55, Chancery-lane, London.

4933. Improvements in register dials for meters and the like. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (George H. Alton, United States.) (Complete specification.)

4934. Improvements in current-feeding devices for electric motorcars or the like. Johannes Wilhelm Ehlers, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MARCH 16.

4976. Improvements in the means or method of signalling on electric tramways. Christopher John Spencer, 2, Market-street, Bradford.

5003. Means for automatically reviving or reinforcing exhausted pulsations upon a telephone line. Morris Clinton Mengis, 78, Fleet-street, London. (Complete specification.)

5016. Improvements in porous diaphragms for electrolytic apparatus. Trevenen James Holland and Arthur Pillans Laurie, 6, Bream's-buildings, Chancery-lane, London.

5032. Improvements in electrical cut-out devices, especially adapted for preventing excessive flow of electric current. Arthur Malignani, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5046. Improvements in electricity meters. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk street, Strand, London.

5050. Improvements in asynchronous rotary converters. William Phillips Thompson, 332 High Holborn, London. (Helios Electricitäts Actien-Gesellschaft, Germany.)

MARCH 17.

5069. Improvements in connection with inverted arc lamps. Henry Mostyn Darrah, of the firm of Baxendale and Co., 55, Market-street, Manchester.

5072. Improvements in and connected with electric incandescent lampholders. George Bayliff, 5, Clayton-square, Liverpool.

5085. Improvements in or relating to apparatus for regulating the arc in electric arc lamps. Edgar Leslie Thorp and Llewellyn Burbank Codd, 50, Wellington-street, Leeds.

5088. Bonding for iron or steel electrical conductors. Robert Thomson, 21, Bothwell-street, Glasgow. (Charles Brown, Switzerland.) (Complete specification.)

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5185. **Improvements in mercurial thermometer alarms in connection with electric contacts for visible or audible indications.** Arthur Morley, 73, St. Stephen's-road, Upton Park, London.

5186. **Improvements in intercommunication telephone systems.** Max Byng and Francis George Bell, 73, St. Stephen's-road, Upton Park, London. (Complete specification.)

5187. **Improvements connected with incandescent electric lamps.** William Charles Gale, 166, Fleet-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published April 7, 1900.

1899.

5100. **Methods for charging and discharging accumulators.** Cooper and Ridley.

5797. **Alternating-current induction motors.** Rhodes.

6032. **Electricity registers or meters.** Loubery, François, and Kunkelmann.

6090. **Method of and means for varying the speed of direct-current motors.** Lamme. (Date applied for under International Convention, Sept. 3, 1898.)

6691. **Systems of electrical distribution and regulation.** Lamme. (Date applied for under International Convention, Sept. 28, 1898.)

6712. **Lines, circuits, and apparatus for telephonic intercommunication.** G. Aboilard et Cie. (Date applied for under International Convention, Aug. 30, 1898.)

6878. **Accumulators or secondary batteries.** Prestwich.

7354. **Dynamometers.** Gibbs.

7641. **Hertzian wave telegraphy to enable signals to be transmitted to any distance by means of intermediate relay stations.** Cole and Cohen.

8340. **Electric welding or metal working apparatus.** Berry and Wallis Jones.

8957. **Connecting devices for electric conductors.** Reason and Mutual Electric Trust, Limited.

8961. **Method of and apparatus for effecting the storing up of speech or signals by magnetically influencing magnetisable bodies.** Poulsen.

9101. **Globes or protectors for electric and other lighting apparatus.** Pennycuick and Barrett.

9351. **Manufacture and production of elements for secondary batteries or electric accumulators.** Strecker.

9518. **Automatic telephonic switches.** Veysy.

9966. **Manufacture of protecting casings or tubular structures for electric cables.** Boult. (Jungbluth.)

11886. **Portable electric drilling machine.** Croneau.

13733. **Apparatus for exciting alternating-current dynamos.** Abel. (Soc. Anon. pour la Transmission de la Force par L'Electricité.)

23681. **Micro-telephones.** Schiff.

24673. **Electric clocks.** Butcher.

24739. **Electric switches.** Ely.

25491. **Accumulator batteries.** Marino.

1900.

1276. **Electric chain link welding machines.** Boult. (Soc. E. Giraud et Cie.)

1399. **Manufacture of compound metal tubes suitable for gas and electrical conductors** Earle.

2370. **Means for maintaining a constant speed of a driven-shaft electric generator, spark generator, or other revoluble part.** Dymond. (Motsinger.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Mar. 17	4,021	3,855	+ 166	43,349	41,402
Blackpool-Fleetwood	,, 17	212	236	- 24	1,684	1,912
Bradford City Trams	,, 18	359	293	+ 66	27,708c	—
Bristol Tramways Co.	,, 16	2,718	2,709	+ 9	—	—
City & South London	,, 18	1,452	1,099	+ 353	13,227	12,242
Dover Tramways ...	,, 17	135	142	- 7	1,586	1,572
Dublin U.T., elec. cars	,, 16	2,945	1,002	+1,943	—	—
Dublin S.D. Electric	,, 16	670	700	- 30	—	—
Halifax Corporation	,, 18	537	315	+ 222	29,185a	10,399b
Hull Corporat'n E.S.	,, 17	741	—	—	—	24 500e
Liverpool Corporat'n	Feb. 24d	6,882	5,723	+1,159	52 098	46 118
Liverpool Overhead	Mar. 18	1,340	1,369	- 29	15,641	14,351
Sheffield Corporation	,, 18	1,854	—	—	—	—
South Staffordshire	,, 16	646	615	+ 31	6,602	6,550

a Since April 1, 1899. b Since June 29, 1898.
c Total receipts. d Partly electrical. e Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¾-1
British Insulated Wire, Ord., 1-40,000	5	..	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	5¾ 6¼
—— 5 per cent. Mortgage Debentures	100	..	98-103
British Electric Works, Ordinary, 50,001-95,000	1	..	¾-1
—— 6 per cent. Cum. Pref., 1-50,000	1	..	¾-1
—— 4½ per cent. First Mortgage Debentures	103	..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	4¾-5¼
Brush Electrical Engineering, Ordinary	2	..	1¾-2¼
—— Non. Cum., 6 per cent. Pref.	2	..	2¼-2½
—— 4½ per cent. Debenture Stock	100	..	108-113
—— 4½ per cent. 2nd Debenture Stock	100	..	102-106
Callender's Cable, Debentures	100	..	111-115
—— Ordinary	5	..	14¼-15½
—— 5 per cent. Pref.	5	..	5¾-6
Crompton and Co.	3	..	3½ 4
—— 5 per cent. Debentures	—	..	99-101
Edison and Swan United, Ordinary	3	..	2-2½
—— 5 per cent. Debentures	5	..	3½-4¼
—— 4 per cent. Deb. Stock, Red.	100	..	93-96
Electric Construction	2	..	2¼-2½
—— 7 per cent. Cumulative Pref.	2	..	2¾-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	104-107
Giffre Electro-Chemical and Power, Ordinary	1	..	¾-1
W. T. Henley's Telegraph Works, Ordinary	5	..	13½-14½
—— 4½ per cent. Preference	5	..	5¾-5¾ xd
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	..	101-105
Telegraph Construction and Maintenance	13	..	36-40 xd
—— 5 per cent. Bonds	100	..	102-106
Telegraph Manufacturing, Ordinary	5	..	9-10
—— 5 per cent. Cum. Pref.	5	..	5½-6
Willans and Robinson, Ordinary, 1-20,000	5	..	11-12
—— 6 per cent. Cum. Pref., 20,001-60,000	5	..	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-1
Bournemouth and Poole, Ordinary	10	..	12-13
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	8½-9½
Charing Cross and Strand	5	..	9-10 xd
—— 20,001-50,000	5	..	9-10 xd
—— 4½ per cent. Cum. Pref.	5	..	5½-6
Chelsea Electricity Supply	5	..	7-8 xd
—— 4½ per cent. Debentures	100	..	110-112
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9½-10½
—— 6 per cent. Cum. Pref.	10	..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	..	100-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4¾-5½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	10-10½
London Electric, Ordinary	3	..	1¾-2½
—— 6 per cent. Pref.	5	..	4¾-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	13½-14½ xd
—— 62,501-85,000	10	..	13½-14½ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1¾-1¾
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6¾-7 xd
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	1½	..	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100	..	104-106
South London, Ordinary	3	..	3¾-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14¼-15½
—— 40,081-52,080	5	..	14¼-15½
—— 7 per cent. Pref.	5	..	8½-9½
Westminster, Ordinary	5	..	13½-14½
Electric Railways.—			
Central London, Ordinary	10	..	9¾-10½
—— Pref. Half-Shares	5	..	4¾-5½
—— ,, ,, deferred	5	..	4¾-5½
City and South London, Consolidated Ordinary	100	..	66-68
—— ,, ,,	5½	..	4¾-5½
—— 4 per cent. Debenture Stock	100	..	125 130
—— 5 per cent. Pref. Stock '91	10	..	140 145
—— ,, ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	..	13-13½
Waterloo and City, Ordinary	100	..	101-104
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17-18
Brisbane Tramway	100	..	104-106
British Electric Traction, Ordinary, 1-30,000	10	..	17-18
—— 60,001-75,000	10	..	16½-17½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	13-13½
—— 5 per cent. Perpetual Debenture Stock	100	..	126-129
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4¾-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	105-108
Costa Rica Electric Light and Traction, 5 per cent. First Deb., 1-1,000 of £100 and 1,001-1,640 of £50 each	—	..	75-85
Isle of Man Electric Power, 1-95,000	1	..	13/16-15/16
—— 6 per cent. Preference, 100,001-170,000	1	..	15/16-1 1/16
Kidderminster and District Lighting and Traction, Pref.	10	..	10-10½
New General Traction, Ordinary	5	..	3¾-4½
—— 6 per cent. Cum. Pref.	5	..	5-5½
North Staffordshire Trams	6	..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	18-19
—— Preference	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 25,667-40,000	10	..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	¼-½
National Telephone, Ordinary	5	..	5-5½
—— 6 per cent. Cum. First Pref.	10	..	14-15
—— 6 per cent. Cum. Second Pref.	10	..	14-15
—— 5 per cent. Non. Cum. Third Pref.	5	..	5¼-5¾
—— 5½ per cent. Deb. Stock, Red.	100	..	97-100
Oriental Telephone and Electric Company	1	..	¾-1

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NOTES.

The Electrical Engineers Volunteers.—It is interesting to note that the first detachment of these volunteers are now well on their way to the front. Thus it was reported that the "Tagus," which is conveying them to South Africa, left St. Vincent on the 23rd inst.

International Automobilism.—We gather that the Automobile Club of France have received four entries in addition to their own for the Gordon Bennett international cup race. The five competitors will be the Automobile Clubs of America, Germany, Belgium, Italy, and France. The vehicles will probably be painted of different colours to distinguish them. Automobile races are to be held in connection with the Paris Exhibition.

Defective Supply. — The consideration of the summonses being brought against the London Electric Supply Corporation, Limited, for penalties in respect of alleged defective supply has been adjourned till to-day, when the whole of them will be considered *seriatim*. In view of the fact that the Corporation have now done much to remove the causes of complaint, we trust that too much will not be made of their defects in the past.

Personal.—We are informed that Mr. Sydney F. Walker, who for many years has carried on a manufacturing business in Cardiff, has now taken up consulting work. Mr. Sydney Walker's address for the present will be Bloomfield-crescent, Bath, and we understand that he will devote special attention to the electric lighting of coal mines, to the equipment of such mines with electrical transmission plant, and to coal haulage and pumping by electricity.

Duty on Electricity.—There has been considerable question of late as to whether the electricity generated by the Ontario Power Company at the Canadian side of the Niagara Falls, and supplied in Buffalo, U.S.A., should or should not be dutiable. The question has come up before, and on enquiry Mr. Spalding, assistant secretary to the Treasury, U.S.A., states that he will not at this stage take up the question, but a former assistant secretary had decided some years ago that electricity was not liable to duty.

Mormon Telegraphs.—A relic of Mormonism has just been deleted in the United States by the purchase by the Western Union Telegraph Company of the Desert Telegraph Company. These lines were laid by Brigham Young previous to the construction of the railways, and extend from Utah to all the Mormon settlements in Idaho and Nevada. The telegraphs were originally used as a means of communication for the business of the Mormon Church, but as they now connect many important industrial centres the lines have become valuable, and the new owners of these lines will doubtless reap great benefit from their acquisition.

Wiring Rules.—We have received the 1900 edition of the electrical installation rules of the Liverpool and Globe Insurance Company. In the introduction we are glad to note that the company agrees in all ordinary non-hazardous risks to accept installations which have been fitted to conform with the rules of the Institution of Electrical Engineers. This is a step towards standardisation of wiring rules which is to be highly commended to other fire offices. The company's own rules are drawn on broad lines, and we note that the company advocates the employment of competent engineers to prepare specifications and to superintend the carrying out of all installations.

City and Guilds of London Institute.—We are informed that the committee have decided that in counties and county boroughs possessing an organisation for the promotion of secondary education recognised by the Science and Art Department, that organisation may, on application through the secretary of the technical instruction committee or otherwise, be held responsible for the conduct of the institute's examinations, and for the establishment of new classes in technology. The committee will, however, continue to require, as a condition for the registration of a class in any technological subject, the approval by the institute of the qualifications of the teacher proposed to be appointed.

Electric Traction in Belgium.—We gather from the *Financial Times* that a company has been formed in Brussels with a capital of £800,000 for the purpose of constructing an electric railway between Brussels and Antwerp. The Allgemeine Elektricitats-Gesellschaft, of Berlin, is said to be largely interested in the present scheme. The length of the proposed railway would be almost 28 miles, and it is expected that the distance between the two towns would be covered in 35 minutes without interruption. It is proposed that the railway should be connected up with the electric tramways in Brussels and Antwerp, and that the company should also undertake the working of these particular lines.

The Amazon Cable.—In an article by Mr. C. P. King in the New York *Electrical Review* we notice a reference to the ill-fated Amazon cable. This, the author informs us, is not in working order during one month of the year, the strong current of the Amazon always causing interruptions. Added to this, trees and other obstructions frequently break it, and it is always undergoing repairs. The need for telegraphic communication is so much felt, however, that the Government and the richer merchants are endeavouring to establish a telegraph line, an agreement having been entered into with the Para State Government to build the line. So far 180 miles have been finished, but a great length remains yet to be constructed.

Central London Railway.—The Bill being brought by the Central London Railway Company before Parliament this year with respect to the running of trains at cheap fares for the labouring classes is one which is practically sure to pass. In their original Act the company were required to run three trains each way every morning and evening, not later than seven in the morning or earlier than six in the evening, at fares not exceeding 1d. per journey. The company now propose to issue workmen's tickets for trains up to half-past seven in the morning at a return fare of 2d., returning by any train the same day. This Bill is being introduced by the suspension of the Standing Orders of both the Houses of Parliament.

Flying Machines.—It is reported that the French Aéro Club has received from an anonymous donor the sum of 100,000fr., which is to be given to the aeronaut who, with a balloon or any other aerial vessel, will start from the headquarters of the club, pass round the Eiffel Tower, and return to the starting-point, a distance of 7 miles, within half an hour. This competition is international. If the prize is not won within five years, it will be withdrawn. These experiments would no doubt be very interesting to the anonymous donor of the prize, but we should think that such experiments were scarcely suitable for trial over a great city like Paris, and in our opinion the sea would allow one a rather better chance if the machinery suddenly failed, and the sea would also in that even suffer less damage than the Paris public.

Halifax Tramways.—A special meeting of the Tramways Committee of the Halifax Town Council was held last week to consider whether any alteration should

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be made in the clauses of the Bill the Corporation were promoting in Parliament, in view of the fact that the Huddersfield Bill had been severely handled by the Parliamentary Committee. It will be remembered that objection was made to the Huddersfield Corporation laying their tramways outside the municipal area. The Tramways Committee finally decided that they would leave their Bill in the present state, as coming before a different committee it might be that a different decision would be arrived at. Strong objection was expressed as to the grounds on which the Huddersfield clauses were rejected, in view of the fact that the committee on municipal trading was not appointed.

St. Marylebone Lighting.—The privilege of lighting this parish is still the subject of applications and Board of Trade enquiries. Thus the third application of the Marylebone Electric Supply Company for a provisional order to light the parish recently came before the Board of Trade. The Vestry strongly opposed the application, and in this respect was supported by the London County Council. Sir Courtenay Boyle, before whom the enquiry came, reserved his decision until a further date. The Vestry in the meanwhile have decided to take no further steps as regards purchasing the works of the Metropolitan Electric Supply Company in their district. The work of Sir Courtenay Boyle will be largely increased, and a considerable delay will probably take place, owing to the vacillating policy of the Vestry with regard to applying for a provisional order of their own.

The British Association.—The draft programme of the meeting of the British Association to be held at Bradford in September informs us that Sir William Turner, F.R.S., is to be the president. The chairman of the different sections are as follows: mathematical and physical sciences, Dr. J. Larmer; chemistry, Prof. W. H. Perkin; geology, Prof, W. G. Sollas; zoology and physiology, Dr. R. H. Traquair; geography, Sir George S. Robertson; economic science and statistics, Major J. P. Craigie (of the Board of Agriculture); mechanical science, Sir Alexander R. Binnie; anthropology, Prof. John Rhys; botany, Prof. Sydney H. Vines; astronomy, Dr. A. A. Common. Evening discourses are to be delivered by Prof. Gotch on "Animal Electricity," and by Prof. W. Stroud on "Range Finders." A lecture to working-men will also be given by Prof. Silvanus P. Thompson.

Royal Meteorological Society.—The fiftieth anniversary of this society occurs next Tuesday, April 3, and, in consequence, a jubilee meeting is to be held lasting for two days. On Tuesday, the president, Dr. C. T. Williams, will deliver an address at the commemoration meeting to be held at the Institution of Civil Engineers at 3 p.m. Delegates from other societies will be received at this meeting. On the same day a conversazione will be held at the Royal Institute of Painters in Water Colours at 8 p.m., when, in addition, there will be an exhibition of scientific instruments, etc. On Wednesday, April 4, the Astronomer-Royal has consented to allow the members to visit the Royal Observatory at Greenich. In the evening a dinner will be held at the Westminster Palace Hotel at 7 p.m. As a memento, bronze medallions are to be struck, which will bear on the obverse side a portrait of Lake Howard, F.R.S.

Labour Clauses.—A good opportunity for the discussion of labour clauses in municipal contracts would be given by the conference of the socialists and labour representatives on town and other councils which is to be held at Glasgow on April 13 and 14 next. The programme arranged for the conference, while giving papers on municipal telephones, the advantage of a labour majority, municipal finances, etc., does not at present include any paper on the interference of town councils with the agreement between their contractors and their employés. In view of the extreme importance of this interference being stopped, the trial might be made of a discussion between the members of this conference and some representatives of the Employers' Federation. Although one can hardly hope that either side would get all they wanted, a happy mean might be arrived at which would prevent great waste of public money in the future.

Wireless Telegraphy on Liners.—As recently stated at the meeting of the Wireless Signal Company, the North German Lloyd Company have fitted their large express steamer "Kaiser Wilhelm der Grosse" with wireless telegraph apparatus. For the rendering of this apparatus effective, a similar installation has been placed at the mouth of the Ems, on an island which the ship passes on coming into port. The ship can thus exchange signals with the mainland long before she is sighted. In this connection suggestions have been made that a similar station should be placed at a lightship off the island of Nantucket, U.S.A., which is about 30 miles from the main coast. Round this island liners have to turn before taking up their course for New York Harbour. If the proposed arrangements were carried out, the inhabitants of New York could know of the approach of a vessel some 12 or 15 hours before her arrival.

Submarine Cable Injury.—A test action brought by the Commercial Cable Company against the owner of a schooner, for damage to one of the cables of the company in Gowannus Bay, was recently tried before the United States District Court in New Haven. The evidence showed that the anchor of the schooner had become entangled in the cable, and that after it was hauled up the cable had been cut through with a meat-saw. The judge held that, although the vessel was in a specified anchorage ground and might not have able to prevent the anchor becoming entangled in the cable, it should have been cleared without cutting the cable. He, therefore, awarded the company £1,000 damages. It was urged by the cable company that their cables in and around New York Harbour had been recklessly destroyed by the masters of ships, and they had, therefore, been compelled to bring a test case before the Court.

Flashlights.—We have before spoken of the proposed regulations of the London County Council with respect to flash and searchlight advertisements. These by-laws, we notice, have now come into force, and provide that "no person shall exhibit any flashlight or searchlight so as to be visible from any street and to cause danger to the traffic therein." The word "flashlight" means any light used for the purpose of illuminating, lighting, or exhibiting any sign, word, device, etc., which alters suddenly in intensity, colour, or direction. By searchlight the Council state that they mean any light exceeding 500 c.p., whether in one lamp or a series of lamps used together and projected as one concentrated light, and which alters either in intensity, colour, or direction. The penalty attached to the infringement of the above by-laws is a fine, for each offence, not exceeding £5. The saving clause as far as electric flashlights are concerned, is that danger must be proved.

Municipal Tramways.—As mentioned at the Chamber of Commerce dinner last week, the Huddersfield Corporation Bill has not been passed by the Select Committee of the House of Commons in its entirety. In this Bill powers were sought to make tramways without the borough boundaries as well as inside, with the sanction of the other local authorities interested, who agreed in supporting the Bill. The committee in its report expresses

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its opinion that, having regard to the intended appointment of a joint committee to consider the question of municipal trading, it would not be justified in sanctioning the proposed tramways outside the borough, except in the case of a short length of three yards in the urban district of Linthwaite, which will be in connection with tramways in that district which are leased to and worked by the Corporation with the sanction of the Board of Trade. The report further points out that, consequent upon the striking out of the tramway powers outside the borough, the committee had reduced the borrowing powers sought by the Corporation from £399,350 to £259,418.

Measuring Capacity.—At the February meeting of the American Institution of Electrical Engineers Prof. J. Pupin described a device for measuring capacity, using alternating currents. This he terms a faradmeter. He comments on the trouble of ascertaining the actual value of a capacity by the ballistic method, due to leakage, absorption, etc. With the method devised by Prof. Pupin the two condensers to be experimented with form practically two arms of a Wheatstone bridge. Two sets of resistances form the other two arms, and a telephone is placed between the junctions of the resistances and condensers respectively, and serves as an indicator. An alternating or interrupted current is then passed through the arms in the usual way, and the resistance is adjusted until no sound is heard in the telephone. In the abstracts we have seen of the paper we do not see recorded the accuracy of the method, but from past experience of telephones used much in the same way for ascertaining the resistance of a liquid by means of alternating currents, we should hardly expect that extreme accuracy could be obtained.

Imperial Telegraphs.—A meeting of the members interested in Imperial telegraphic communication was held in the House of Commons on Friday last, Sir E. Sassoon presiding. The Chairman gave an account of the work connected with the agitation during the recess, the amount of public interest awakened in the subject, and the satisfactory progress made in the collection of information exposing the defects of the present system. He showed how utterly the cable companies had failed to rise to the height of their obligations in the course of the present war, and laid great stress on the Imperial character of the Pacific cable scheme as constituting by far the most valuable factor in the project of encircling the globe with an all-British cable. He then spoke of the commercial aspects and the far-reaching effects of the great difficulty experienced by the merchantile and industrial community to obtain any alleviation of what the Government themselves admitted to be exacting rates. After a speech from Sir C. Dilke a general discussion ensued, and a requisition was drawn up and signed to the effect that the meeting "ask the Leader of the House whether, in view of the public interest aroused in the matter of Imperial telegraphic communication by recent events, he would put forward the annual subsidy vote first on an early Friday in order to enable a full discussion to be held."

The Chambers of Commerce Congress. — The fourth congress of the Chambers of Commerce of the Empire is to be held on June 26, 27, 28, and 29 next. The meeting is called on account of the numbers of Colonial men who will come to Europe for the Paris Exhibition, and will, therefore, be practically on the spot. The meeting is to be held in London, however, the Fishmongers' Company having sanctioned the use of their hall near London Bridge. The hon. president of the congress will be the Right Hon. the Earl of Selborne, and the list of hon. vice-presidents is made up of almost every notable man in connection with home, Colonial, and Indian interests. The acting president will be Mr. A. G. Sandeman, the president of the London Chamber of Commerce. The subjects which it is probable will be dealt with by the congress include: The decimal system of weights, measures, and currency; railways, light railways, and railway communication with India and the East; secret commissions; international arbitration; cable communication, construction, rates, and codes; the promotion of mutual trade between the United Kingdom and the Colonies, India, etc.; municipal trading; and an Imperial council to consider commercial questions of Imperial interest, etc. The expenses of this congress are to be paid by a guarantee fund, as in previous years, and we notice that upwards of £700 has already been subscribed. Information respecting the above congress can be obtained of Mr. Kenric B. Murray, secretary, London Chamber of Commerce.

An Aluminium Line.—From the Pacific Coast we get the report of the annual meeting of the Electric Transmission Association, which contains a good deal of information. A paper by Prof. Perrine, D.Sc., on a forty-three and a-third mile aluminium line goes to show that the alarmists about dear copper may cease to fear, for it is probable that a substitute could without difficulty be obtained so far as line wires are concerned. The author described a two-phase line to transmit 1,000 kw. at 8·8 per cent. C^2R loss. The wire used is 294 mils diameter, weighs 419·4lb. per mile, and has a tensile strength of 22,700lb. per square inch. The stress at 1 per cent. elongation is 800lb., the electrical conductivity is 59·9 per cent. of Mathiessen's standard for soft copper. The resistance of the line is 92 ohms, which is for 42·8 miles, so that the engineer's measurement—43⅓ miles—is probably a little out. There has been no permanent elongation of wire in cold weather. The insulation between one wire and earth varies, according to atmospheric conditions, from 160,000 ohms on a rainy day to 44 megohms on a clear day. The calculated capacity of wires 1 and 2 tested alone is ·32 microfarad, as measured ·35—*i.e.*. the self-induction is ·164 by calculation and ·17 by measurement. A point which may be noted, but which is the effect of the self-induction and capacity and not of the material, is that these phenomena over-compound the step-up transformers. The capacity between the two wires varied with weather from ·3 of a microfarad to ·9 of a microfarad. The changes thus caused have to be provided for in regulation.

Electric Heating.—A novel application in electrical heating is described by Mr. E. J. Hart in the current number of the *Electrical World*. In the instance in question the electric heater is applied to the intake pipe from Lake Superior, which is used to provide water to the town of Marquette, in Michigan. Previously, considerable trouble had been found with this intake in the winter, due to the formation of ice in the pipe. The trouble is not with the surface ice of the lake, but with the needle ice, as it is called, which is formed when the icefields are driven out of the bay by winds, and the same winds prevent new ice forming on the surface. The water is then cooled down slightly below freezing point, and this needle ice is formed below the surface in the intake pipe. The electrical heater, which is used to prevent these fine ice particles being carried into the intake pipe and solidifying, consists of an inner and outer drum. The inner drum is 19in. in diameter and 5ft. long. The flanges on the end of this drum are soldered on to the outer drum. No. 18 iron wire is wound in a spiral on an asbestos covering round the inner drum. The heat generated in this resistance wire is then

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relied upon to slightly raise the temperature of the water passing through on its way to the town mains. The heater would not be kept in constant use, but only when the weather was favourable to the formation of this needle ice. From the description we gather that the apparatus, although fixed, has not yet been actually used. It is designed by Mr. C. Retillic, the head of the municipal electric light plant of Marquette.

Telegraph Interference.—The recent case tried in the Supreme Court at Cape Town, in which the Eastern Telegraph Company claimed damages against the tramway company for interference in the telegraphic communication over their submarine cable from the earth currents of the tramways, was decided in favour of the tramway company. The Supreme Court, however, has now granted the telegraph company leave to appeal against this decision. Without a doubt, from the evidence which was obtained from Prof. Jamieson and others, the earth currents from the tramways caused serious inconvenience to the telegraph company, and in consequence we hold that the latter should be compensated. How far the compensation should go depends on the cost of making provision for the avoidance of interference in future. Some interesting information in connection with the interference of earth currents from tramways with reference to scientific instruments, is soon to be expected from the committee of experts who have conducted experiments in this country. While these experiments were undertaken with the idea of preventing the magnetic observatory at Kew being rendered useless, the information acquired by the commission will be of world-world interest in view of the eminent men representing both sides. It is exceedingly difficult, of course, to give a money value to the records obtained in magnetic observatories, but if the tramways in this country are extended, as seems probable, by means of the trolley system with an earthed return, it may be necessary to give up all idea of obtaining magnetic records from any inland observatories.

Systems of Charging.—Complaints are made somewhat frequently in England that the system of charging adopted in our electric lighting stations are not such as can be readily understood by consumers. These complaints, as a rule, are as much due to the want of reasonable consideration as to any fault in the system of charging. We have recently seen, however, the system of charging being used in a municipal electric light station established at Wallingford, U.S.A. We have read and reread the description of the system which appears in the *Electrical World*, and are quite unable to understand the reason underlying the system, or whether electricity meters are actually used or not. The scales of charges are different for business premises and for domestic residences. In each instance the scales are divided as to the number of days in which the lights are used per month, and are fixed at a certain rate per month per 16-c.p. lamp. Thus a store, which uses its lamps only six days per week, and runs them on the average five hours per day in the winter, has to pay 1s. 10½d. per 16-c.p. lamp during May, June, and July, 2s. 8½d. during February, March, April, August, September, and October, and 3s. 6½d. during November, December, and January. We are told that these presumably flat rates are based on the approximate cost of ¼d. per 16-c.p. lamp-hour, but we defy any consumer to obtain even an approximate idea as to whether he is being over or under charged. Rates of this kind also tend to great waste of light, and consequently are not to be recommended in view of the fact that their only advantage is that meter rents are saved.

Calcium Carbide.—The following is an abstract appearing in *Science Abstracts* of a paper contributed last year by Mr. B. Calson to the *Zeitschrift fuer Electrochemie*. The author fully discusses the respective merits of coarsely and finely powdered raw materials in the manufacture of calcium carbide, and expresses his opinion as to the advantage of a coarse mixture. The heat necessary for obtaining the carbide is partly utilised in heating and melting the raw materials—*i.e.*, carbon and lime. Neither the specific nor the melting heat of these two bodies is affected by the size of the grains employed. A number of proofs in favour of a coarse mixture are given, such as the solubility of the raw materials in the already formed carbide, and the greater ease with which the gases formed can find their exit without giving rise to explosive eruptions, as in the case of a dense mixture and the accompanying throwing up of fine dust, etc. Another important point seems to consist in the better utilisation of the heat of the gases generated in their upward passage, and also the prevention of bridging over of the molten particles. The theoretical quantity of lime and coke together for the production of 1,000 kilos of carbide equals 1,440 kilos. Actual trials by the Deutsche Gold and Silber Scheideanstalt in Frankfort have shown that 1,590 kilos are required in practice with the coarser mixture there employed. In the case of fine material 3,000 kilos and upwards are required. The process used at the above works is the one introduced by J. Pfleger for employing coarse mixtures, and has some novel features, which the author promises to discuss in a future communication.

Telephone Wayleaves.—The National Telephone Company and the Pembroke Urban District Council have at length come to an agreement as to the terms under which the company shall be allowed to lay their pipes underground. The conference at which these terms were arranged was held on Friday last, when several representatives of the company were present. These representatives naturally explained that the imposition of a heavy wayleave meant a tax on those people using telephones, and that these subscribers to the telephone system would in this way be called upon to pay more than their share of the rates. The question in Pembroke has been in dispute for a considerable time, and has cost the parties interested a large amount of money. Finally, the company had decided to disconnect all subscribers unless the necessary permission to lay their wires underground was given by the District Council. To avoid this, it was decided ultimately that the wires could be placed underground, and the following terms were agreed upon—viz., that the company should pay an annual rental of £10 per mile of trench opened to lay mains. They must also pay 10s. for every manhole on their system and 1s. per pole per annum. Besides these charges they agree to provide and maintain 12 fire-alarms at the low figure of £3. 10s. per annum, and three free telephones for use in the Council's offices. On the whole we suppose the terms are reasonable, and trust that the Pembroke Council will not regret the step they have taken. It is certainly a convenience for all concerned to have the wires laid underground, and we believe that the true interests of the ratepayers are served if only a nominal charge is made for the permission to open the streets.

Copper Standards.—The report of the committee of our Institution of Electrical Engineers on standard copper has now been received in America, and is commented on in an editorial article in the *Electrical World*. The chief fault in the recommendations of our committee on the standardisation of copper, according to our contemporary, seems to be that the Fahrenheit scale of temperature has been used, and that small differences still exist between the standards and those of America

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These differences, however, are exceedingly small, as, for instance, the resistance of a metre-gramme of soft copper is fixed by our committee at 0·150822 ohm at 60deg. F. The report, dated 1893, of the American Institution of Electrical Engineers makes this value 0·15045. As the difference is only one quarter of 1 per cent., it does not cause any serious discrepancy between English and American wiring tables. Our contemporary also wishes that the standard temperature for the resistance of copper wire had also been retained as the standard temperature when calculating the resistance coefficient. It is finally suggested that our committee's report should be considered at the electrical congress which is to meet at the Paris Exhibition, in order that a definite standard to apply all over the world should be fixed. It is stated, however, that the resolutions concerning the stranding of wires and the other practical data found in the British report could well be adopted universally. We quite agree with our contemporary in the advantage of having a world-wide standard, but we do not expect that the British manufacturers, or even the manufacturers in America, will give up the Fahrenheit scale of temperature or adopt the metric system of weights and measures at the dictation of the committee meeting in Paris.

Magnet Constants.—The following *résumé* of a paper presented by Mr. C. Cree to the Royal Society last year on the "Magnets used in the Determination of the Earth's Horizontal Magnetic Force," is taken from the March number of *Science Abstracts*. In the original paper the values of the constants (temperature coefficient, induction coefficient, moment of inertia, and distribution correction) of over 100 collimator magnets of the Kew pattern have been determined at Kew Observatory, and in the present paper the author discusses the values obtained. The temperature coefficient is determined from observation at 0deg., 18deg., and 36deg. C., and the numbers obtained support the correctness of the parabolic formula employed for calculating the magnetic moment at any temperature for the magnetic moment at 0deg. Attempts were made to deduce relations between the values of the different "constants," but they were not very conclusive, partly, no doubt, owing to the fact that the dimensions of the magnets are not recorded. The author also discusses the probable errors introduced into the determination of the horizontal component owing to the possible errors which exist in the values of the "constants." In particular the effect of errors in the value assumed for the distribution constant, P, and also the approximations used in applying the correction for this, are discussed, with the result that it is shown that a very appreciable error may easily be introduced on this account. From a discussion of the observations made with the observatory unifilar, the author concludes that the centre of the deflection bar is not vertically below the point of suspension of the fibre which carries the deflected magnet, and he discusses the effect of this asymmetry on the value obtained for H.

Power Transmission Schemes.—In view of the opposition now being brought by the Association of Municipal Corporations against the Power Bills now before Parliament, it is interesting to read the comments of the electrical Press abroad on this opposition. The *Electrical World* of New York, in its issue for March 17, criticises these transmission schemes as follows: "Some very interesting and promising schemes have lately been put forward in England for the long-distance transmission of electrical energy in bulk, on a plan that has long since become familiar in this country as well as in some parts of Continental Europe. For the life of us we cannot see what the objections are to such work in England, where cheap power must become more and more a matter of national existence; but, as our London correspondent has lately detailed, a most virulent opposition is being exercised against the project from various municipal authorities who see in it the undermining of their power, prestige, and perquisites. If England allows this kind of thwarting to stand in the way of her progress, she will not merely have to take sound lickings from the Boers until she overmasters them, but she will have to take worse punishment from more powerful foes. England's voluntary decadence would be a disaster for the world, just as her victories are those of equality and progress, and it is for her to make the right choice in just such emergencies as this. It should be understood that these English transmission companies ask no monopoly. All that they seek is the permission to sell current cheaply to any customer they can reach, regardless of his previous condition of servitude to a petty municipal plant; but they are apparently to be denied this opportunity to cheapen English goods in the markets of the world. If England doesn't care, we don't. It is a good thing for us to have these Little Englanders ruling the roost." Criticisms such as these should help the promoters of these Bills when giving evidence before the committee.

London Tramways.—Last week we were able to give the bare fact that the House of Commons Committee had reported to the House in favour of the London County Council Tramway Bill. The remarks of the chairman of the committee in announcing the decision of the committee are worthy of more extended notice. He referred to the large expenditure contemplated by the Bill, which made it the largest and most important of its kind yet before the House. Of 40 vestries whose districts were represented by the London County Council, all had agreed to the propositions of the Bill except Hackney, Wandsworth, and Battersea, while the Southwark Vestry had raised a few points on individual clauses. The committee were satisfied that, if London was to have the full advantage of electric tramways, it would not be desirable that special provisions should be introduced into the Bill for the protection of the three vestries which had petitioned. The committee were influenced in this decision by the fact that Hackney had six members, Wandsworth two, and Battersea two on the London County Council, so that if any grievance arose in their districts they had equal opportunity with other districts represented on the County Council of bringing that grievance forward. With respect to the opposition from the gas and water companies, the verdict of the committee was to the effect that no evidence had been brought forward to prove that any damage had been caused to gas or water pipes in this country by the introduction of electric traction. The committee were satisfied that, subject to the regulations of the Board of Trade and to the enactments of the Tramway Act of 1870, reasonable provision was made to meet the requirements of the gas and water companies. With respect to the question of cheap fares raised by the Vestry of Battersea, the committee held that insufficient evidence had been brought before them to enable them to pass an opinion as to the reasonableness of the existing fares. They also thought that the whole question of fares should be considered by the representatives of all the local authorities interested, and that they would be wrong in introducing special clauses on the representations of Battersea alone. The committee, after the remarks by the chairman to the above effect, found the preamble of the Bill proved, and reported the same to the House of Commons. The result is only what was to be expected, and it rightly leaves the London County Council a free hand in organising the whole of the tramways within its areas.

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YORK ELECTRICITY SUPPLY WORKS.

(Concluded from page 405.)

An inspection of the drawings reproduced herewith should render the arrangement of steam and feed pipes sufficiently clear. The main steam-ring is composed of 6in. steel lap-welded pipes, which are slung by means of rods. In Figs. 5 and 6 will be seen the connections from the engines to the condenser, and the alternative exhaust direct into the atmosphere; this latter is carried to a cast-iron pipe of 12in. diameter. For the connections between the feed pumps and hot-well, on the one hand, and the economiser, on the other, we must refer the reader back to Fig. 3. The pipe work has been executed by Messrs. Stewart and Menzies as sub-contractors to Messrs. Crompton and Co., Limited. The economiser is situated outside the boiler-house. It is of Messrs. E. Green and Son's well-known make, and contains 192 tubes, the scraper being motor-driven. While on the subject of the boiler-house equipment it may be added that the furnaces are hand-stoked at present, though it is intended to provide mechanical stokers, which will be worked in conjunction with a bucket conveyor extending to the coal store.

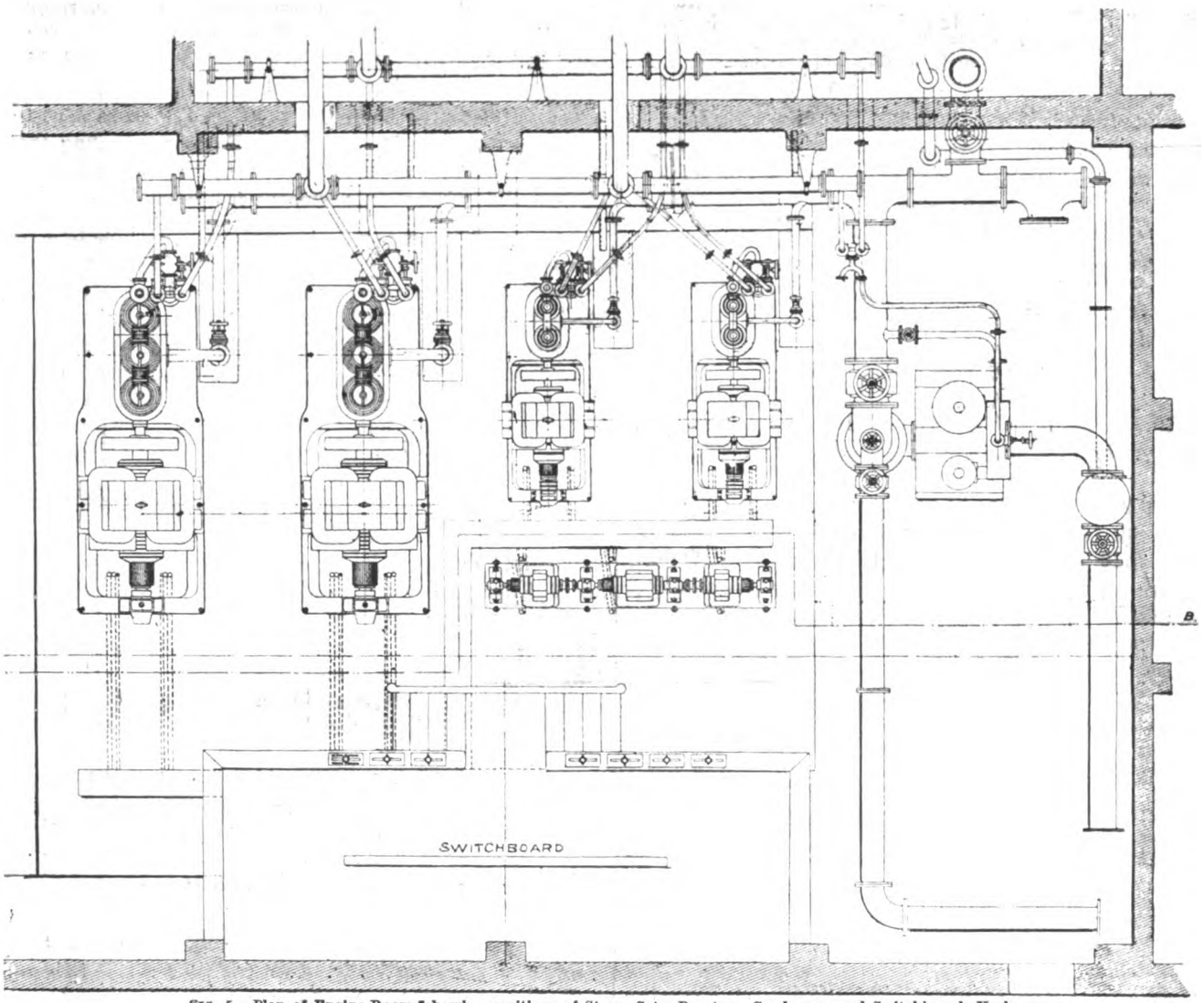

FIG. 5.—Plan of Engine-Room, showing positions of Steam Sets, Boosters, Condenser, and Switchboard, York.

We may now proceed to a description of the engines. These are of the Willans and Robinson standard vertical, inverted compound, enclosed type. Four engines are installed at present, two of which indicate 40 h.p. each when running at 520 revolutions per minute, while the others are of larger size, indicating 150 h.p. each at 460 revolutions per minute. They work condensing with a steam pressure at the stop valves of 120lb. per square inch. Corresponding sizes have interchangeable parts. The governor adjustment is such that when the whole load is taken off, the variation in speed does not exceed 5 per cent. It was stipulated in the specification for the engines that the water consumption of each of the larger sets should not exceed 19lb. per indicated horse-power at full load, while the corresponding consumption of the smaller size was not to exceed 22lb. Steam separators and speed indicators are fitted. Each engine is mounted on a common bed-plate with the dynamo which it drives. The central condenser into which the engines exhaust is situated as shown in Figs. 5 and 6. It is of the jet type, by the Worthington Pumping Engine Company. The air-pump is of the vertical twin-cylinder beam pattern by the same firm. This has a high-pressure steam-cylinder 12in. in diameter, and a low-pressure steam-cylinder 20in. in diameter, with two single-acting pump buckets, each of 25in. diameter and 18in. stroke. The auxiliary valves, which admit steam to the operating piston of the main steam-valves, are of the rocking type, working over ports similar to those of an ordinary Corliss engine valve. As there are only two pieces inside of the steam-chest, there are only three working parts altogether which are not in sight in the valve motion. The valve motion of this pump is the feature of special importance. Although it is of the steam-thrown type, its construction is such that the objectionable features usual to this type of valve have been removed. The motion for the auxiliary valves is derived from a central disc cast on the end of the main beam shaft. From a pin on this disc there is a link connecting to a crank on the outside of the steam-chest; this crank serves as a tappet arm to throw the cranks operating the auxiliary steam-valves. There are only two stuffing boxes in this valve motion, and these are in connection with the two auxiliary valve spindles at each end of the main valve chest, and as these spindles are moved by direct connections the full power of the engine can be utilised to move them should they tend to stick in the packing. Attention is particularly called to the few parts forming the valve motion, the accessibility of every portion of it, and the ease with which the main valve can be removed for examination or renewal, merely

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by taking off one bonnet at the end of the main chest and withdrawing the entire valve complete. The condenser is capable of condensing 25,000lb. of steam per hour continuously, maintaining a vacuum equivalent to 26in. of mercury in the main exhaust pipe. Sufficient condensing plant is therefore installed for about 1,200 h.p. The requisite water for condensing is taken from the River Foss at a point 68ft. distant.

The dynamos (Fig. 6) are of the continuous-current shunt-wound type with drum armatures, by Messrs. Crompton and Co., Limited. All parts are interchangeable for corresponding sizes. Each dynamo is driven direct from the shaft of its respective driving engine, as shown in Fig. 5. The two larger machines are each capable of yielding an output of 157 amperes at 475 volts terminal pressure, or 75 kw., at normal speed—*i.e.*, 460 revolutions per minute. These dynamos are capable of running steadily at an E.M.F. of from 460 to 520 volts, with a variation of speed not exceeding 5 per cent. from the normal. One spare armature is provided for the 75-kw. sets, which will be employed in the future for traction work as well as for lighting. To this end their field magnets have been provided with series winding, which will, however, be used only when the machines are actually supplying power for traction work. The series winding is proportioned to raise the voltage of the machines from 500 volts at no load to 550 volts at full load, without the adjustment of the shunt-regulating resistance or alteration of the governors.

The two smaller machines have each an output of 100 amperes at 240 volts terminal pressure, or 24 kw. at normal speed—*i.e.*, 520 revolutions per minute. They are capable of running steadily at an E.M.F. of from 230 to 260 volts, with a variation of speed not exceeding 5 per cent. from the normal. Two spare armatures are provided for the 24-kw. sets, one of which is wound to give the terminal voltage mentioned above, while the other is wound to give double this E.M.F. The field circuits are arranged so that the machines may be run either as 230 or 460 volt generators, being connected in parallel for the first E.M.F. and in series for the second. It is intended to use these smaller machines as balancers on the three-wire system during the periods of heavy load, but should it be found desirable, the 230-volt armature of one of the sets may be substituted by the 460-volt armature provided for the purpose. This latter arrangement enables the smaller machines to be used alternatively for battery-charging purposes.

Besides the dynamos described above, there are also two motor-driven dynamos or boosters (shown in Fig. 5), each having an output of 50 amperes at from 10 to 70 volts, or a maximum output of 35 kw. The two dynamos are driven by a single motor, which is mounted on a common bedplate with the dynamos. This motor is situated between the dynamos as shown, its shaft being connected to the dynamos' shaft at each end by means of flange couplings. The regulation of both the motor and the dynamos is effected by means of resistances in their respective field circuits. The boosters will be used principally for charging and discharging the batteries when the E.M.F. at the omnibus bars is either higher or lower than the E.M.F. of the battery. Each dynamo is capable of giving an E.M.F. of from 10 to 70 volts when running on open circuit, and of running with any current between zero and 50 amperes. In designing the combination special attention was given to the accessibility of parts. An overhead travelling crane, by Garrick and Ritchie, of Edinburgh, having a span of 31ft. clear, and capable of lifting eight tons, serves the engine and dynamo room; it is provided with quick lift gear for loads not exceeding one ton in weight.

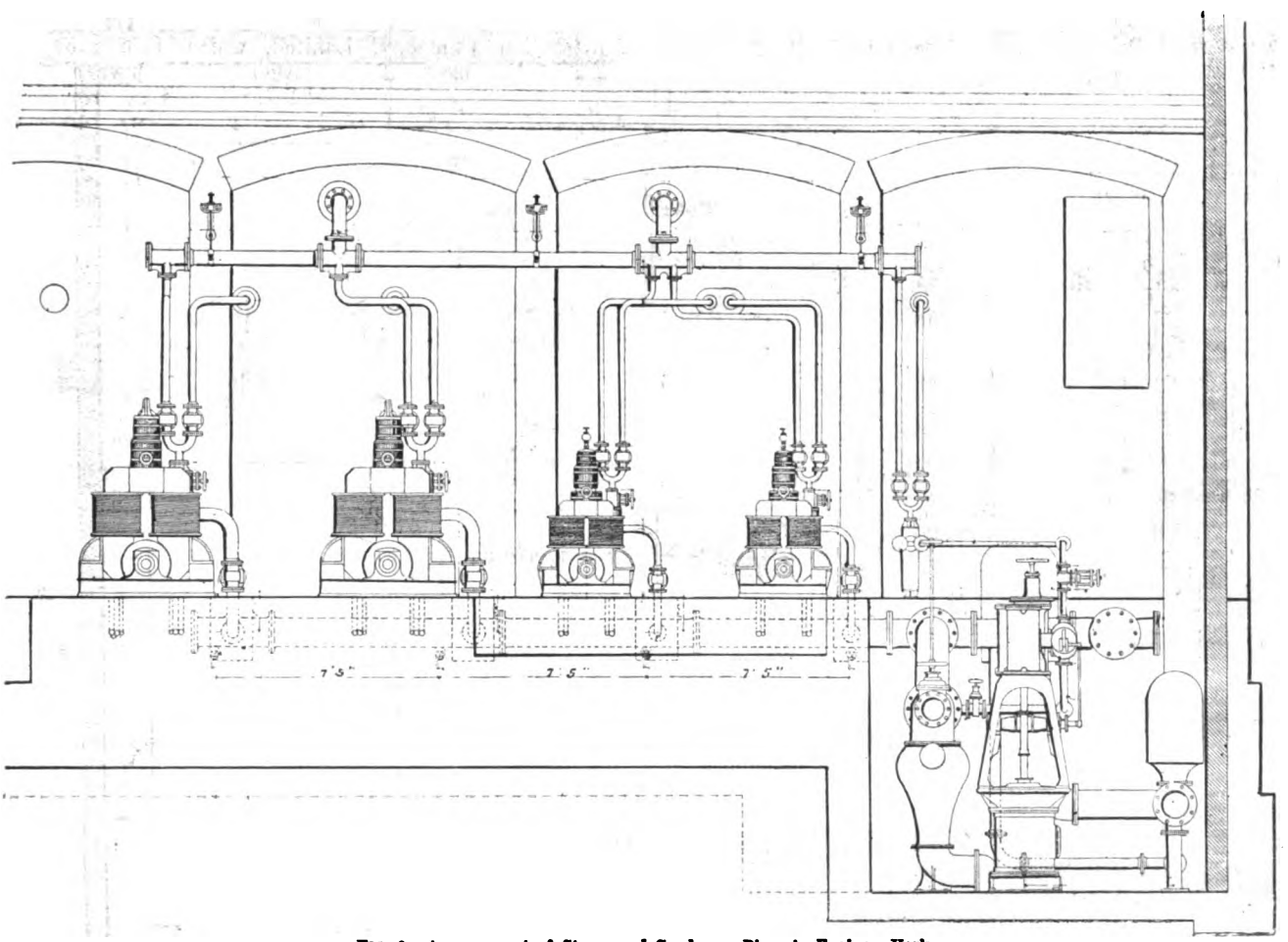

FIG. 6.—Arrangement of Steam and Condenser Pipes to Engines, York.

The accumulators which have been installed are of the Tudor type There are 325 cells, divided into two batteries. The batteries are designed to take the light load, or to assist in carrying the heavy load over the peak.

We come now to the switchboard, which is of Messrs. Crompton and Co.'s well-known type. It is divided into three panels, all the apparatus in connection with the battery and boosters being arranged on the middle panel, while the instruments on the negative side of the dynamos and feeders are mounted to the right, and the positive side instruments to the left. All connections which carry current through the slate are of bar copper. Kelvin ampere-gauges are used, the feeder voltmeters being of the Weston type.

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Alternating with the feeder bars are fixed on each slate four vertical dynamo bars, similar to the feeder bars. The usual complement of automatic and other switches is provided, besides which there are two battery switches of Prof. A. B. W. Kennedy's own design, similar to those which have been employed with success in the Chester and Carlisle stations. Switchboard attendants are apt to find the manipulation of this type of switch rather confusing at first, as its various positions are not a little complicated. Figs. 7 to 13 give these various positions

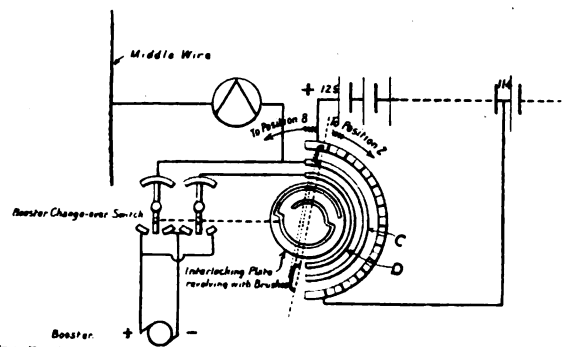

FIG. 7.—Position 1: End of Discharge, Beginning of Charge. Position 7: Discharge direct from Battery. All Cells in Circuit.

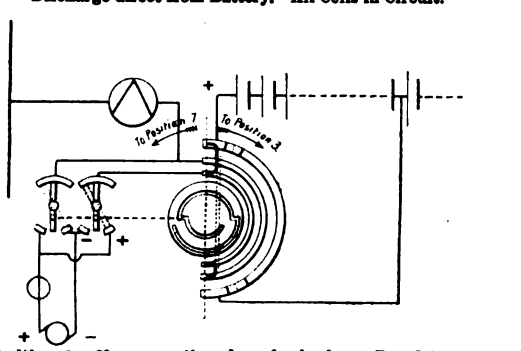

FIG. 8.—Position 2: Charge continued as far back on Regulator as possible. Ready to switch in Booster. Position 6: Beginning of Discharge direct from Battery. Booster taken off.

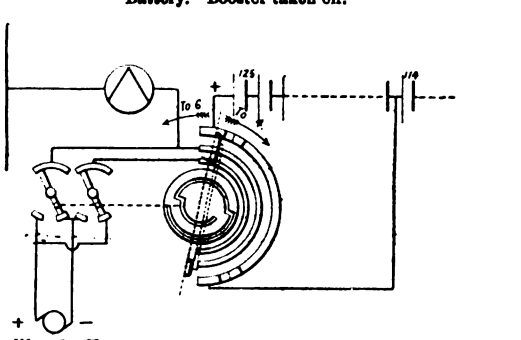

FIG. 9.—Position 3: Charge continued through Booster. All Cells in Circuit. Position 5: End of Charge. Volts on Booster reduced and Booster put on top cell.

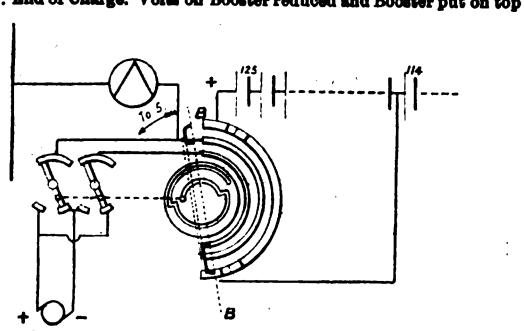

FIG. 10.—Position 4: Charge continued. Booster brought back so far as not to overcharge end cells. This is to the limiting position, B B.

in diagram form, while Fig. 14 is a diagram of the switchboard connections. The arrangement of the instruments on the board is very compact, a symmetrical and pleasing appearance being at the same time secured, though not at the expense of confused connections behind. On the contrary, an unusually neat job has been made of the latter, no crowding being apparent at the back of the board despite the number of switches, etc., distributed over a comparatively small area of slate. This happy result has been contributed to in no small degree by the method adopted of arranging the leads from the dynamos and the feeders. These are brought to the wall at the back of the switchboard, cleated to the required height, and then arched over the few feet of intervening space to the 'bus bars, thus securing minimum encumbrance of the board. The resistance in the shunt of each dynamo is placed in the void under the switchboard gallery, the regulating switches being mounted on the front rail of the switchboard platform.

From the switchboard two $^{61}/_{18}$ feeders are run to a five-way dividing point in the town. Each of these feeders consist of two conductors, a separate cable being used for the middle wire. The two feeders are connected in parallel both at the station switchboard and at the dividing box. Triple potential leads are run from each of the feeding points to the switchboard. For the distributing network of mains triple-concentric cable has been employed, the middle conductor being joined up throughout the system. Provision has been made for the future multiplication of the feeders, as extensions of the distributing network render this necessary. The whole of the main work under the original contract was carried out by the Callender Cable and Construction Company, Limited, which firm are also executing the considerable extensions which have already become necessary. The street-lighting arcs, as previously mentioned, are placed 10 in series across the 460-volt

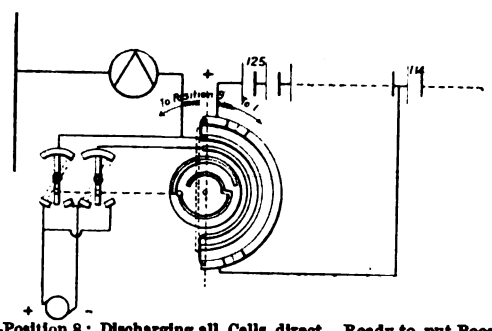

FIG. 11.—Position 8: Discharging all Cells direct. Ready to put Booster in to help Discharge. Position 12: Discharge direct from Battery. All Cells in and Booster taken out.

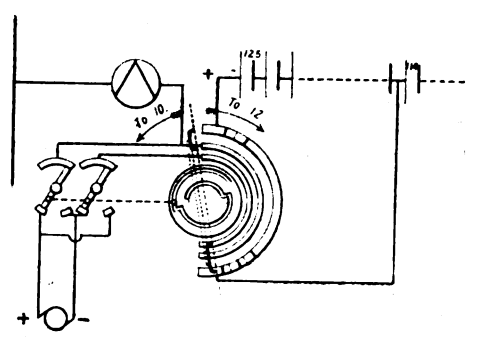

FIG. 12.—Position 9: Discharge through Booster helping Battery; Position 11 Reducing Volts on Discharge, Cutting-out Cells, and Reducing Booster Volts.

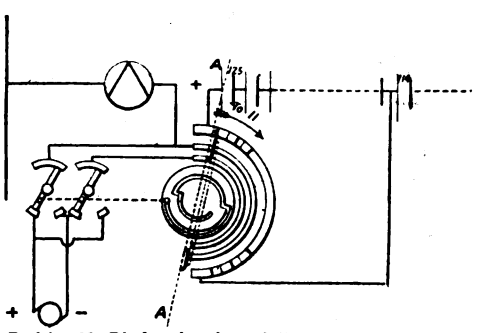

FIG. 13.—Position 10: Discharging through Booster, with all Cells in Circuit. This is the limiting position, A A.

mains. Some of these arcs are carried by brackets of the designs shown in Fig. 15, while others are suspended from posts.

Little remains to be said with regard to the main work and station equipment, but it should be mentioned that the instalment of the latter, for the whole of which Messrs. Crompton and Co., Limited, were the contractors, was supervised on behalf of the firm by Mr. E. W. Abbott, while Mr. Henry Maw has represented Prof. Kennedy during the work of instalment. To these two gentlemen must be accorded every credit for the successful manner in

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which the work has been completed. Mr. C. A. Midgley, who was appointed to the post of city electrical engineer in July, 1899, has acquired a most promising undertaking, and upon him devolves the responsibility for the considerable extensions which are contemplated. In conclusion, we have to thank Prof. Kennedy, together with the several contractors and gentlemen mentioned above, for their courtesy in placing at our disposal the information which we have been enabled to give herewith.

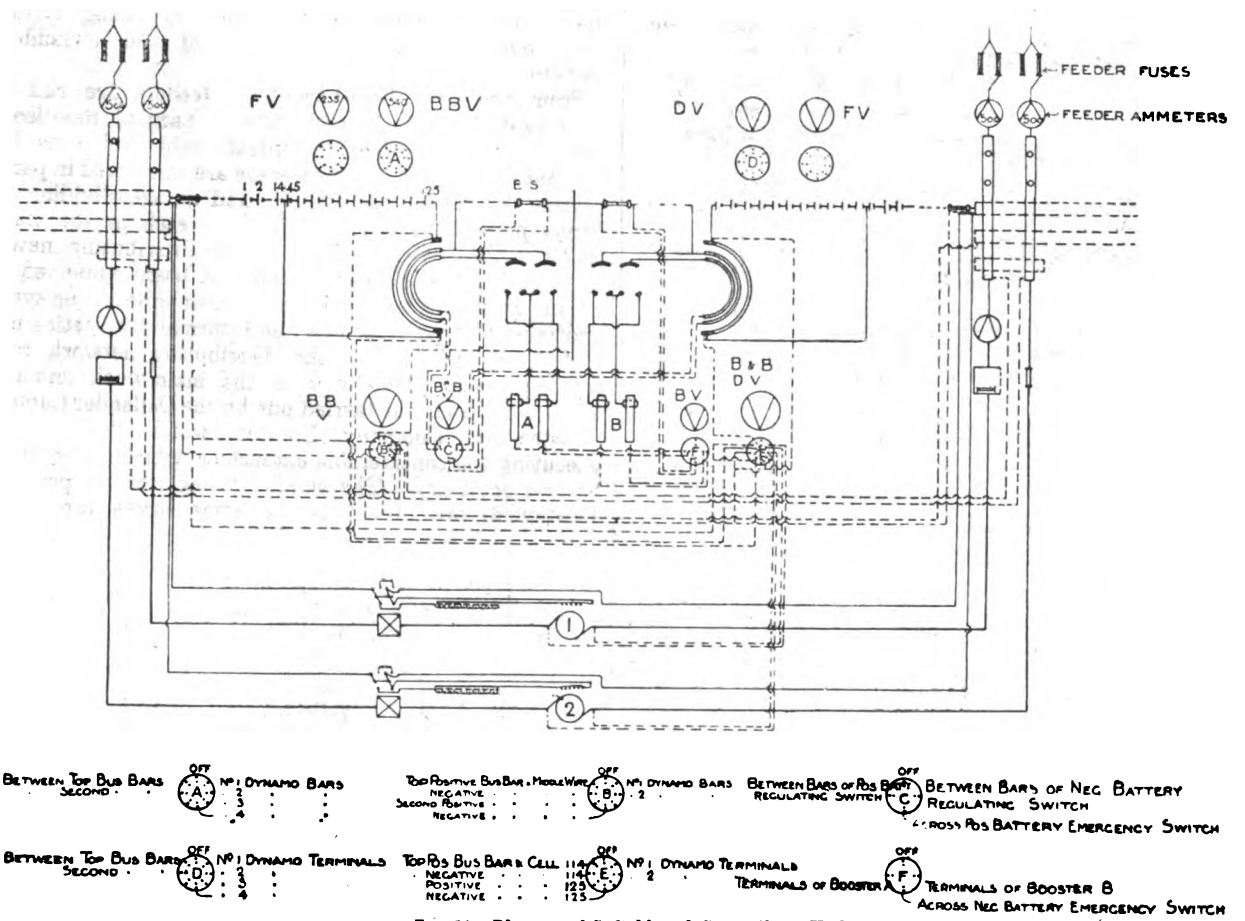

FIG. 14.—Diagram of Switchboard Connections, York.

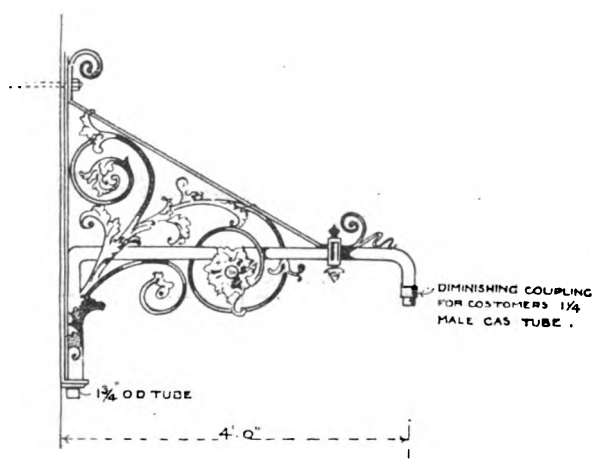

FIG. 15.—Arc Lamp Bracket for Street Corner, York.

GLASGOW CENTRE OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

A meeting of above branch of the Institution was held on the 23rd inst., Prof. Magnus Maclean, M.A., D Sc., occupying the chair, when a paper on "Methods of Charging for Public Electricity Supply" was read by Mr. W. W. Lackie, M.I.E.E.

The author dealt with this important problem in a most interesting manner, and described the difficulties which had to be overcome in devising a means of charging which should be fair to all consumers and at the same time be easily understood by the consumer. The influence of the standing charges on the price charged was then dealt with by Mr. Lackie. It appears that in Glasgow the capital charges at the present time amount to £90 per kilowatt (although it is hoped that by the time the new stations are all in working order the capital cost will fall to about £65 per kilowatt), and of this amount it seems that land and buildings cost £14 per kilowatt, £44 per kilowatt go for mains, and machinery is responsible for a further expenditure of £25 per kilowatt. Items such as accumulators, meters, instruments, make up the remainder. After taking depreciation at 1 per cent. on land and buildings, 2½ per cent. on mains, and 7½ per cent. on machinery, 6 per cent. on meters, etc., it was shown that the total standing charges amounted to £3. 12s., adding 4·1 per cent. for interest and sinking fund, and a further sum for management expenses, the total standing charges per kilowatt were shown to be £8. 16s.; thus each consumer whose maximum demand amounted to 1 kw. involved the department in an annual fixed charge of £8. 16s., and how to get each consumer to pay his share in the least disagreeable way was the problem which station engineers had to face. The author then proceeded to deal with the various methods which had been proposed, such as a fixed annual charge and a nominal price per unit, a varying method of charging, and the Wright demand indicator system. On the whole, the author considered that the Wright system had most nearly met the requirements of the case. Proceeding, Mr. Lackie pointed out that electricity supply, especially for lighting, was in its very nature a most unsatisfactory commercial undertaking, owing to the very high capital charges, and in proof of this he drew a comparison of the electricity and gas departments of Glasgow Corporation; the plant at the gasworks being reduced to equivalent kilowatts. The capital cost at the gasworks was £11. 15s. per equivalent kilowatt, against £90 for the electricity department, while the standing charges were in the former case 14s. 6d. and in the latter £8. 16s. per annum. In the gasworks the manufacturing charges amounted to 70 per cent

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of the revenue, while the corresponding charges in the electricity department was 38 per cent. Interest and sinking fund absorbed only 5 per cent. of the gas department revenue, while it absorbed 29 per cent. of the electricity department's revenue.

After an interesting discussion, Mr. Lackie was awarded a hearty vote of thanks for his most instructive paper.

GREENOCK ELECTRICITY WORKS.

The above works were officially opened in December last, and we then gave a description of the station (*E. E.*, No. 23, vol. xxiv., p. 719) and of the machinery. At that time it was not possible to give photographs of the works, but now, through the courtesy of the principal contractors, the India Rubber and Telegraph Works Company, Limited, we are able to do so. This firm supplied the steam dynamos, balancer, boosters, switchboard, steam and exhaust pipes, feed heater, motors, and feed pumps, etc. The Callender's Cable and Construction Company were the contractors for the mains, and Messrs. Babcock and Wilcox for the boilers.

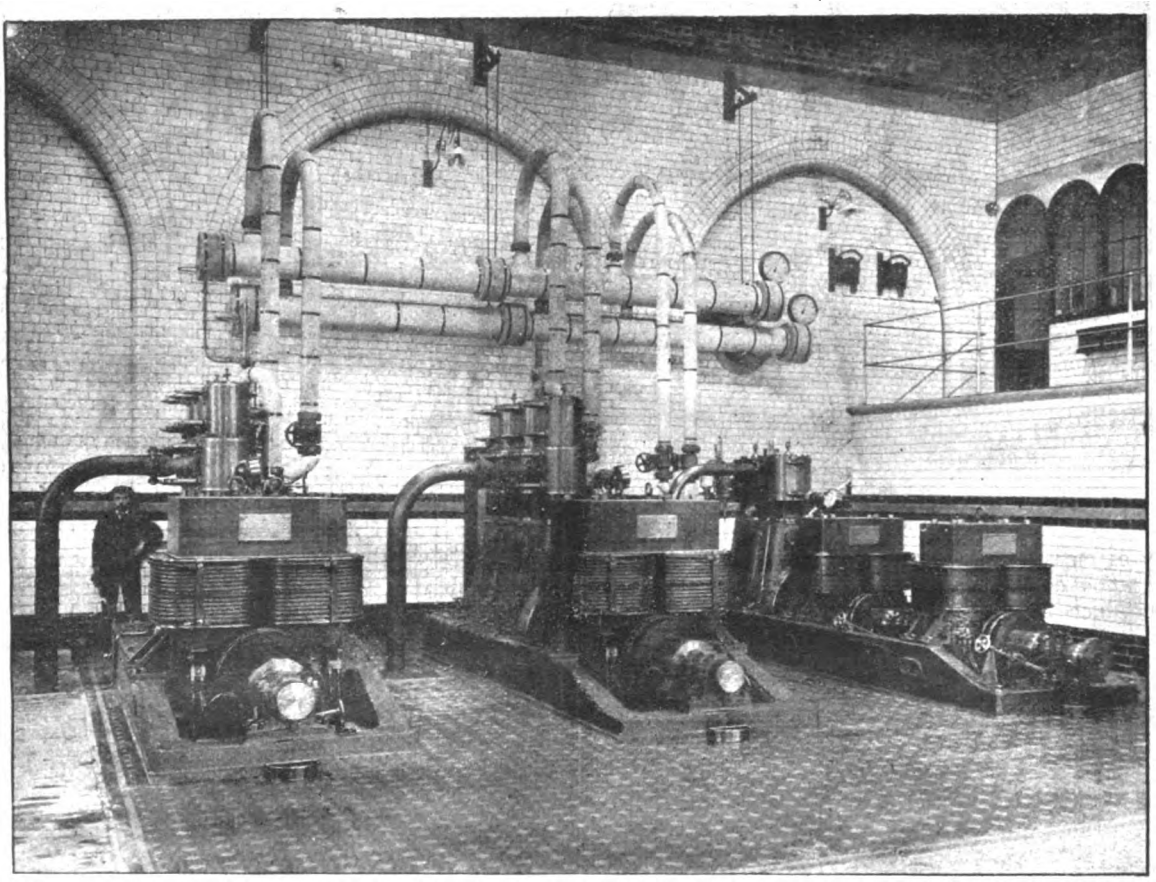

FIG. 1.—View of the Engine-room at Greenock.

The general appearance of the engine-room (Fig. 1) is indicative of the substantial character of the work, carried out to the designs of Mr. S. E. Fedden, the burgh electrical engineer. The generating plant consists of two Silvertown 180-kw. steam dynamos, each giving an output of 300 amperes at 500 to 600 volts at 420 revolutions, and capable of an overload of 30 per cent. The dynamos have large commutators with carbon brushes, and are specially designed to meet Mr. Fedden's specification with respect to non-sparking at any load with the brushes in a fixed position. This condition is perfectly fulfilled. A special feature in the magnet windings is the division of the bobbins into two portions by means of an ebonite flange, the object being to reduce the tendency to short-circuit by limiting the difference of potential between the various layers of the shunt windings. Series windings are also provided with a view to future tramway work. The engines are of Messrs. Belliss and Morcom's three-crank equal-angle self-lubricating type, running at 420 revolutions per minute, and are of sufficient size to easily drive the dynamos under the above overload.

The switchboard (Fig. 2) is of very handsome design, and exceedingly well arranged; the panels are of slate, enamelled front and back, carried in a wrought-iron frame, which is strongly stayed to the wall in such a manner as to leave a clear passage behind. The ampere-meters and dynamo voltmeters are of the Lord Kelvin type, the voltmeters for the boosters and feeders being of the Weston pattern. Silvertown zero cut-outs are provided for each dynamo, and also for the boosters. Each feeder is fitted with a duplex fuse and suitable two-way switch. The voltmeter switches are so arranged as to enable any reading to be obtained of either of two voltmeters, so that calibration errors can be readily discovered. The middle wire is earthed through an ammeter and a set of three graduated fuses. Apart from the switchboard itself, the arrangement of the cables behind it and underneath are worthy of special praise. Thus Fig. 3 shows the wiring in the space below the switchboard, which is also used as a resistance-room. The feeders come in on the left-hand wall, while on the right are seen the cables going to the various machines in the station. The wiring behind the switchboard itself is effected without in any way obstructing the free passage.

The buildings, for which Mr. Fedden acted as architect, include a complete set of offices, testing-rooms, and stores, with bathrooms and lavatories, and a special point is the arrangement for bringing the conductors from the electrical machinery through cable chases 4ft. wide by 5ft. 6in. high to a cable and the resistance-room (Fig. 3) underneath the switchboard gallery.

The street-lighting as at present carried out is confined to 44 10-ampere arc lamps of the Brockie-Pell type, connected in four circuits 11 in series. The arc lamp-posts are of steel, with handsome cast-iron bases, and are arranged so that they can be utilised for tramway overhead conductors. The mains, by Callender and Co., are laid on the solid system, with provision in some cases for drawing in extra distributing cables. The feeders are one of 0·5 square inch section, one of 0·4 square inch section, and three of 0·25 square inch cross-section.

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Mr. Fedden, by continued exertion and backed by the goodwill of his contractors, was able to commence both public and private lighting seven months and ten days after excavation for foundations was commenced, thus beating, we believe, all previous records (and this during a year when immense difficulty was experienced in the delivery of material). We must congratulate Mr. Fedden and the whole of the contractors upon the result of their labours, which have given to Greenock a model station,

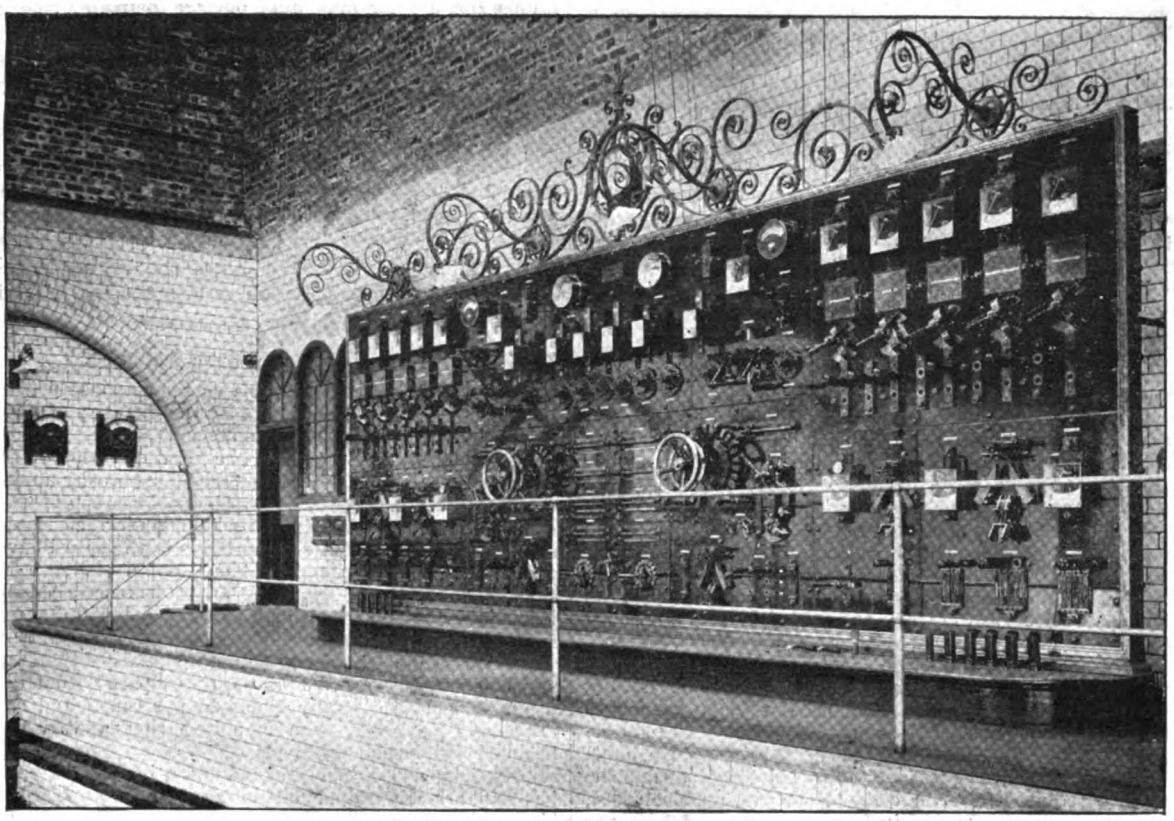

FIG 2.—The Greenock Switchboard.

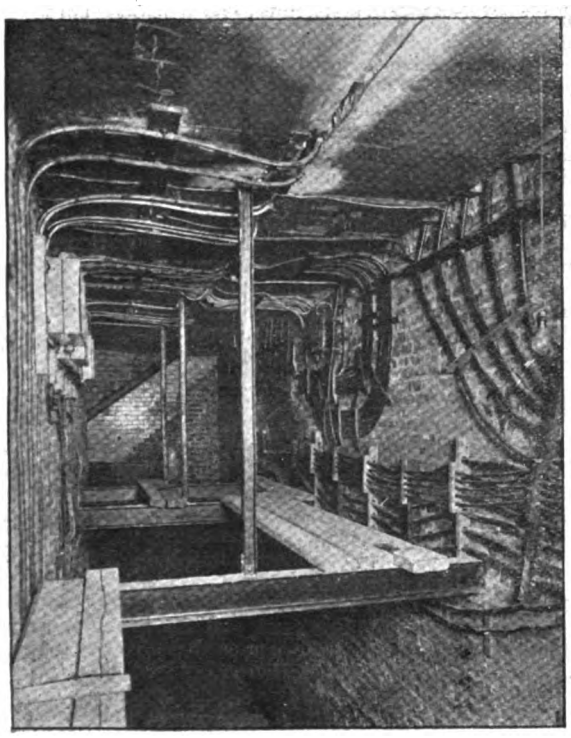

FIG. 3.—Resistance-Room below the Switchboard.

and while doing so we must not neglect to include in our congratulations Mr. Best, the energetic representative of the Silvertown Company, who has completed his by no means light task in such a satisfactory manner.

INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on Thursday week the chair was occupied by Prof. Perry, in the absence of the President.

Prof. PERRY announced that donations had been received from various gentlemen to the benevolent fund amounting to £158. 16s. 6d., and also some donations to the building fund. He asked the secretary to read the names of these donors as an encouragement to others to send in contributions.

Mr. E. J. WADE then read abstracts from his paper on "Storage Battery Problems," a portion of which appeared in our last issue, and the conclusion is given herewith.

Storage Battery Problems.

BY E. J. WADE, ASSOCIATE.

(*Concluded from page 414.*)

Thus, the potential difference between all parts of the opposing electrodes falls gradually and uniformly, and the variations of acid strength, small at first, slowly increase, until by the time the E.M.F. of the outermost layers, working in the strongest acid, has dropped to about 1·85 volts solely by reason of their advanced state of discharge, the specific gravity of the solution round the inner layers will be 1·030 or thereabouts, and their E.M.F. also only about 1·85 volts, although they may not have done a tithe of the work of which they are capable. At this stage the specific conductivity of the active materials becomes the chief factor in controlling the further course of the discharge. The resistance of the outer and most sulphated layers goes up rapidly, and for a short time the burden of the discharge is probably taken up by the layers immediately beneath them. These, however, soon follow suit, and the resistance of the inner layers of the electrolyte, from which, by now, almost the whole of the acid has been abstracted, also being very high, the potential difference between the electrodes very quickly drops below the normal limit. It is now apparent why the output of a cell decreases so much on heavy discharges, and also why little or no increase of capacity can be obtained by using masses of active material of more than a certain thickness. The higher the rate of discharge or the more impeded the diffusion, the less is the interior of the active material drawn upon for the maintenance of the current; while if either of these conditions is pushed to an

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extreme, nearly the whole of the work is done by a very thin outside layer, and by the time this is exhausted hardly any acid will be left in the electrolyte surrounding the remainder. Of course, as soon as the discharge is stopped fresh acid begins to diffuse in, and after a little while a further discharge is obtainable. By repeating this proceeding a sufficient number of times the larger proportion of the deficiency on the first discharge may be made up.

Recharging is seldom effected at such extremely high rates as are sometimes used for the discharge, but they must often be quite sufficient to liberate acid in the pores of the active material considerably faster than it can be dissipated; and, although in this case the effects of imperfect diffusion are not so evident and the details of the procedure which brings them about are still more complicated, yet, following the same line of reasoning as has just been applied to the discharge, certain general conclusions may be drawn. The outer layers of active material will absorb more than their due proportion of the current, and by the time they are fully desulphated the inner layers, as yet only partially charged, will be surrounded by abnormally strong acid to enable them to maintain an equivalent voltage. Unless, therefore, the current is prolonged for a time after gassing has commenced and the end of the recharge only determined by a sufficiently high potential difference being attained, there is some likelihood of the inner layers not receiving their proper charge at all; and in any event the gassing, by expelling some of the electrolyte from the pores and destroying its continuity, must itself greatly retard the process. Not only, then, is the output of a cell materially diminished through insufficient diffusion, but its durability and life must also be more or less seriously affected owing to the injurious conditions to which portions of the active materials and their metallic supports are thereby subjected: conditions favourable to the breaking up of the molecular structure of the former with "sulphating" and all its attendant evils, and to the destruction of the latter by local action. These effects are chiefly experienced by the innermost layers of active material which work in abnormally weak acid towards the end of the discharge and abnormally strong acid towards the end of the charge; and, in addition, do not undergo that thorough desulphation on charging necessary to help to bring them back to their normal state. The outermost layers also suffer, however, inasmuch as they are liable to be over-discharged to the point of reversal every time the full output is required from the cell. At the positive electrodes, wherever the layer of peroxide in immediate contact with the support is broken up from any of the preceding causes, the metal itself will become exposed to electrolytic action and its sulphation and corrosion greatly facilitated.

A third effect of imperfect diffusion is to reduce the electrical efficiency of the cell. In part it acts by lowering the average E.M.F. of discharge and raising that of recharge, the missing electrical energy appearing as heat generated at the end of both processes, when the outside electrolyte diffuses in and mixes with that of unequal strength contained in the pores of the active materials. But when this takes place, the conditions of equilibrium previously existing as regards E.M.F. between all parts of the active material are disturbed; local currents flow, more heat results, and consequently the ampere-hours available on discharge are also somewhat diminished, and those necessary for recharge somewhat increased. The loss of energy due to these causes was pointed out and demonstrated by Messrs. Duncan and Wiegand in 1889. It follows, and is, indeed, found to be so in practice, that the best efficiency of a cell is obtained by commencing its discharge immediately the recharge is finished, and *vice versâ*. When the discharge rates are high or the diffusion poor, the difference may be considerable. Undoubtedly the abnormal sulphation is the most serious result of impeded diffusion, for not only does it directly depreciate the electrodes and bring about a permanent reduction of their capacity in proportion to the quantity of active material affected; but also, by choking up the space available for the electrolyte, it aggravates the causes through which it was itself started, and so increases the temporary losses of capacity due to high discharge rates, besides reacting unfavourably on the cell's efficiency. The only practical method of determining the extent to which diffusion into the pores of the active materials is provided for in a cell is to compare its outputs at different discharge rates. There have been cells on the market of the Faure type, and possibly are still, which show a steadily increasing capacity down to a 30 or 40 hour rate. Such inadequate diffusion is due either to the masses and layers of active material being too thick, or to the free access of the electrolyte to their surfaces being too much impeded, or to their porosity being insufficient; often it is brought about by a combination of these causes. The two former conditions can easily be improved by proper mechanical design. To compensate for the latter special devices are sometimes employed, such as perforating the active materials, or providing channels through their interior or enclosed spaces in their midst to act as reservoirs of electrolyte; but the more usual plan has been to mix various substances (such as magnesium sulphate, salt, sugar, carbon, and so forth) with the lead compound used for pasting, and to remove them afterwards by solution or the action of the forming current.

Still, when all these precautions are taken they will not increase the diffusion beyond a certain degree. That this is so is shown by those commercial cells of Planté type, in which extremely thin layers of active material are employed with a very free access of electrolyte to their surfaces, for even these do not attain their maximum output at more than a 12-hour discharge rate, although there is very little diminution at about a nine-hour rate, but above this it falls off with increasing rapidity. The fact is, to go to the root of the trouble, the molecular porosity of the active materials, whether of the Faure or Planté type, needs to be considerably increased. If an ordinary active material prepared from a paste of litharge or red lead could be enormously magnified, it would be seen that the minute spaces between the individual grains are very caverns in comparison with those that penetrate the grains themselves, and it is these latter which appear to prevent the diffusion from proceeding at more than a certain rate, no matter how large the former may be. The total porosity of an active material is in itself, therefore, but a very partial guide as to its capabilities. For instance, its molecular pores might be almost stopped up with irreducible sulphate resulting from improper treatment during its first formation or afterwards, and yet it could possess a very open structure as judged by a microscopic examination or by the quantity of liquid it was capable of absorbing. Devices such as those just now mentioned may, within limits, improve the total porosity of the active materials, but they leave their molecular porosity unaltered, for this depends almost entirely on the lead compound used as raw material, and is rigidly fixed by its chemical composition and specific gravity. The only exception is in the case I have already referred to, where the partial sulphation of dense materials, such as Pb, PbO, or Pb_3O_4, at an intermediate stage of their first formation leads to growth and expansion and a consequent increase in their ultimate porosity.

The molecular porosity of active materials of the Planté type, and of all those of the Faure type prepared from litharge or minium, is probably only about 25 per cent., and can hardly exceed 40 per cent., even assuming that a very heavy preliminary sulphation takes place. A more porous material is obtained by the electrolytic reduction of lead chloride which has had a small proportion of zinc chloride fused with it. The two form a molecular compound that sets to a crystalline mass of low specific gravity, and when the zinc chloride and the chlorine of the lead chloride have been removed, every molecule of the lead remaining is surrounded by a space of about twice its own size. It possesses, therefore, a true molecular porosity of 65 to 70 per cent., and is capable of holding about two-thirds of its own apparent volume, or twice its actual volume of electrolyte. This active material perfectly fulfils the proper conditions as regards the quality of its structure, but as regards the degree of porosity, it is only a step in the right direction. In the ideal active material everyone of its molecules should be surrounded by space sufficient to hold enough electrolyte for its complete discharge, so that no diffusion has to take place either from outside or between different parts of the active material itself. To achieve this result it must be able to contain not merely twice, but 10 to 20 times, its actual bulk of electrolyte, corresponding to a molecular porosity of 90 to 95 per cent. It is, of course, one thing to indicate the ideal conditions, and quite another to show how they are to be attained. The problem is to prepare an active material possessed of an extremely high molecular porosity without too much reducing its cohesion and mechanical strength generally. There are, at any rate, no fundamental difficulties in the way. Many substances exist, such, for example, as carbon in the form of charcoal, which prove that porosity and strength can go together. A remarkable instance is furnished by "block magnesia," a basic magnesic carbonate, which has a 90 to 95 per cent. porosity and can take up about nineteen-twentieths of its own nominal volume of liquid, and yet will withstand a crushing strain of more than 80lb. per square inch. Given an active material with similar qualities, practically the full theoretical output corresponding to a 50 per cent. sulphation could, I believe, always be obtained from a cell, no matter how high the rate at which it were discharged. But what is of still more importance, the durability of the cell should be immensely increased and its life proportionately lengthened, and most of the causes that give rise to abnormal sulphation being eliminated, there would be little permanent loss of capacity or electrical depreciation. Then, too, an exceedingly high electrical efficiency should be realised, for the dissipation of energy in the form of heat would be reduced to an almost negligible quantity. If all these improvements are possible, there is yet hope that lead cells may eventually fill their unique position as the sole practical means of storing electrical energy, far more adequately than they have hitherto done; but whether or no this comes about, I feel assured that no substantial advance remains to be effected except in the

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direction I have indicated, and the only other alternative will be to discover a new combination altogether.

Part II.

In the first part of this paper I have said that the utility of the lead-sulphuric acid-lead peroxide combination appears to be due to the insolubility of the active material of both electrodes under all normal conditions of treatment. This is not, however, the whole matter, for essential as the insolubility of the compounds may be to success, it would probably be insufficient were it not in conjunction with certain properties which are inherent in lead and its compounds and form one of their most marked chemical characteristics.

Lead, like all the metallic elements, unites with other elements and radicles to form normal compounds and salts of a perfectly definite composition, such as the monoxide, peroxide, sulphate, and so forth. It also enters with greater ease than most of the metals into more complex combinations to produce "basic salts" (sometimes termed "sub-salts"), in which it is partly combined with O or HO, as an oxide or hydrate, and partly with some other element or radicle. Usually it is capable of producing not merely one, but a whole series of basic salts with each radicle, of which the basic chlorides, nitrates, and acetates are well-known examples. In addition to this, it is almost unique amongst the metals in the facility with which it combines with two or more different radicles, other than O or HO, and gives rise to curious compound salts, such as

"Lanarkite," $Pb_2\begin{Bmatrix}SO_4\\CO_3\end{Bmatrix}$ "Leadhillite," $Pb_4\begin{Bmatrix}SO_4\\(CO_3)_3\end{Bmatrix}$

"Phosgenite," $Pb_2\begin{Bmatrix}Cl_2\\CO_3\end{Bmatrix}$ Lead chlorosulphide, $Pb_2\begin{Bmatrix}Cl_2\\S\end{Bmatrix}$

But besides all its normal, basic, and poly-acid salts and compounds, lead will, under suitable conditions, form others which cannot accurately be represented by any formula at all. The two most important commercial preparations of lead—namely, white lead and red lead or minium—both furnish well-marked examples of this behaviour.

The first of these is a basic lead carbonate whose average composition when prepared by the old "Dutch" process is generally represented by the formula $2PbCO_3$, $Pb(HO)_2$, or $Pb_3(CO_3)_2(HO)_2$; but this is purely an approximation, as the relative proportions of carbonate and hydrate are found to vary very appreciably in different samples, even if produced under practically identical conditions. By other processes, especially precipitation methods, any number of basic carbonates of indefinite composition may be obtained, in which the proportions of CO_3 and HO vary over a much wider range, and show very little preference for uniting in any simple ratio such as is expressed by the formula just given. Minium also has no fixed or definite chemical composition. Under the action of reagents it behaves as if it were composed of lead monoxide and lead peroxide, and the formula 2PbO, PbO_2, or Pb_3O_4, most nearly represents its average composition; but samples fully possessed of the fine scarlet colour, its distinctive physical property, have been found to approximate more closely to Pb_6O_7, Pb_4O_5, Pb_2O_3, or to some other degree of oxidisation between these simpler ratios.

Now Mendelejeff has ascribed some of the peculiarities of lead and its compounds (as also of boron, silicon, and other inorganic elements) to their "polymerisation." That is to say, he assumes that the molecule of lead may sometimes consist of a large but undetermined number of atoms, Pb_x; while, in the same way, the molecule of lead monoxide is not necessarily composed of one atom of lead and one of oxygen, PbO, but of many multiples of these quantities, $Pb_x O_x$; so also lead peroxide may be $Pb_x O_{2x}$, and so on. The assumption does not, of course, affect the percentage composition of the lead compounds as ascertained by analysis, but only their molecular weights, and these cannot be directly determined. This theory is partly based upon and affords a simple explanation of the readiness of lead to form the basic and poly-acid salts just referred to. Some of the atoms of lead in the complex molecule combine with one radicle and some with another; and if, purely for the purposes of illustration, we suppose that there are 12 atoms of lead present, or that the molecule of lead monoxide from which they are derived has a composition $Pb_{12}O_{12}$, some of them may be expressed in the following formulæ:

Basic hydrates—$Pb_{12}\begin{Bmatrix}O_6\\(OH)_8\end{Bmatrix}$ $Pb_{12}\begin{Bmatrix}O_6\\(OH)_{12}\end{Bmatrix}$

Basic chlorides—$Pb_{12}\begin{Bmatrix}O_6\\Cl_{12}\end{Bmatrix}$ $Pb_{12}\begin{Bmatrix}O_8\\Cl_8\end{Bmatrix}$ $Pb_{12}\begin{Bmatrix}O_6\\(OH)_6\\Cl_6\end{Bmatrix}$

Basic carbonates—$Pb_{12}\begin{Bmatrix}(CO_3)_6\\(OH)_{12}\end{Bmatrix}$ $Pb_{12}\begin{Bmatrix}(CO_3)_8\\(OH)_8\end{Bmatrix}$

Sulpho-carbonates—$Pb_{12}\begin{Bmatrix}(SO_4)_6\\(CO_3)_6\end{Bmatrix}$ $Pb_{12}\begin{Bmatrix}(SO_4)_3\\(CO_3)_9\end{Bmatrix}$

But the theory also equally well explains the real nature of the lead compounds of variable and indefinite composition. Their behaviour has always seemed somewhat puzzling, and they were generally regarded as not being chemical compounds at all: merely intimate mixtures of other and simpler compounds. Thus, white lead was a mixture in varying proportions either of normal lead carbonate and lead hydrate, or of some definite basic carbonate with an excess of normal carbonate.

$$2PbCO_3 + Pb(HO)_2 = Pb_3(CO_3)(HO)_2 + PbCO_3.$$

Red lead was a mixture of lead monoxide with lead peroxide, or possibly of lead sesquioxide with an excess of monoxide.

$$Pb_3O_4 = 2PbO + PbO_2 = Pb_2O_3 + PbO.$$

It will be evident, however, that we have only to assume a sufficiently complex molecular structure, and any number of true compounds between lead and a given set of radicles become theoretically possible: compounds of such closely allied composition that their physical and chemical properties grade imperceptibly from each one to the next, and so defy isolation. No doubt in many instances the whole series of compounds will be so unstable, and so easily resolved into their proximate components, that chemically they do appear to be nothing more than mixtures of them. In other cases only the combinations in simple ratios may possess much stability; but in every case the latter will probably be somewhat more stable and more readily formed than the remainder, which need suitable conditions for their production.

The manufacture of red lead furnishes a good example of the application of the theory, and a suggestive instance of the way in which a series of compounds is brought about and of the relationship of its various terms to each other. The further oxidation of litharge by roasting at a temperature not so high as that required for its own formation, does not appear to consist in the conversion of successive molecules of PbO direct to Pb_3O_4, or some other definite oxide, but in the gradual absorption of oxygen by each molecule, which takes it up, atom by atom, and passes through a whole series of oxides of gradually increasing richness, the action proceeding more or less simultaneously and uniformly at all parts of the mass, according to the relative adequacy of the air supply. Again, supposing the constitution of the monoxide to be $Pb_{12}O_{12}$, the series of compounds obtained may be represented as follows; but fully to account for the observed facts its molecular composition would have to be far more complex, so as to provide numerous other oxides between each of the terms shown:

$Pb_{12}O_{12}$	$12PbO$	PbO
$Pb_{12}O_{13}$	$11PbO + PbO_2$	—
$Pb_{12}O_{14}$	$10PbO + 2PbO_2$	Pb_6O_7
$Pb_{12}O_{15}$	$9PbO + 3PbO_2$	Pb_4O_5
$Pb_{12}O_{16}$	$8PbO + 4PbO_2$	Pb_2O
$Pb_{12}O_{17}$	$7PbO + 5PbO_2$	—
$Pb_{12}O_{18}$	$6PbO + 6PbO_2$	Pb_3O_2

The first column gives the assumed molecular composition of the oxides; the second expresses it in terms of separate molecules of monoxide and peroxide as they would appear under analysis; and the third merely shows the simplest proportional composition. Most commercial minium comes somewhere between Pb_4O_5 and Pb_3O_4, prolonged roasting generally being required to bring it quite up to the latter proportions; but as samples are occasionally found to be still further oxidised, the series is extended to the sesquioxide, Pb_2O_3. Here or hereabouts, the extreme limit to which the oxidation can be pushed by roasting is reached, because the temperature necessary to carry it to this stage is nearly as high as that at which the deoxidation of the sesquioxide by heating commences. The two opposing tendencies balance each other, and the absorption of oxygen then comes to an end.

I now propose to make use of this "polymerisation" theory in dealing with the various phenomena observed in lead cells, for it enables us to reconcile their physical and chemical aspects, and to give a more consistent and satisfactory account of the changes taking place than can otherwise be done: and it is with a view to making the application of the theory as clear as possible that I have felt it advisable to set out the foregoing considerations regarding the lead compounds in general and minium in particular at such length. In the first place, I assume that the fully-formed active materials, electrically prepared at both electrodes, are not Pb and PbO_2, but Pb_x and $Pb_x O_{2x}$; that is, they are allotropic or polymeric modifications; or they have a complex molecular structure—whichever term or phrase we please. On closing the external circuit, the molecules of lead at the negative begin to combine with SO_4 from the electrolyte, not, however, breaking up into independent molecules of normal lead sulphate, $PbSO_4$, round a nucleus of uncombined metal; but the molecules, as a whole, taking part in the combination and, as the discharge proceeds, passing through a continually changing series of sub-sulphates, without any rupture of their molecular complexity. At the positive the reactions, though different, take place in an exactly similar manner. Oxygen is gradually abstracted and SO_4 substituted in its place, a sequence of compounds of sulphate and peroxide being produced. Still keeping to our imaginary 12 atoms of lead to the molecule, these two series of compounds may be represented as follows:

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Pb_{12}	$Pb_{12}(O_2)_{12}$
$Pb_{12}(SO_4)$	$Pb_{12}(O_2)_{11}(SO_4)$
$Pb_{12}(SO_4)_2$	$Pb_{12}(O_2)_{10}(SO_4)_2$
$Pb_{12}(SO_4)_3$	$Pb_{12}(O_2)_9(SO_4)_3$
$Pb_{12}(SO_4)_4$	$Pb_{12}(O_2)_8(SO_4)_4$
$Pb_{12}(SO_4)_5$	$Pb_{12}(O_2)_7(SO_4)_5$
$Pb_{12}(SO_4)_6$	$Pb_{12}(O_2)_6(SO_4)_6$

But neither of these series is continued until the active material is fully sulphated and the compound $Pb_{12}(SO_4)_{12}$ reached. Just as the oxidation of litharge by roasting is necessarily arrested at some stage before it is fully converted into peroxide, so here a limit is presently attained; and a little consideration will show that some such limit is not merely probable but inevitable, and that a direct cause, partly physical, partly chemical, can be assigned for it.

We know that both lead and lead peroxide possess a very considerable electrical conductivity; but that, on the other hand, pure lead sulphate is practically a non-conductor. Both the negative and positive active materials must therefore undergo a great change of resistance in the course of their sulphation; a change either spread more or less uniformly over the whole discharge, or else occurring abruptly at some special stage. The latter appears to be what really happens, for although our information regarding the changes of resistance in lead cells is extremely vague and meagre, we know that there is not much variation throughout the main portion of the discharge, but that the resistance begins to rise considerably towards the end. The exact point of change is immaterial to the present argument, but I believe that when the active materials approach a proportional composition Pb_2SO_4 and $Pb_2O_2SO_4$ respectively, the rate of increase of their resistance experiences a rapid acceleration, and their resistance itself goes up enormously. The fact of importance is that wherever and whenever such a change of resistance takes place, it must necessarily terminate the discharge, and bring about all the phenomena which do occur. Just as fast as the resistance of the active materials, and, therefore, the internal resistance of the cell, rises, the potential difference at its terminals will fall away; and by the time the internal resistance has become very large in proportion to that of the external circuit, the potential difference will be reduced practically to zero. Or, to put it another way, just as fast as the resistance of the active materials rises, more and more of the electrical energy they would otherwise liberate is expended, so to speak, in their own molecules, until, when the rest of the resistances in circuit become relatively negligible, equilibrium is nearly established and the liberation of energy almost ceases. This is why it is impossible to push the discharge of a cell further even by short-circuiting it; and yet on breaking the circuit—*i.e.*, increasing the external resistance to infinity—the E.M.F. rapidly rises to nearly its original value, thereby showing that the chemical affinities are neither exhausted nor saturated. The aggregate results of the chemical changes at each electrode during a complete discharge are expressed in their simplest terms in the following equations:

At the negative—

$$\begin{Bmatrix} Pb \\ Pb \end{Bmatrix} + SO_4 = \begin{Bmatrix} PbSO_4 \\ Pb \end{Bmatrix}$$

At the positive—

$$\begin{Bmatrix} PbO_2 \\ PbO_2 \end{Bmatrix} + H_2 + H_2SO_4 = \begin{Bmatrix} PbO_2 \\ PbSO_4 \end{Bmatrix} + 2H_2O.$$

But augment the E.M.F. of the discharged cell ever so slightly from an outside source, and the point of equilibrium is passed; the active materials begin to absorb energy instead of liberating it, and incipient reversal commences. In fact, in primary battery language, the cell has polarised, but, unlike other cells, at both electrodes. (I am here assuming that the negative and positive electrodes contain equivalent amounts of active material, and both discharge under such equal conditions as regards maintenance of acid supply in their pores, etc., that they polarise or reverse at the same time.)

If the applied E.M.F. is sufficient to maintain a current through the cell, a kind of double reaction now goes on at both electrodes. At the negative the lead still continues to sulphate, but at the same time the sulphate already there begins to peroxidise; at the positive the peroxide still undergoes reduction to sulphate, but at the same time the sulphate already there further reduces to lead. Although the preceding statement probably gives a better idea of the real nature of the changes taking place, we may also put it more simply, and say, as regards the net results only, that on the one side lead is directly peroxidised, and on the other side peroxide is directly reduced to metal, the proportion of sulphate in both cases remaining constant throughout. These reactions will continue until all the lead is peroxidised and all the peroxide reduced; and the two series of compounds through which the active materials may be supposed to pass are given below, commencing with the two last terms of the previous series, which represented their composition at the end of a complete discharge.

$Pb_{12}(SO_4)_6$	$Pb_{12}(O_2)_6(SO_4)_6$
$Pb_{12}(O_2)(SO_4)_6$	$Pb_{12}(O_2)_5(SO_4)_6$
$Pb_{12}(O_2)_2(SO_4)_6$	$Pb_{12}(O_2)_4(SO_4)_6$
$Pb_{12}(O_2)_3(SO_4)_6$	$Pb_{12}(O_2)_3(SO_4)_6$
$Pb_{12}(O_2)_4(SO_4)_6$	$Pb_{12}(O_2)_2(SO_4)_6$
$Pb_{12}(O_2)_5(SO_4)_6$	$Pb_{12}(O_2)_3(SO_4)_6$
$Pb_{12}(O_2)_6(SO_4)_6$	$Pb_{12}(SO_4)_6$

In this way the composition of the two active materials is exactly transposed without the proportions of sulphate present being further increased. At the same time, their molecular structure is maintained throughout the reversal, so that, although the internal resistance is far higher than at any period during the discharge or recharge, the conductivity of the active materials is never really interrupted.

The following equations give the sum of the reactions during a complete reversal in their simplest terms:

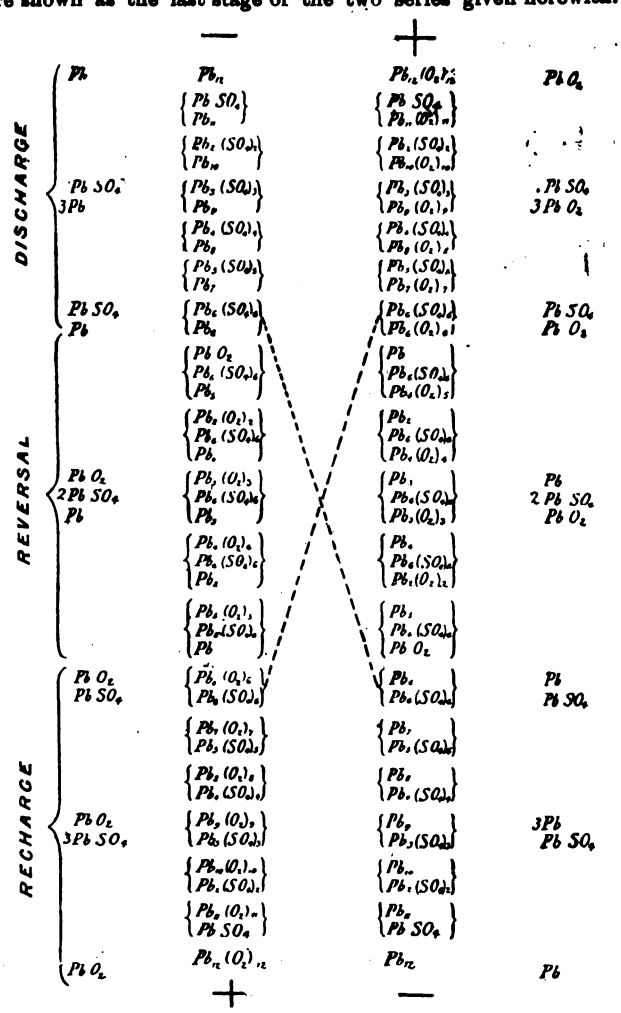
At the negative—

$$\begin{Bmatrix} PbSO_4 \\ Pb \end{Bmatrix} + \begin{matrix} SO_4 \\ SO_4 \end{matrix} + 2H_2O = \begin{Bmatrix} PbO_2 \\ PbSO_4 \end{Bmatrix} + 2H_2SO_4$$

At the positive—

$$\begin{Bmatrix} PbO_2 \\ PbSO_4 \end{Bmatrix} + \begin{matrix} H_2 \\ H_2 \end{matrix} + H_2SO_4 = \begin{Bmatrix} PbSO_4 \\ Pb \end{Bmatrix} + \begin{matrix} 2H_2O \\ H_2SO_4 \end{matrix}$$

The symbols are arranged in double lines to indicate the probable dual nature of the reactions to which I have just referred. As soon as all the lead has been oxidised at the one electrode and all the peroxide reduced at the other, the reversal is finished, and the back E.M.F. of the cell rises rapidly; but as, at the same time, the proportion of sulphate begins to diminish in both active materials, their internal resistance falls with equal suddenness, and the end of the reversal is consequently not marked by so much increase in the potential difference required to maintain the flow of current as might be expected. The next stage is equivalent to the recharge of a cell which ordinarily follows on a discharge, except that the direction of the current and the composition of the two active materials are reversed; but in either case the reactions are exactly the same, and consist in the gradual abstraction of sulphate from both active materials until they are finally brought back to lead and lead peroxide, just as they existed at the commencement of the discharge. The series of compounds through which this is effected will be similar to those of discharge, but now occurring in the converse order, and they are shown as the last stage of the two series given herewith.



These represent the whole of the changes experienced by the active materials during their passage through a complete cycle

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consisting of discharge, reversal, and recharge; or, by passing from the one series to the other along the diagonal lines connecting similar terms in the two series, the more usual cycle of discharge and recharge only. The hypothetical molecules containing 12 atoms of lead are still presumed, and the terms in the first two stages—discharge and reversal—are, of course, the same as those already given, but with the chemical symbols now arranged slightly differently. The formulæ on either side show the simplest proportional composition of the active materials, as they would appear under analysis, at some of the intermediate points. The total effects of the recharge, expressed in their simplest terms, are as follows:

At the negative—

$$\begin{Bmatrix} PbSO_4 \\ Pb \end{Bmatrix} + H_2 = \begin{Bmatrix} Pb \\ Pb \end{Bmatrix} + H_2SO_4.$$

At the positive—

$$\begin{Bmatrix} PbSO_4 \\ PbO_2 \end{Bmatrix} + SO_4 + 2H_2O = \begin{Bmatrix} PbO_2 \\ PbO_2 \end{Bmatrix} + H_2SO_4.$$

To make the account of the charging reactions complete, it would be necessary to consider the production of persulphuric acid, $H_2(SO_4)_2$, the exact constitution of the lead peroxide when thoroughly desulphated, and, closely connected with these, the abnormally high E.M.F. obtained towards the end of the charge and the first few minutes of discharge; but as they are none of them directly related to the main reactions, I do not propose to deal with them here.

Probably of all the phenomena observed in storage cells, the least studied, but the most interesting and important theoretically, are those of reversal. Quite apart, however, from their direct bearings on storage battery problems, the electrolytic conversion of electro-positive lead into electro-negative lead peroxide, and *vice versâ*, and the molecular mechanism by means of which these results are effected, well deserve further study for the light it may throw on the relationship between the chemical and electrical forms of energy as well as on other problems of chemical physics. I cannot recall ever having seen any definite chemical theory of reversal propounded, but believe the general idea is—it certainly was mine for a long time—that at both electrodes the active materials have to be fully converted into lead sulphate before they can undergo further oxidisation or reduction. Indeed, if the usual explanations of the discharge reactions are adapted, this seems to be the only possible procedure, but one which at the same time brings out most strikingly the discrepancies between fact and theory. The view, no doubt, appears to derive support from the very evident "sulphating" that so frequently accompanies the reversal of electrodes, and may, if they contain large masses of active material, lead to their entire disintegration in its endeavours to make room for itself; but this is due to excessive local action, as will be explained later. On the other hand, any type of electrode in which the active material is distributed in thin layers may be reversed without showing the slightest trace of sulphate throughout the operation or suffering any loss of capacity, provided a sufficiently heavy current is maintained. Fortunately, one piece of evidence exists which, to my mind, lends strong confirmation to the views I have put forward as to the real nature of the reactions of reversal, and that is the appearance of lead peroxide on the surface of the negative active material towards the end of its complete discharge; but although the fact has frequently been cited in explanation of the rapid fall of voltage, I do not think its full significance has hitherto been realised. As Mr. Swinburne once pointed out, it seems almost impossible to suppose that the peroxide can be produced by the cell's own unaided energy, and no doubt in practice it is brought about by a reinforcement of its potential difference from other cells in series with it and not so fully discharged. However this may be, it does not affect the value of the observation itself, which lies in showing that the formation of peroxide sets in before the active material is fully sulphated and in indicating how the reversal commences. I am not aware that uncombined lead has ever been detected in the active material of an exhausted positive; but given a cell whose negatives have the larger capacity so as to ensure the positives being thoroughly run down, and I think some indications of it might be found if discharged under suitable conditions. More probably, though, no test can be devised to which the metal will respond with the same ease as its peroxide, and before it is reoxidised by local action.

With regard to the assumption I have made earlier in the paper, that the proportional composition of the active materials at the stage where their resistance rises so rapidly as to terminate the discharge and bring about the reversal is Pb, $PbSO_4$, and PbO_2, $PbSO_4$ respectively, my chief corroboration, so far as direct analysis is concerned, comes from Mr. Robertson's analysis of positive active material given in Prof. Ayrton's paper of 1890. He found that the sediment from the positives and the discharged positive active material itself both approximated in composition to the second of the two formulæ just mentioned. Unfortunately, neither there or anywhere else that I know of are quantitative data given as to the composition of discharged negative active material, but I have repeatedly found that Planté-type electrodes properly reversed afford just the same output whether positives or negatives, so that if the one formula is accepted the other should hold good also. Of course, the percentage of sulphate present in the discharged active material tells nothing, and is only misleading unless account is also taken of the sulphate there at the commencement of the discharge. In the case quoted above the fully-charged active material was found to be quite free from sulphate, but this is unusual even for new electrodes, and most exceptional for those which have been in use for any length of time; consequently in many instances the percentage of sulphate in the active materials when discharged considerably exceeds that required by the formula.

A more practical confirmation, based on the general experience of a large number of people, is supplied by the specific capacity of the active materials. Although only with difficulty, outputs very nearly as high as 50 and 60 ampere-hours per pound of active material have been and can be obtained, corresponding to close upon 50 per cent. sulphation; but never, I believe, under any conditions whatever, have these figures been exceeded. It is well known that towards the end of a discharge the curve of the potential difference of a cell varies considerably in character according as the negative or positive electrodes have the smaller capacity and are the first to give out; dropping off with extreme suddenness in the former case, and more gradually, although still with considerable rapidity, in the latter case. Now if, as I maintain, the potential difference at this stage is chiefly controlled by changes going on in the conductivity of the active materials, then the lack of conformity between the two curves must connote a corresponding variation in the way the resistance of the two active materials rises. At the negative the increase is sudden and large, putting a very definite limit beyond which further sulphation is impossible and reversal commences; and analogy with the sub-oxides of lead suggests that this is most likely to occur when a composition, Pb_2SO_4, corresponding to Pb_2O, is attained. At the positive the rise in resistance takes place more slowly, and although soon sufficient to bring the potential difference down to the point at which the discharge is usually stopped, yet, if it is allowed to continue, the sulphation is able to proceed some stages further with a steadily falling voltage. Here, again, analogy with the oxides of lead points to the change commencing at the composition PbO_2, $PbSO_4$ corresponding to the sesquioxide, PbO_2, PbO, and augmenting gradually as the composition of the active material approaches to PbO_2, $2PbSO_4$, corresponding to red lead, PbO_2, 2PbO.

We have now examined the normal constitution of the active materials under all conditions of use, and I have endeavoured to show by the aid of the hypothesis of polymerisation how at every stage, except when fully charged, it consists of true compounds of lead sulphate with lead or lead peroxide; or, during the period of reversal, with both at the same time. Yet no direct chemical evidence can be adduced as to the existence of any one of these compounds, with the possible exception of Dr. Frankland's "brown salt," PbO_2, $2PbSO_4$, which he believes he isolated in 1889, and even in this instance Messrs. Gladstone and Tribe were unable to confirm his results. To all chemical tests the active materials behave merely as mixtures containing normal lead sulphate in various proportions, but the lack of corroboration in this direction was only to be expected by analogy with red lead, white lead, and similar compounds, and it only serves to show the degree of their instability. Unfortunately there is other most troublesome evidence as to the extreme feebleness of the compounds now in question: not only do they break up under all chemical tests outside the cell, but even in the cell itself they act similarly under many conditions that cannot in practice always be avoided, and herein we have the origin of "sulphating," and the source of most of the infirmities which so largely limit the life and commercial usefulness of lead cells. On the slightest provocation, the molecules of active material forsake their allotropic or polymeric structure, and are resolved into what, from a general chemical standpoint, would be called a more normal state, but one which in its special relationship to storage cells I shall here term abnormal. Each complex molecule splits up into a number of simpler ones, some of normal sulphate and others of lead or lead peroxide. Taking, for example, the composition of the fully discharged active materials as represented by the two terms previously given, these would break up as follows:

$$Pb_{12}(SO_4)_6 = 6Pb + 6PbSO_4$$
$$Pb_{12}(O_2)_6(SO_4)_6 = 6PbO_2 + 6PbSO_4.$$

Such a change easily accounts for all the effects characteristic of "sulphating." The rearrangement of structure can hardly be accomplished without producing some alteration in the bulk of the active materials; and it is most probable that the independent molecules of sulphate will require more room than when in a combined state. A strain is thus put on the active materials which tends to reduce their porosity generally, while at the parts where the sulphation actually occurs the pores will be almost blocked up. If it is more than can be relieved by

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more compression of the active materials, their disintegration will commence, and if the sulphation is excessive, the effect extends to the support, which either expands, buckles, or bursts asunder according to its construction and the amount of the strain experienced. It is difficult to suppose that the free molecules of Pb and PbO_2 can themselves long escape sulphation, and so visible patches of white non-conductive irreducible sulphate soon make their appearance. Other known results, such as reduction of capacity, follow obviously, and need not be dwelt upon. Prolonged contact with the acid electrolyte appears to be quite sufficient in itself to cause the active materials to pass over to this abnormal state; but in all probability the result is largely dependent on the percentage of sulphate they contain and only becomes acute after a certain stage is reached, for in practice cells left on open circuit are found to sulphate more or less, according to the extent to which they have previously been discharged. Fully charged active materials maintain their normal condition with considerable tenacity, but it is quite possible that the very gradual loss of capacity so often experienced by negative electrodes, and for which no satisfactory explanation has yet been offered, may be due to a change of molecular structure. The effect is generally accompanied by shrinkage of the active material, and in this connection it is somewhat significant to note that Schutzenberger's allotropic form of copper was found to revert to its more usual state after prolonged immersion in dilute sulphuric acid, this change also being accompanied by shrinkage.

Although the instability of the active materials is inherent in their very nature, and its results cannot be always or entirely avoided under any practical working conditions, yet much of the trouble is usually brought about by minor causes, some of which, at any rate, are preventable. Local action, due to impurities in the electrodes or electrolyte, or to the presence of active oxygen in the form of persulphuric acid or hydrogen peroxide, or to excessive strength of acid, is one of the most frequent. The active materials, especially if fully charged or nearly so, are probably first partially sulphated just as when discharging, and so disposed to break up in the usual way; but the local action may also have a directly disruptive effect upon their molecular constitution as the proporsion of sulphate increases. The most marked effects of local action, however, are experienced during the period of reversal, for not only do the molecules of active material then contain their maximum of sulphate, but both lead and lead peroxide at the same time, and a condition of far greater instability results even than on complete discharge. If the current is stopped during this stage, local action and sulphating proceed with great rapidity, and they are not entirely checked when the current is flowing unless it is of very considerable strength. On this account it is impossible properly to reverse many types of electrodes, for, owing to the very high resistance of the active materials throughout the process, the current is most unequally distributed and only a small fraction penetrates the portions not quite close to the support. Excessive local action ensues, and even if the electrodes are not rendered useless, the active materials will be choked with large percentages of sulphate which it is impossible to reduce afterwards.

Another cause which no doubt plays a considerable part in breaking down the normal constitution of the active materials is undue weakness of the electrolyte. This condition seldom exists in the bulk of the solution, but owing to imperfect diffusion, as is fully explained in the first part of this paper, is frequently realised during discharge by the portion contained in the pores of the active materials. Most probably, as soon as the percentage of acid present falls below a certain limit, incomplete sulphation occurs, and compounds containing lead monoxide or hydrated monoxide, $Pb(HO)_2$, are then produced, and the variations in the specific gravity of the electrolyte during discharge sometimes agree best with a reaction of this nature. Distinct evidence, indeed, has frequently been obtained of the presence of monoxide in discharged positive active material, and upon this has been based an oxidation theory of the cell reactions, which assumes that at the positive, at any rate, the formation of sulphate is only an incidental result, contributing nothing to the E.M.F., and being, in amount, no function of the output. I prefer, however, to adopt the explanation I have suggested above, and consider that whenever indications of imperfect sulphation are observed they do not show the double sulphation theory to be at fault, but rather point to defective working conditions which prevent the proper and normal reaction from taking place.

Discussion.

The discussion on the paper was opened by **Dr. Armstrong**, who said the Institution was to be congratulated on having received so valuable a paper on such an important subject. Mr. Wade had stated his case with unusual clearness, and his arguments were logical and reasonable. The paper, he thought, divided itself into two sections. Mr. Wade first discussed the question as to the changes going on in the accumulator. He (the speaker) had had a good deal to do with accumulators, and had directed Mr. Roberteon's experiments. He felt there were in that direction still many problems for the chemist and electrician, and with this paper some slight advance had been made. The author first put forward the fundamental idea that they were dealing with lead and lead oxide, and showed the conversion from one to the other. Although he agreed in this with the author, he thought that probably a great deal happened in between the two stages. He was, however, not in a position to say what did happen. The problem of lead cells was a complicated one. Although Faraday experimented on the electrolysis of sulphuric acid, they practically knew little more than when Faraday left the subject. What was certain, however, was that the electrolysis of H_2SO_4 did not take place in the simple way which was ordinarily assumed. There were probably many products produced which played an important part in it. He felt that Mr. Wade had not sufficiently noted the possibility of such changes taking place. With regard to lead cells, they did not understand how the lead oxide was formed from the sulphate in some cells. There were also other cells from which the lead was obtained as lead without any trace of oxide. There was a great deal to be learnt as to what happened to both the H_2SO_4 and the lead compounds in the cells. Mr. Wade attached importance to the kind of compound formed, and put forward the theory that they were not dealing with lead oxide or lead sulphate alone, but a more complex subject containing both. The theory was a perfectly reasonable one, and a good deal could be said in its favour. In the paper it was stated that "unfortunately there is other most troublesome evidence as to the extreme feebleness of the compounds now in question." The author did not seem to trouble himself much as to the existence of these compounds. Mr. Wade had distinctly put forward a theory which enabled them to understand how it was that only half of the substance became active material. It was known as a fact that much beyond that could not be obtained. The most important part of the paper was, he thought, the last, where the author discussed the character of the charge and discharge, porosity, and the free diffusion of acid into the material. If they were to improve on the charge and discharge rate of cells, it must be in the direction pointed out. He was not prepared to go with the author in his view, except in the theoretical arguments. It was absolutely necessary that there should be a high degree of porosity in the plates, as they were dealing with acid which diffused itself at a comparatively slow rate. It was absolutely essential there should be a free passage for the acid in and out of the material, and the author made a very practical addition to his subject by impressing on them the need of great porosity.

Prof. Ayrton said that the paper was one of the best they had listened to for many a long year. He thought they should know much more about storage cells, and should have better storage cells. Since, 20 years ago, when he was connected with the first accumulator company, he had taken a great interest in the subject. Dr. Armstrong spoke of the experiments of Mr. Robertson in 1890 on "Analysis of the Plugs in the Porous Plate." He had brought with him the original curves exhibited on the subject that year in the Edinburgh Institution. In referring to these experiments with E.P.S. cells the author stated that "in this special instance the previous treatment of the cell was exceptionally favourable, and as on a 12 hour discharge rate its capacity came out about 33 per cent. above its listed value, it had evidently been worked up to a state of efficiency but seldom attained, still less maintained." Why was this statement true? Was it because they used a new cell? The cell in question had been daily used for over two years. The reason of its high capacity was that the E.M.F. on discharge was not allowed to go below 1·8 volts. It was just the going a little below this which spoilt the capacity of the cell. Never going below this voltage, the cell was continually charged and discharged without losing its capacity. The reason why he laid stress on this fact was that he had recently been told that it explained the ruin of the London Electric Cab Company. He hoped there was somebody there who could tell them whether it were correct or not. Last year there was a controversy in the electrical Press on the subject. The E.P.S. Company had entered into an undertaking to keep the cells up to a certain percentage of their capacity for three years, but the cab company came to an abrupt end. One of the electrical papers suggested that it was accumulators which caused the downfall. The E P.S. Company wrote a letter to the paper, which was published, to the effect that the E.P.S. Company had fulfilled its contract. The E.P S. Company agreed to keep the cells up to a certain percentage, provided that they were never discharged below 1·8 volts. This was a clause of the contract of which the cab company did not appreciate the importance. The cabs came in, the cells were found to be below 1·8 volts, and thus they went outside the contract. It was quite possible that this was the fact of the failure. The Tudor Company also made a similar condition in their maintenance contracts. After their experiments had been thus proved, why did not the cab company fix on the cab a voltmeter and make the cabmen return when the voltage went down to a certain point? One other point was the porosity of the plates, and he considered that the failure of some cells was mainly due to the want of this porosity. There were certain reasons which bore out this theory. The first point was that in the ordinary discharge the potential of the cell fell rapidly at the beginning, then slowly, and then quickly again. This first rapid fall did not exist at all in a cell if it had been left charged for a considerable time—in fact, so far from going down, the curve actually rose slightly. This would tend to bear out the theory that the strong acid in the pores had time to diffuse. There was, however, no special reason for the rise. There were two ways of charging a cell. It was usual to charge it with constant current. They could, however, charge a cell in a totally different way—viz., by charging at constant potential. To charge

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with constant current involved a long period of wasted energy. In the second method they started with a large current and kept it on only for a short time—in fact, in 40 or 60 minutes the cell could be charged. In this method there was not any gassing, as would be expected. By this second method more energy could be put into the cell, and in a shorter time than by the first method, and also more energy could be taken out. Thus, in the cell experimented with, 151·8 watts were put in and 123 given out on the constant-current method, as against 231 2 watts put in and 163 watts given out on the constant-potential method of charging.

Mr. W. Hibbert said he could not entirely agree with the author. Up to the experiments referred to by Prof. Ayrton, it was the common practice to attribute the actions to the hydrogen and oxygen, and the function of the H_2SO_4 was ignored. When the first papers were published the theory was not accepted. Dr. Frankland defined the same theory in a slightly different form, and from that time there had been different theories, which did not all agree as to the action of the H_2SO_4 in the cells. To begin with, Mr. Wade said that he founded his position largely on the allotropic condition of the lead. This assumption Dr. Armstrong said was logical, but he (the speaker) thought the basis was not right, and he challenged the statement that the lead was in an allotropic condition. His reason was this. The author quoted in the first place the work of Darrieus and certain known experiments to show that the lead in an accumulator was not in the same condition as ordinary lead. One of these experiments showed that finely-divided lead would not give the same capacity as lead from electrolysis. There were also other reasons. He (the speaker) had repeated these experiments, and found no confirmation of the results obtained by Darrieus. On the other side of the battery were the peroxide plates, and Dr. Shiels determined the electrical resistance of the peroxide from a plate and commercial peroxide, and found them differ to such a small amount that he thought they did not differ in an allotropic sense. He thought there were no good reasons for supposing that the lead and lead peroxide were allotropical, and a great deal depended on that. As to the statement that "fully-charged active materials maintain their normal condition with considerable tenacity, but it is quite possible that the very gradual loss of capacity so often experienced by negative electrodes, and for which no satisfactory explanation has yet been offered, may be due to a change of molecular structure," he thought this clearly showed a tendency to find explanations in molecular structure. Mr. Wade rightly referred to the importance of porosity. There was one suggestion he should like to make, and that was the desirability of promoting diffusion as much as possible. It was well known that the accumulation of stronger acid at the lower part of the cell was disadvantageous, and would give rise to potential differences at different parts of the plates. These would greatly diminish if diffusion could be promoted. A second reason was that the fall of E.M.F. at the close of the discharge left a large portion of the active material not acted upon. This would not be so great if the diffusion were increased. The scaling in a cell when discharged below 1·8 volts could also, he thought, be overcome by proper diffusion. The reason why it was essential that the voltage should not fall below a certain point was that, as the acid changed, the potential varied very largely. When the E.M.F., for instance, had fallen to 1·76, the strength of the acid in the pores was 1·2 per cent., but when it fell to 1·5 the strength of the acid was not a measurable quantity, and, in fact, practically only water, and Dr. Gladstone had shown that after the acid disappeared the action changed altogether. After passing the potential difference of 1·8, they had a region in which the theory was not applicable.

Mr. G. H. Robertson said he heartily congratulated Mr. Wade on his paper. It was so long ago since his experiments that he would not speak on the subject. He thought they ought to make some progress from the facts put before them.

Mr. G. L. Addenbrooke said the whole debate had taken such a chemical turn that he thought he should be out of place in speaking of the commercial side. He wished to remark on the cost of supply current from accumulators as compared with the cost of steam. They could charge accumulators at a cost of about ½d. per unit, and supply current from them at about ½d. per unit, and consequently the cost of passing the current through the accumulators would not add more than 1d. to the cost of electricity than if generated directly by steam-engines. He thought if the capacity of accumulators could be increased about 20 or 30 per cent. for the same price, it would increase the number of openings for their use some three or four times.

Mr. G. C. Allingham said the breaking-up action in the discharge of a cell was one of single sulphation. When H_2SO_4 was electrified in the discharge, hydrogen was given off on the oxide plate and oxygen at the spongy-lead plate. The hydrogen ions simply reduced the oxide to a lower oxide. This, he thought, seemed to explain why the active material could be more than half discharged. He thought there was no reason why the sulphation of the spongy-lead plate should be carried out at the expense of the acid. Mr. Wade's paper showed the necessity for diffusion in the body of the cell as well as in the pores of the plates. If there were no diffusion in the body of the cell, all the acid would accumulate at the two plates. This seemed to him to render useless the hopes of the makers of accumulators who filled in the space between the plates with a solid electrolyte.

Mr. W. R. Cooper said that if the accumulator had been born a primary battery, instead of a secondary, a great deal of trouble would have been missed. There were several causes which brought about the trouble, amongst these being the comparison of the Kelvin equation and the thermo-electric effect. They were probably dealing with different materials to those dealt with in the equation, and there was a great lack of reliable thermo-electrical data. Mr. Wade accounted for the activity of the lead in the cells by assuming a more complex structure than that possessed by ordinary lead. Most people, he thought, would take the opposite view. As to the active material not being fully sulphated, he thought this was accounted for by a deposition of lead sulphate. Prof. Ayrton seemed to think that the charging by constant potential was a thing not easily explained. It was simply that with such a high current a great deal was done in a little time which took much longer with a lower pressure.

Prof. Ayrton here said what he wanted to say was that in this way they could charge the inner portion without gassing, which the author thought was not possible.

Mr. J. Swinburne said most of the phenomena mentioned in the paper could be explained by the simple sulphate theory. A good deal could be explained by remembering that the sulphate was an insulator. With litharge they could get their lead to do what they wanted, but Mr. Wade seemed to think it could not run down to pure sulphate, but to one of his particular compounds. It was possible to get a white film of sulphate deposited on to the plate, which gradually became an insulator. Most of the phenomena could be explained very simply, but there were some people who were not content with a simple explanation and wanted a complicated one.

Mr. Wade then adjourned his reply until the next meeting, at which a paper is also to be read on "The Electrical Equipment of Ships of War," by Mr. Grove.

The following is a list of the candidates balloted for:

Members.—Prof. R. T. Glazebrook, F.R.S., 23, Queen's-road, Richmond, Surrey; Prof. H Stroud, M.A., D.Sc., Durham College of Science, Newcastle.

Associate Members.—A. Adams, 75, Waterloo-street, Glasgow, N.B.; H. L. Dixon, Guildhall, London, E.C.; G. Horley, 11, Millbank-street, Westminster, S.W.; W. A. Kemm, Slatter's Hotel, St. Margaret-street, Canterbury; S. G. Leech, 19, Barton-street, West Kensington, W.; C. Lopdell, Owen House, St. Mark's-place, Torquay; C. A. Noton, 76, Church-street, West Hartlepool; H. Savage, 28, Craigerne-road, Blackheath, S.E.; J. B. Talbot-Crosbie, Scotstown House, Glasgow, N.B.; C. Turnbull, jun., Hylton Lodge, North Shields; E. White, Electric Supply Station, Sunderland; W. S. T. Worthington, Bakewell, Derbyshire.

Associates.—E. R. Clarke, 11, King's Bench-walk, Temple, E.C.; G. F. C. Gordon, 1, Tower-hill, Springburn, Glasgow; F. M. Moody, Treeton, Rotherham; C. A. Pulsford, 41, Ashton-terrace, Glasgow; E. S. A. Robson, Selbourne Lodge, Sale, Cheshire; T. Sewell, 47, Parolles-road, Upper Holloway, N.; F. S. Shaw, Poste Restante, Yokohama; E. C. Smith, 80, Mildenhall-road, Clapton.

Students.—A. F. T. Atchison, Mason University College, Birmingham; G. W. S. Driver, St. Mary's Vicarage, Worcester; G. G. Ede, East Lodge, Rogate, Petersfield, Hants; F. C. Higgs, The Willows, Brierley Hill, Staffordshire; A. H. Jones, 60, Leander-road, S.W.; A. H. King, 118, Bridge-road West, Battersea, S.W.; E. R. Verity, 8, Bolton-road, Harleeden, N.W.

CITY OF LONDON (VARIOUS POWERS) BILL.

The consideration of the City of London (Various Powers) Bill by the Select Committee of the House of Commons of which Sir William Houldsworth is chairman, gave rise to some interesting evidence both in favour and against Part VI. of the Bill, under which power is sought to construct public service works in, over, or under the streets in the City. There was a large number of opponents to this part of the Bill, including the Charing Cross and Strand Electric Lighting Company, on whose behalf Mr. Wilmot Seale, secretary of the company, gave evidence. The company, he said, feared the powers which the clause would confer on the Corporation, because it would enable the officers of the Corporation to dictate and control the system of supply and the working of the undertaking, the powers being such, in fact, as no public authority hitherto had been allowed to exercise in connection with electric lighting.

SIEMENS ENGINEERING SOCIETY.

The annual conversazione of the engineering society connected with Messrs. Siemens Bros. and Co. was held in the Charlton Assembly Rooms on Wednesday last, and was well attended. The usual programme of music and recitations was varied by demonstrations on "The Capabilities of the Phonograph" and "The Properties of Vortex Rings." In a side room there were also given some interesting experiments on vacuum tubes, wireless telegraphy, chloride plates, etc. A great deal of attention was attracted by a Blackburn pendulum used to trace out curves in sand on a blackboard. A cinematograph display was also given, in spite of the stringent rules of the London County Council. These rules were avoided by keeping the whole of the apparatus outside the assembly room and projecting the pictures through a window. Invitations were issued by the council of the society to many past members who are not now on the staff of the firm; in this way the conversazione afforded a good opportunity for renewing old friendships.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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ELECTRICAL DRIVING OF FACTORIES.

The paper of Mr. Gibbings on this subject contains information, surmises, and suggestions. The information is valuable, the surmises debatable, and the suggestions acceptable. Mr. Gibbings has introduced another bone of contention as to our backwardness in adopting the apparatus paraded by electrical engineers. Our "technical instruction" is at fault. Continental folk are in a better position to learn—they do learn; they apply their acquired knowledge, and they go ahead. All this forms a very pleasant topic upon which to sermonise, but we doubt if it has any reality in fact. There are none so blind as those who will not see, and ofttimes, in the effort to appear occult, the preacher labours in any and every direction except the plain, straight road before his eyes. There is no necessity to deride technical education in this country, or the pure cussedness of owners of factories. The reason for backwardness is far more simple, and wholly natural. Indeed, the wonder would be were the condition of things other than they are. In the first place, ask the question, During what period of years electric transmission has been possible has transmission been practical? Perhaps possible during a score of years at the outside; practical, say, half that time. Imagine a factory equipped fifteen years ago—was there a single electrical engineer of repute, or any other engineer, who would then have advised an electrical motor equipment? Emphatically, no. The factory would have had steam at the cost of five or ten thousand pounds, or any other number of pounds. Again, was there any sane engineer who would have advised the owner of that factory ten years ago to scrap his steam plant and substitute electrical motors? and again the answer must be "No." Proceed to a time five years since, and the building and equipment of a new factory to compete against the other one. Now, perhaps, the wise engineer would have installed an electrical equipment, and justly so. He would have no scrap heap to consider, only the latest and best of everything. Think over a few simple problems of this kind, and enquire about the period since which competition became keener and keener. Seek further to know whether on the Continent or in America the greatest utilisation of electric transmission has not been in new developments, new departures, and, to a less extent, in substitution. It will be found that electricity has not, either on the Continent or in America, in a wholesale manner ousted steam where steam was in possession; it has been installed where steam was not. No factory can afford to scrap-heap its apparatus upon the appearance of every improvement, and the people who are so eager to get owners to do this are the very people who have not studied the economical question. In special cases, in new equipments, the best, whatever it is, can be installed. Yet the best of to-day ought, according to many theorists, to be consigned to the scrap heap to-morrow. Even with lighting apparatus, which twenty years ago—aye, till ten years ago received far more attention than transmission apparatus,

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the ten-year-old central station is not the equal of that equipped to-day. We hold, then, that it is neither to British conservatism, nor to the want of technical instruction, nor to any other outside cause, that electric transmission in England is in a backward state, but to a very natural law which underlies all business progress. Now, let us for a moment consider the natural law which governs substitution. Assume that the factory has a steam or gas plant. This plant in the valuation of assets is estimated to be worth a certain sum. If it can be sold for that sum, well and good, but if everybody goes in for substitution that estimate is not realisable. The capital account includes the amount of the estimate, and upon that amount of capital dividend has to be paid. Hence the conditions of things is that the apparatus substituted must not only earn dividends upon its own capital account, but an extra profit to provide dividend upon the capital lost by the act of substitution. The figures given by Mr. Gibbings in his tabular statements show substantial profits, but although we imagine the profits to be real, these figures do not show it. The abstract is one thing, the concrete is vastly different. A little more elaborate argument is required to indicate what takes place when the substituted apparatus is hired, but we have to come to the result that the gross saving has to provide something on account of lost capital. The net saving will be the gross saving less the cost of hire and the amount required by dividend on lost capital. The conditions surrounding many smaller power plants are altogether favourable for substitution, especially where the hire rather than the purchase system obtains.

POWER BILLS.

The Hybrid Committee appointed by the House of Commons to consider the Distribution of Power Bills will hold its first meeting on May 3. The members of the committee are: Sir J. Kitson (Colne Valley) chairman, Sir A. R. Scoble (Hackney), Mr. G. C. T. Bartley (Islington), Mr. T. G. Ashton (Bedfordshire), Mr. J. Howard (Middlesex), Mr. A. Billson (Halifax), and Colonel C. W. Long (Worcestershire). The five Bills which are to be considered by the committee are the Durham Electric Power Bill, the Tyneside Electric Power Bill, the Lancashire Electric Power Bill, the South Wales Electric Power Bill, and the Shannon Water and Electric Power Company's Bill. It will be seen that the members of the committee do not represent areas directly interested.

THE RATES OF CHARGES OF THE CITY OF LONDON ELECTRIC LIGHTING COMPANY.

Just as we go to press we see from an advertisement that the City of London Electric Lighting Company has again decided to revise its rates of charges. This revision was hinted at at the annual meeting of the company, and was, we understand, definitely decided on at a Board meeting held this week. If the company in question continues to alter its rate of charges as frequently as it has done in the past, it can only expect great dissatisfaction amongst its customers. Thus, at the beginning of last year, the charge per unit for energy used for electric lighting was practically 7d. per unit, as six units had to be consumed in any quarter per 8-c.p. lamp fixed before any reduction was made in the price per unit. In view of the fact that the majority of the consumers only use their lights five days per week, this was equivalent to an average consumption of more than three hours per day of their total number of lamps fixed. In consequence of the threatened competition of the Charing Cross and Strand Electricity Supply Corporation a revised scale was introduced in July last, and made applicable to all electricity consumed from after the June quarter. Under the rates then fixed the consumers had the option of taking the supply for light by one of two methods. In the first the charge was 5d. per unit for any amount up to a number of units equal to the number obtained by dividing the number of watts in the maximum power demanded by 10, and 4d. per unit for all units above this amount. In the second scale an all-round price of 4½d. per Board of Trade unit was allowed. In consequence of the great reductions given by these rates the number of consumers connected to the mains has increased very largely. These consumers will naturally consider that the company has taken an unfair advantage of them when they see the new scale of charges, which are to be enforced after the expiration of the present quarter. The following is the company's statement of these new rates: Every customer will be charged for the current which he may consume up to 12 units per annum per 8-c.p. lamp fixed (or its equivalent) at the rate of 8d. per Board of Trade unit. All current consumed in excess of the above-mentioned 12 units per 8-c.p. lamp will be charged at the very low rate of 2d. per Board of Trade unit. The company adds that the effect of this system of charge will be that those consumers who use their lamps for long hours will greatly benefit, according to the periods for which they employ their lamps, whereas those customers who use their lamps very occasionally, and then only for short periods, will have to pay a more equitable proportion of the cost of supplying them. Twelve units per annum are approximately equal to one hour's average daily use of an 8-c.p. lamp.

They also state that in cases of mixed installations of many long-hour and few short-hour lamps suitable arrangements will be made upon application, so that such consumers may derive the full benefit of the scale in respect of their long-hour lamps.

TABLE I.—Comparative Cost per Unit to a Consumer using all his lights seven days per week for the average time per day mentioned in the first column.

Average lighting, hours per day.	Price per unit. Old rate.	New rate.
1	5d.	8d.
1½	4·72d.	6·4d.
2	4·55d.	5·26d.
3	4·37d.	4·2d.
4	4·27d.	3·65d.
6	4·18d.	3·06d.

TABLE II.—Comparative Cost per Unit to a Consumer using all his lights five days per week for the average time per day mentioned in the first column.

Average lighting, hours per day.	Cost per unit. Old rate.	New rate.
1	5d.	8d.
1½	5d.	8d.
2	4·77d.	6·63d.
3	4·51d.	5·06d.
4	4·38d.	4d.
6	3·52d.	3·52d.

In order to see how these new rates will compare with those which have been in force during the last nine months, we have prepared two tables, which we give herewith. The first point which strikes one in perusing the new scale is that the reduction from 8d. to 2d. per unit is only made when the total consumption for the year exceeds 12 units. Under the old rates a sliding scale was applied to each quarter's bill, independent of the consumption for the quarter previous. In this way, while in the winter the light was obtained at a considerable reduction, in consequence of the large amount of electricity consumed, in the summer quarter the consumption might not be sufficient to give any electricity at all at the low rate. Under the new scale this is not so, and while most consumers will have to pay 8d. per unit for the energy consumed in the summer months, they will also have to make up their total consumption to 12 units per 8 c.p. lamp fixed per annum before any

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reduction is given in the winter. In making the comparisons between the cost of supply under the old rate and the new rate, we have not allowed for the above consideration, as it is exceedingly difficult to ascertain a fair average case of the relative consumption in summer and winter. In this way our calculations as to the cost per unit at the old rate will be, as a rule, slightly higher than would obtain in practice. The first table gives a comparison of the cost per unit on the assumption that the consumer uses his light every day in the year. It will be seen from this that such a consumer has to burn the whole of his lamps for an average of three hours per day throughout the year before he obtains his electricity as cheaply on the new system as on the old, and it must also be remembered that the flat rate of 4½d. per unit applies to all consumers, so that in may cases the electric lighting bills will jump up 78 per cent. The second table is calculated on the basis of the lights being used only five days per week, as is the case in a very large proportion of the consumers on the City of London Electric Lighting Company's mains. Thus all such places as offices are closed on Saturday evenings and also on Sundays. It will be seen from this that at least 3½ hours' consumption of light by the whole number of lamps installed is required in order that the new rates may not entail a heavier bill per annum than formerly. The new scale can be criticised from two points of view—the electrical engineering and the commercial. From the first we agree that the directors may fancy they have adopted a scientific basis for their charges, inasmuch as the consumer has to pay at a high rate until a fixed sum of 8s. per lamp has been earned. The fault, however, is in the basis of reduction, which should be the maximum supply demanded rather than the equivalent 8-c.p. lamps fixed. The present basis discourages the extension of lighting, and opens a wide door for corrupt practices. The man who uses 32-c.p. lamps instead of 16-c.p., and keeps his application form unaltered, will defraud the company; and, again, anyone who tries to economise by replacing 16-c.p. lamps by 8 c.p. will defraud himself. In either case disputes will arise which could and should be avoided. From the commercial point of view, the directors of the company are to be strongly condemned. They appear to have no definite opinion to guide them in their business, and to make changes when they do more harm than good. A prompt reduction might have averted the threatened competition last year, but it was only given after the competing order was practically granted. The present step will give every assistance to the Charing Cross and Strand Company in financing their City undertaking, and will further increase the bad feeling which exists between the City of London Electric Lighting Company and their consumers.

ISLINGTON VESTRY'S ELECTRIC LIGHTING LOANS.

At the Islington Vestry Hall last week a conference, convened by the Islington Vestry, of vestries and district boards of the Metropolis who have electric lighting undertakings was held for the purpose of considering matters connected with the delays in getting electric lighting loans sanctioned by the London County Council.

Out of nine or ten vestries eligible there were represented eight—namely, Islington, Fulham, Hammersmith, Hampstead, Newington, St. Pancras, Shoreditch, and Whitechapel.

Mr. G. S. Elliott, L.C.C., who was voted to the chair, opened the proceedings and explained the position. He stated that the London County Council refused to sanction the loan because Islington had not supplied the details asked for. He agreed that if that was so the County Council was in the right, but on investigating the matter he found that the Vestry had done all that they could to satisfy the officials of the superior authority. Many plans and documents, as well as 17 pages of closely printed specifications, had been sent, and still the County Council was not satisfied, notwithstanding that in the case of West Ham they sanctioned a loan of £50,000 with very little explanatory matter. The officers of the Council appear to have criticised the details, and ultimately agreed to sanction loans for £10,000 and £38,000 in the place of loans of £13,200 and £56,261 which the Vestry asked for. The Vestry therefore declined these loans, and called a conference of local authorities placed similarly to the Islington Vestry to discuss the position.

Mr. W. F. Dewey, vestry clerk of Islington, read a letter from the London County Council intimating that it would not be doing its duty if it sanctioned borrowing by local authorities on estimates furnished by such authorities without being satisfied from the reports of its own officers that the amounts proposed to be borrowed were reasonable.

Mr. Dryden, chairman of the Finance Committee of the Islington Vestry, moved a resolution to the effect: "That this conference of representatives of local authorities in the Metropolis, who are also electric lighting undertakers, is of opinion that the procedure of the London County Council in connection with sanctions to loans for electric lighting purposes is not warranted by statute or by the practice of other sanctioning authorities, and that such procedure tends to undue delay in the carrying out of important works as well as to unnecessary expense and waste of official time on the part of the local authorities engaged in such works." He said that the Local Government Board had recently sanctioned very large loans for public baths in Islington, and yet had not demanded minute details of the work to be done.

Mr. Green, of Fulham, seconded.

Delegates from Shoreditch and Newington objected to the words "by statute or" in the resolution, as suggesting that the London County Council were accused of acting illegally.

Other delegates supported the resolution, which was ultimately carried by 21 votes to 1.

Mr. R. Gordon then moved: "That, in the opinion of this conference, the practice of the Local Government Board of holding a public enquiry in the locality by a competent inspector, at which opportunity is afforded to ratepayers who may object to attend and state their objections, and where, in the absence of such objections or other special circumstances, the *ex parte* evidence of the officials and experts of the authority applying for the loan is accepted as sufficient to justify the application, should be followed by the London County Council."

There was considerable opposition to this motion, it being thought by some of the delegates that the vestries would be surrendering some of their powers if the resolution were passed, and that the Local Government Board procedure was much preferable to that of the London County Council.

On a show of hands the voting was equal, and the motion dropped, the chairman declining to give the casting vote.

On the motion of Dr. Robinson, of Shoreditch, the following additional resolution was agreed to: "That the London County Council be requested, in their forms for detailed particulars, to follow the Board of Trade forms, so as to harmonise with the book-keeping system in which electricity accounts are bound to be kept."

This was agreed to unanimously, and it was further decided to send copies of the two resolutions passed to the County Council.

A vote of thanks to the chairman closed the proceedings.

DUBLIN ELECTRIC LIGHTING.

On Friday last Mr. P. C. Cowan, chief engineering inspector of the Local Government Board, opened an enquiry in Dublin in connection with applications for various loans proposed to be raised by the Corporation. The principal loan proposed was for £254,000 for electric lighting. A number of expert witnesses are to be called in connection with this application, and counsel have been briefed on both sides. Thus Messrs. S. Bushe, Q.C., M. C. Macinerney, Q.C., and P. O'C. White appeared for the Corporation; Messrs. T. M. Healy, Q.C., M.P., and J. M. Day appeared for the ratepayers opposing the application; and Mr. D. O'C. Miley appeared for the Dublin Electric Light Syndicate.

Immediately the enquiry was opened applications were made both on behalf of the ratepayers and on behalf of the electric light syndicate. The ground for the first application was that sufficient time had not been given in the notice to enable the expert witnesses who were to be present to arrive. The Solicitor of the Dublin Electric Light Syndicate explained that they had a Bill now before Parliament for the lighting of Dublin, which had not yet passed the second reading. It was ultimately decided to take the other matters first, and leave the loan for electric lighting till the end of the day. When these other matters had been discussed, Mr. Kerrigan, city accountant, stated that the total expenditure by the Corporation up to Dec. 31, 1899, on electrical works was £84,171. 11s. 9d. The best revenue they had in any year was £5,052. The last two years were especially bad ones, due to causes which could be explained by the engineer.

Alderman Meade, chairman of the Electric Lighting Committee, stated that the idea was to have the best possible system of electric lighting in the most economical way. Until last session the Corporation had not power to borrow money in order to comply with their provisional order and supply the citizens with electric light. As soon as they got power they

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set about the work and got the best scheme they possibly could. Referring to the Pigeon House as a generating station, it was, he thought, most suitable for the purpose. The Corporation would be able to generate and supply electric light cheaper than anyone else could do it.

The enquiry was then adjourned to Tuesday.

The first witness called on Tuesday was Mr. ROBERT HAMMOND, who is now advising the Dublin Corporation on electrical matters. He explained that in the early days of electric lighting the Fleet-street site would be considered a good one, but with the great increase in the demand for light an alternative site became necessary. He considered that the difficulty of the distance between the centre of supply and the generating station was entirely got over by means of the system he proposed. In fact, economical generation was the most important consideration in the selection of the Pigeon House site. This site was about three miles from Fleet-street, where, as in the case of the London Electric Supply Corporation, the generating station was five miles from the area of distribution. He explained how convenient the Pigeon House site was in providing facilities in obtaining seaborne coal, and also ample water for condensing purposes. Of course, the sea-water would not be used in the boilers. There was also ample room at the site for extensions, and the works would not cause annoyance to anyone by smoke or vibration. He proceeded to give details of his scheme. The generating works are to be designed for the supply of 100,000 lamps of 8 c.p. The transmission to Fleet-street will be at 5,000 volts on the three-phase system, and some 19 sub-stations are proposed, which will receive their supply from Fleet-street at the same pressure. Mr. Hammond proceeded to read some statements from a circular by Mr. A. Wright, of Brighton, with respect to the advantages of a somewhat similar scheme for that town. It was explained that Mr. Wright was present, and that he was called on behalf of the ratepayers. Mr. Hammond said that Mr. Wright estimated the cost per unit delivered in Brighton at 1·68d., but he hoped in Dublin to deliver electricity into the city at ¾d. per unit. He estimated the total earnings under his scheme at £38,500, and reckoned on a gross profit of about £22,000. He also explained that he proposed to utilise the old system of feeders and distributing mains round the Fleet-street station and that there would be no difficulty in joining up between the new system and the old.

Cross-examined by Mr. Healy, Mr. Hammond said that he was aware that the Pigeon House site was outside the jurisdiction of the Corporation, but he knew it was in the county of Dublin, and that the Bill for extending the area of the city would bring it within the city boundaries. With reference to Prof. Kennedy's remarks on the Pigeon House site, Mr. Hammond contended that the difference of opinion was only based on the idea that a more convenient site might have been obtained elsewhere. In Rathmines and Pembroke he had used the continuous-current system because he considered them best for the areas in question. If the Boundaries Bill was not passed they could get the right from the authorities interested. Of the three mains which he would provide from Pigeon House station to Fleet-street, one would be a stand-by, and the other two would be able to deliver 2,600 kw. between them. The loss in the mains might be about 10 per cent. He had added the money already spent in Fleet-street station—*i.e.*, £18,000—and that already borrowed, and had found that there would be a profit on the whole amount. He had included the question of the foundations on the site, and had included all necessary works in his estimates.

Re-examined by Mr. S. H. Bushe, Mr. Hammond said that, owing to Prof. Kennedy having to go to the States on professional work, he had been appointed in Dublin on Prof. Kennedy's recommendation. The whole controversy between low-tension continuous and high-tension alternating currents was closely connected with the size of the area to be supplied. In small towns he advocated the low-pressure system. With respect to the controversy as to whether continuous-current or alternating-current arc lamps were better, he had provided a sufficient amount to use either in Dublin. On this question of arc lighting Mr. Hammond remarked that the result of electrically lighting the city at night was to put down crime and reduce the number of police. An arc lamp was equal to one policeman.

Mr. HEALY here interposed with the statement that, whatever happened, they might take it for certain that the number of police in Ireland would not be reduced.

In answer to a question from the inspector, Mr. HAMMOND spoke as to the advantage of being able to make extensions when needed.

On the enquiry being resumed on Wednesday, Mr. R. HAMMOND called attention to other places abroad in which the system proposed by him for Dublin was in use. He particularly referred to the case of Montreal, and to the transmission from the La Chine Rapids on the St. Lawrence to that town. In this case four 1,200-h.p. 5,500-volt generators were used with a frequency of 60 complete periods per second. The system was a three-phase one. At the present time about 1,500 motors were supplied from the lighting circuits in Montreal at low pressure. He also referred to the report made with respect to the success of a similar system in New York.

Mr. S. Z. DE FERRANTI said he had carefully considered Mr. Hammond's scheme, and believed it was quite capable of giving light to the city on a commercial basis. The reasons for having the generating works outside all large centres of population were sound, and the practice was followed all over the world. He agreed with Mr. Hammond's statements as to the advantages of the Pigeon House site. He then went into the system in detail, explaining that it was a most economical way of supplying Dublin with light and power. Dealing with the question of the conversion from the three-phase system to the single-phase for the old district, Mr. Ferranti stated that the chief difference in the change over would be in the frequency. He considered that the consumers would derive considerable benefit from the reduction of the frequency from 83 periods, as at present, to 60. The lower frequency would allow single-phase motors to be employed, as was the case in Frankfort, where close on 2,000 h.p. for single-phase motors was supplied from the lighting circuit. He agreed with Mr. Hammond's comparisons as to the cost of gas and electricity—*i.e.*, that electricity at 6d. per unit would be equal to gas at 3s. per 1,000ft. The proposed price of 4½d. would thus be a great inducement to consumers to come on to the electric system. In cross-examination, Mr. Ferranti pointed out that while the loss in the trunk mains at full load would be 4½ per cent. with two mains, it would be reduced to 3 per cent. by having the three mains on. The mean loss throughout the day would probably be only 1 per cent of the whole energy supplied. He estimated that the net loss of the year between the generating station and the consumer would be about 12 per cent., but this would not affect the regulation of the system. The maximum loss at full load would be 12½ per cent. of the maximum power supplied, whereas in the other systems proposed it would be higher.

We are indebted to the *Dublin Evening Mail* for the report of the enquiry from which the above abstract was taken.

ELECTRICAL DRIVING OF FACTORIES FROM THE PUBLIC POINT OF VIEW.*

BY A. H. GIBBINGS, M.I.E.E.

It may be stated without fear of contradiction that almost every manufacturer or user of machinery in this last year of the nineteenth century, is more or less acquainted with the fact that electricity can be employed for the transmission of power. But beyond this general statement it is unsafe to venture an opinion as to the extent to which the uses or the possibilities of electric motive power are understood, even in a vague and indefinite manner. We may even go still further, and state that the percentage of machinery users who have used or who are using electric motors is very small indeed. This number is, however, increasing rapidly day by day, owing to the great extensions of electricity supply cables in the various towns, and the inducements in the form of cheap rates of supply and the renting out of motors which are offered by the owners of some supply undertakings. By the kindly response of central-station engineers, municipal and otherwise, I have been able to prepare the inserted list (Table I.), which shows the extent to which the electric motor has already been adopted in various places. Notwithstanding the progress which is indicated in this list, it is apparent that much better results should have been obtained, considering the number of years during which many of these central stations have been in operation. There can be no question that in America and on the Continent, wherever the same advantages are in existence, the electric motor has been very much more freely utilised.

It is impossible to come face to face with such a significant state of affairs without asking one's self the pertinent question, Why is it? Much undoubtedly may be ascribed to our natural conservatism and our unique position in the world of commerce, and something also to legislative and insurance restrictions. Further, a great deal of our slowness in adopting this modern method of driving machinery is undoubtedly due to the considerable capital outlay required in making any change of a complete and radical nature; and, in fairness to ourselves, it must be borne in mind that against this common factor of capital cost must

* Paper read before the Northern Society of Electrical Engineers, March 13, 1900.

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TABLE No. 1.—TABLE SHOWING THE EXTENT TO WHICH THE ELECTRIC MOTOR HAS BEEN ADOPTED IN VARIOUS PLACES.

Name of Local Authority or Company	Number of Motors on Mains			Aggregate Horse Power	Number of Units Sold for Motive Power in 1899	Price per Unit Charged	Remarks
	On hire	Not on hire	Total				
Aberdeen	7	—	—	156½	—	3d. 1st hr., 1d. after	According to the Brighton Rebate system of charging
Ayr	—	2	2	12	—	3d.	Only connected recently
Barking Town (Essex) ...	—	2	2	17	—	Not yet settled	Be connected in a few days
Barnsley	—	10	—	50 b.h.p. probable demand	—	7d. first hour max. demand, 1½d. after. Consumers of 10,000 and upwards 7d. first hour, 1d. after	There is a probability of large demand in the near future
Barrow-in-Furness ...	—	10	10	46	3,726	6d. 1st hr., 1½d. after	Nine months—March to December. Wright's system of charging. Several of the motors were not connected until towards end of year, hence small number of units sold
Bath	—	5	5	6	1,303	3d.	
Bedford	—	10	10	65½	95,000	3d.	
Belfast	14	41	55	268	74,000	4d. 1st hr., 1½d. after	Other 88 h.p. applied for
Birkenhead	—	5	5	16 b.h.p.	4,489	3d. and 6d., 4d. per B.O.T. unit, with reduction to 3d. after 1½ hours running on Brighton system	
Blackpool	—	7	7	14	1,100	2½d.	Motors are supplied with current from the Tramway's mains at 500 volts
Blackburn	40	12	52	145	39,209	2½d. and 1½d.	All the motors have not been running a complete year; in fact some have only been used since October and November
Brighouse	—	6	6	15	—	5d.	Motors not been connected during the whole 12 months
Brighton	—	150	—	—	—	—	Current not separately registered
Bristol	6	26	32	100	58,906	1½d. discount up to 20 per cent. minimum, charge 25s. per kilowatt per quarter	A supply of continuous current 250 or 500 volts, has just been commenced, 30 of the 32 motors are joined to alternating mains. Largest motor 30 b.h.p.
Bury	—	12	12	33	5,510	Jan. to June, 1899, 2½d., then altered to 3d. 1st hour, and 1d. after	
Canterbury	—	4	4	3½	—	3d. per B.T.U., with discount	Only running nine months. Don't expect much of a motor load here
Cardiff	—	11	11	12½	4,550	2½d. and 2d.	4½ h.p. fixed Dec. last. 4 h.p. drive fans which have not been in use much. Could have more if let out on hire
Carlisle	—	46	46	159½	374	2d.	Three consumers only
Cheltenham	—	3	3	4½	1,836	3d.	There are also 3 or 4 motor-fans, 3 being 18 in. fans; the units for these are not included, as the customers have not separate circuits for them
Chester	—	38	38	94	15,666	2½d. to 1½d.	On sliding scale according to quantity
Coventry	—	6	6	12	1,569	Units used per quarter for each kilowatt demanded up to 220, 4d.; above 200 and up to 520, 3d.; above 520, 2d.	
Croydon	—	7	7	8½	—	7d. and 2d.	Demand Indicator system
Darwen	—	9	9	8	—	3d.	Hardly working last year
Derby	—	31	31	146	39,929	3d. and 1d.	
Dewsbury	—	9	9	25	2,437	3d.; 1½d. charged after first 3 hours	
Dublin	—	3	3	6	—	5d.	Practically no motor work is done. The motors used are only for ventilating, and not separately metered
Eastbourne	—	12	12	10	—	4d.	550 units sold at 4d. on separate meters, all other small motors are on same meters as the lights, and are charged at same rate, viz., 7½d. per unit
Ealing	—	4	4	8½	3,000	3d.	
Edinburgh	—	—	385	—	413,920	1½d.	
Exeter	—	3	3	4	371	3d.	Special rate for motors only just put in force
Glasgow	—	76	76	282	81,924	6d. to 1½d.	Results at 31st May, 1899, end of financial year. Charges are according to voltage:—100 v., 6d. and 2½d.; 200 v., 6d. and 2d.; 250 v., 6d. and 1½d. Consumers averaging 5 hours per day at full load are charged 2½d., 2d., and 1½d. for all units
Halifax	3	9	12	68	9,450	2½d., less 15 per cent.	Nearly the whole of these motors are on a special direct current power main laid last August. Alternating current motors have been discarded. Large number of motors waiting to be joined up when system is changed to direct current
Hanley	2	9	11	25	2,518	2½d. and 1d.	First 4 hours per day are charged at 2½d., all after that at 1d. per unit
Hampstead (Vestry) ...	—	5	5	11	—	6d. and 2½d.	6d. first hour
Harrogate	—	2 large Motors & about 12 small Fan Motors	14 (about)	50 (approximate)	60,355	3d. and 2½d.	
Hastings	—	3	3	1½	About 500	6d. for 1st two hours and 1½d. beyond	No demand for motors except for lifts
Huddersfield	14	25	39	88	48,935	2½d. 1st two hours, 1d. afterwards	Showroom opened in 1894 for purpose of exhibiting heating, cooking, and motive-power appliances, which have been since that date let out on hire
Islington	—	3½	—	—	About 1,000	3½d.	Same after dark as for day supply. District not a manufacturing one
Kingston-upon-Thames ...	—	3	3	6	—	3d.	Have only been installed a few weeks
King's Lynn	—	2	2	1½	19	3d.	Motor only just connected. Station has only been running four months
Lancaster	—	35 (about)	—	150	27,562	3d.	
Leeds	—	30	—	86	19,465	2d., less 5 per cent.	
Leith (Scotland)	—	15	—	151	42,936	1½d.	This is only the first year of supply. We started on 16th February, 1899. Most of the power is taken by a firm of motor makers, who use it for testing purposes as well as driving their machinery
Lincoln	—	3	3	7	4,744	6d. first hour, 2½d. afterwards	The motors are used for driving the blowing apparatus at the Cathedral
Liverpool	—	237	237	770	226,880	2d. for first 3,000 and 1d. in excess of 3,000 per quarter	
Manchester	—	464	464	1,691	—	2½d. and 1½d.	Cannot state number of units sold, as a portion of energy for motive power is sold through lighting meters
Morley	—	5	5	22	816	3d. per B.T.U.	
Newington	—	3	3	18	1,975	2½d.	Number of units sold in less than half-year
Newport (Mon.)	—	5	5	9½	630	2d. up to 3,000 and 1½d. after	Single-phase alternating motors. Continuous not yet connected

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TABLE No. 1 *(continued)*.—TABLE SHOWING THE EXTENT TO WHICH THE ELECTRIC MOTOR HAS BEEN ADOPTED IN VARIOUS PLACES.

Name of Local Authority or Company	Number of Motors on Mains			Aggregate Horse Power	Number of Units Sold for Motive Power in 1899	Price per Unit Charged	Remarks
	On hire	Not on hire	Total				
Nottingham	—	—	125	450	113,000	Price from Jan. to March 2d. and 1d., Wright's system. Since Mar. 1899, 1d. 7d. and 3d.	
Paisley	—	1	1	6	—		7d. applies to 1 hour daily
Portsmouth	39	14	53	72	19,309	2½d.	
Plymouth	—	2	2	3	—	2 large consumers at 2d. 4½d.	
Salford	—	30	30	200	29,000	3½d. first hour, 1d. afterwards	Cannot distinguish from lighting a/cs. Supply only started in Sept. 1899. Figures do not include traction motors
Sheffield	—	23	23½	30	6,862	2d. and 1d.	About 1,000 h.p. has been applied for, but cannot be connected until our new station is ready
Shrewsbury	—	8	8	29	—	4d. Over 600 units per quarter 3d.	25 per cent. of these motors have been on circuit only a few months
Southport	—	7	7	9	About 200	6d. and 2d.	Practically no motors were fixed here 9 months ago when I came to Shrewsbury. I think we will get several more. Largest size fixed 12 b.h.p.
South Shields	—	1	1	2	—	3d.	Just started
St. Helens	6	2	8	23	2,080	2d.	Supplying current since June last
Sunderland	—	39	39	356	104,190	2½d.	The figures given represent the number of motors connected up to Jan. 30th, 1900.
Taunton	—	12	12	24	About 850	2d.	Changed the periodicity of station from 125 cycles to 60 cycles per second last June; consequently had no motors before change of plant. We are now pushing the use of motors. Corporation do not let out on hire
Tunbridge Wells	—	1	1	2	—	3d.	Alternating current
Wallasey	4 (On F. Wiring System)	1	5	10	1,246	3½d.	Every consumer well satisfied
Walsall	—	19	19	52	12,921	2½d., with 10 per cent. discount, for 10,000, and 12½ per cent. for 15,000 2½ per cent. for cash within a month	
Watford	—	1	1	1	—	8d. first hour, 1½d. afterwards	Wright's max. D.I. system. Had not commenced continuous running in 1899
Whitehaven	—	4	4	17	1,610	3d.	One motor only connected during 1899. Reduction of price probable
Wolverhampton	—	16	16	26	5,504	1½d.	Out of the total of 26 h.p. some 15 h.p. was connected in the last quarter of 1899
Worcester ...	5	5	10	66	118,527	1½d. to the Waterworks; 3d. and 1½d. on Brighton system if in excess of 1 hour's use of max. demand; 6d. if total units less than 1 hour's use of max. demand	
Great Yarmouth	—	7	7	21	1,312 (to Mar. 31st, 1899)	3½d.	
Allerton, Woolerton and Childwall	—	1	1	1½	Not recorded	4d.	Residential neighbourhood
Great Crosby and Waterloo	—	1	1	¾	Not recorded	3d.	Residential neighbourhood
Birmingham	—	186	186	475	—	4d. for first 100 units consumed per month, 2d. for subsequent quantity	
Bournemouth	—	7	7	5	—	3½d.	Not an industrial centre
Burton-upon-Trent ...	—	1	1	½	—	2½d.	
Cambridge	—	4	4	7½	—	—	There are 3 small motors of ½ h.p. each which receive current through the lighting meter, and so their total is included with the lamps and charged 7d. first two hours and 3½d. after on the max. demand system. There is one 6 h.p. motor which is charged for at 3d. per unit
Chelsea	—	25	25	102	10,318	3d.	
Crystal Palace District ...	—	3	3	100	404	5d.	Two of these motors are used for pumping purposes practically only during the summer months, and the other is for working a dinner lift
Folkestone	3	3	6	18	—	7d. and 1d. Wright's for the 1 h.p., and 8d. for the lifts	
Galway	—	4	4	5	2,617	3d. per hour	Others supplied by contract
Guildford	—	2	2	5	69	3d.	Only one motor actually in use last year, 1899
Hove	—	23	23	49	19,403	3d.	The town is entirely residential, therefore there is little use for motors
Kensington and Knightsbridge, London, W.	—	20	20	75	—	4d.	Residential and not a manufacturing district. Electric lift motors
Lambeth	—	13	13	30½	1,415	4d. less rebates, according to consumption	The motor demand is rapidly increasing since station was opened in September, 1899
Mardy	—	2	2	¾	—	—	Fixed price per quarter
Newcastle-on-Tyne (Newcastle and District Electric Lighting Co.) ...	—	11	11	85	—	2½d. to 1½d.	Cannot separate the units sold for power, as in certain cases contracts exist for a term of years, and the price is for all purposes
Northampton	1	13	14	50·5	5,765	3d. for first 3 hours, 1½d. after.	
Norwich	13	84	97	358	240,138	3d. for first 500 used in a quarter, 2d. for the 2nd 500, and 1½d. for anything over 1000	Revenue for 1899, £2,044. These motors give a load at Central Station of about 70 kilowatts as near as can be estimated
Notting Hill	—	7	7	21	3,091	4d.	
Oswestry	—	1	1	3	—	—	A considerable length of main had to be laid for this motor only. The motor drives a pump which lifts sewage from a low-lying level, and the Corporation pay £30 a year for current
Pontypool	—	2	2	½	—	6d.	These motors are run through the lighting meter, as cost of extra meter would be more than saving in cost of electricity at lower price—3d. per unit
Reading	—	17	17	88	9,074	3d. to 2d. for motors under 4 b.h.p., 1½d. for 4 b.h.p. and upwards	Three months trial here only. Nominal rental with optional purchase at end of time. Continuous current system only started in 1899; no motors connected before. A large increase in prospect.
Richmond (Surrey) ...	—	2	2	1	180	4d.	No manufacturing here of any sort; town purely residential. We have, however, a considerable sale of current for launch and motor-car recharging of batteries
Salisbury	5	1	6	5½	£15 3s. 0d. (revenue)	4d. first hour, 1½d. after	Motor load is very small at present, but hope that it will increase
Scarborough	—	4	4	9	258	2½d.	We have only started a special rate for motors this last summer; the first motor was started July 29th and the second in November, which accounts for the small number of units sold
Windsor	9	—	9	31·5	9,124	4d.	10 h.p. of the amount put down here was not in use until October, 1899
Woolwich	—	4	4	7	—	3d.	These motors have been on for a month or two only, and the units sold last year were very few for motor work
Wycombe	34	1	35	66½	8,917	4d. and 1½d.	We have on order about 50 h.p. of motors

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be set the cheaper and different conditions of labour on the Continent and in America.

I am not at all satisfied, however, in my own mind that the reasons just enumerated are in themselves entirely sufficient to account for our sluggishness in the matter under consideration. Manufacturers generally have ready resources of capital when the outlay can be proved to be in the interests of economy, and electrical engineers have made praiseworthy efforts to popularise these machines, which, as they well know, provide their stations with a day load. I am inclined to think that the principal reason of our backwardness is the better system of technical education which exists in other countries. The effect of a comprehensive system of technical instruction, which is within the reach of every artisan, no matter what may be his trade, is such that the cost of production and factory equipment has been studied more scientifically on the Continent than in this country. The result is that manufacturers have been keenly alive to the merits and demerits of the various methods of power transmission, and they are able to fully appreciate the many details which enter into these problems. I do not propose in this paper to deal with the many advantages which electric transmission of power possesses in comparison with mechanical transmission. They are more or less well known and appreciated. Neither shall I attempt to enlarge upon or discuss the question of the comparative economy of the two systems, in which so many considerations and side issues are involved. This aspect has been treated in a most clear, comprehensive, and characteristic manner by Mr. Raworth, in his recent paper read before the Manchester Society of Engineers, and the full text of which has already appeared in the technical journals. The object of this paper is to present to you a few facts which have been brought to light in connection with the supply of electricity for motive-power purposes during a period of four years from the mains of the Bradford Corporation, in connection with which an endeavour has been made by means of a hiring-out system and advice gratis to popularise and extend the use of electrical driving. I have tabulated the result of that inauguration in Table II.

TABLE No. II.—Number of Motors Supplied from Corporation Mains.

Year	Owned by consumer.	Owned by Corporation.	Total		Board of Trade units sold per annum.
			No.	B.H.P.	
1891	1	—	1	3	—
1892	6	—	6	20	3,222
1893	26	—	26	110	19,346
1894	30	—	30	128	28,884
1895	35	—	35	143	35,919
1896	58	7	65	244	54 972
1897	72	46	118	414	117 176
1898	99	122	221	832	218 974
1899	152	259	411	1,636	463,630

I think you will agree with me that this tabulation is in itself sufficiently explicit without any further detailed explanation beyond the plain statement that the system of letting out motors on hire is the chief factor which accounts for the highly satisfactory results obtained. I would even go further, and say that the hire system is almost the sole factor, as it has undoubtedly directly influenced the adoption of electrical driving by those individuals and firms who own their own motors. The foregoing table gives the results up to the end of December last; but since then, and up to the end of February, the number of additional motors connected has been 88, with an aggregate brake horse-power of 389. Of these 69 were let out on hire. These continued applications clearly indicate two things—viz., the impossibility to stem the demand for cheap and efficient power when the system has been fairly started, and the fact that this latest method of power transmission must be more economical than other existing methods; and hence that its ultimate exclusive adoption is assured through the mere force of business competition.

Behind these general summarised results, however, there exist many details which have proved of great personal interest to me during the four years since the inauguration of the system. The greatly diversified uses to which these electric motors have been applied has necessitated, in the majority of cases, careful personal examination and advice, duties which I need hardly state did not by any means come within the strictly official routine of the city electrical engineer, and which have almost entirely been outside the ordinary knowledge of the Electricity Committee.

(To be continued.)

FORTHCOMING EVENTS.

FRIDAY, MARCH 30.

Electro-Harmonic Society.—At 8 p.m., at Café Monico, smoking concert.

Institution of Civil Engineers.—At 1.45 p.m., students' visit to the works of Messrs. John Bazley White and Bros., Limited, Swancombe.

North East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., at Newcastle-on-Tyne, paper on "The British Naval Engineer," by Mr. D. B. Morison.

SATURDAY, MARCH 31.

Royal Institution.—At 3 p.m., Lecture IV. of six, on "Polarised Light," by Lord Rayleigh, M.A.

MONDAY, APRIL 2.

Royal Institution.—At 5 p.m., general monthly meeting.

Society of Engineers.—At 7.30 p.m., ordinary meeting.

TUESDAY, APRIL 3.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Papers on "Economical Railway Construction in New South Wales," by Mr. H. Deane.

Royal Meteorological Society.—At 3 p.m., at Institution of Civil Engineers. Jubilee commemoration meeting and presidential address, by Dr. C. T. Williams, and conversazione at Royal Institution of Painters in Water Colours, Piccadilly, at 8.30 p.m.

Society of Model Engineers.—At 7 p.m., ordinary meeting. Paper on "Model Boilers," by Mr. J. C. Crebbin.

Society of Arts.—At 8 p.m., paper on "Process Engraving," by Mr. Carl Hentschel.

WEDNESDAY, APRIL 4.

Royal Meteorological Society.—At 11.30 p.m., visit to the Royal Observatory at Greenwich, and dinner at Westminster Palace Hotel at 7 p.m.

THURSDAY, APRIL 5.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper on "The Electrical Equipment of Ships of War," by Mr. C. E. Grove.

Chemical Society.—At 8 p.m., ordinary meeting.

Civil and Mechanical Engineers' Society.—At 8 p.m., paper on "Flywheel Accidents," by Prof. A. Sharp, B.Sc.

Rontgen Society.—At 8 p.m., paper on "The Influence of the X Rays upon the Growth and Development of Micro-Organisms," by Dr. Norris Wolfenden and Dr. Forbes Ross.

FRIDAY, APRIL 6.

Institution of Civil Engineers.—At 8 p.m., students' meeting. Paper on "Experiments on Struts with and without Lateral Loading," by Mr. H. E. Wimperis, Wh.Sc.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper on "A Comparison of Railway Bridge Structures of Moderate Dimensions and of Methods of Determining their Working Loads," by Mr. Eustace W. Porter, A.M.I.C.E.

Royal Institution.—At 9 p.m., discourse on "Solid Hydrogen," by Prof. Dewar, M.A.

SATURDAY, APRIL 7.

Royal Institution.—At 3 p.m., Lecture V. of six on "Polarised Light," by Lord Rayleigh, M.A.

Glasgow and West of Scotland Technical College Scientific Society.—At 7 30 p.m., annual general meeting.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY.

We have received the following statement of electricity generated, sold, etc., by this company during the past year:

City-road Station.

Units generated	1,199,094
Units sold	920,094
Units used on works	29 584
Total quantity accounted for	949 678
Quantity unaccounted for	249,416
Maximum supply demanded (kilowatts)	1,290

Wandsworth Station

Units generated	1,068,230
Units sold	846,421
Units used on works	26,301
Total quantity accounted for	872,722
Quantity unaccounted for	195,508
Maximum supply demanded (kilowatts)	781

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

257. In some dynamos direct-coupled to a steam-engine, the centre line of the field magnet is placed some distance nearer the flywheel than the centre line of the armature. Is this really necessary, and if so, why?—H. V. C.

258. State the advantages of rail welding in tramway work compared with the usual methods of bonding; also state how the strain on rails due to variation of temperature may be ascertained.—F. B. A.

ANSWERS.

Question No. 251.—Three transformers were being connected in mesh, their primaries to three-phase 'bus bars at 2,500 volts, their secondaries to three-phase bars at 320 volts, and by mistake the primary of one transformer was reversed with reference to its secondary. When alternator was switched on to 'bus bars at proper speed and field only 1,500 volts appeared on 'bus bar voltmeter instead of 2,500, whereas when any one of the three transformers were switched out the volts immediately rose to 2,500. Can any reader explain this?

Best Answer to No. 251 (*awarded* 10*s.*).—The low voltage is undoubtedly the result of an excessive and more or less inductive overload on the alternator. The coupling up of the transformers would be as in Fig. 1, and if correctly coupled there would be no sign of a current flowing round the mesh as a whole either on the primary or secondary side, whether the transformer were loaded or not. That this is the case is clearly seen from Fig. 2, which represents the curves of voltage of the three arms of the mesh with their correct phase relations, heights above the axis being voltages in one direction and height below voltages in the opposite direction, round the mesh. From the nature of the relations the algebraic sum of the three voltages taken at any instant will be found to be always zero—*i.e.*, at any moment two of the arms have voltages across them (and carry corresponding currents) in one direction, and the third arm has a voltage and current equal to the sum of the voltages and currents

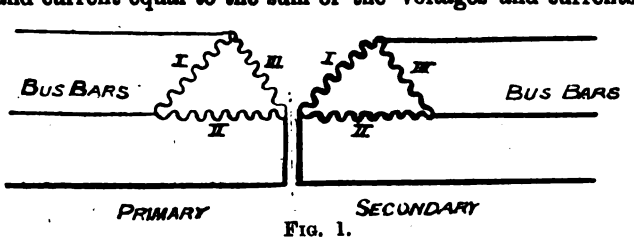

FIG. 1.

respectively in the other two arms and acting in the opposite sense round the mesh, the result, so far as the mesh as a whole is concerned, being nil, though the currents delivered to the 'bus bars may have any value. Consider next the effect of reversing the relative direction of primary and secondary coils on one of the transformers. The secondary voltage curves will now stand as in Fig. 3, assuming arm 3 to be reversed, and it is evident that the sum of the three voltages round the mesh is no longer zero, but varies sinusoidally from 0 up to twice the voltage across one phase, as shown by the tall curve, and has a $\sqrt{M}\,S$ value equal to twice the 'bus bar ($\sqrt{M}\,S$) voltage. This resultant voltage acts only round the secondary mesh quite independently of the position of the incorrect coupling—*i.e.*, whether in the primary or the secondary, for the primary is supplied with its three voltages always correctly in phase direct from the alternator. This would, however, not hold if a single transformer with a common core were used in place of the three separate transformers.

The effect of the above large voltage acting round the low-resistance secondary mesh is, of course, to produce a very large flow of current round the mesh and to draw a corresponding primary current from the alternator. If the transformers are badly designed and have considerable magnetic leakage, the current will increase until the vectorial sum of the back E.M.F. due to leakage (which goes up practically in proportion to the current flowing) and the ohmic loss in the secondary mesh is equal to the voltage acting round the mesh (twice the secondary 'bus-bar voltage). The actual true power taken from the

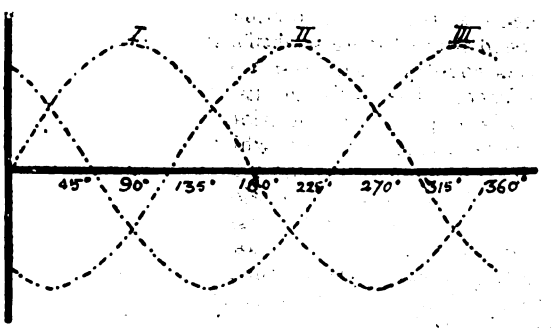

FIG. 2.

alternator may be quite small, the current being considerably out of phase. If, however, the magnetic leakage between primary and secondary coils is negligibly small, the secondary current round the mesh will increase simply according to Ohm's law, and will probably attain a higher value than in the last case, the actual power taken from the alternator being also considerably greater. In the former case the alternator is called upon to give a large current which is fairly inductive; in the latter case a larger but less inductive current, the effect on the alternator voltage drop being about the same in the two cases. The fact that, in the case under consideration, a drop of 1,000 volts occurred without apparently any noticeable drop in engine speed would indicate that the current round

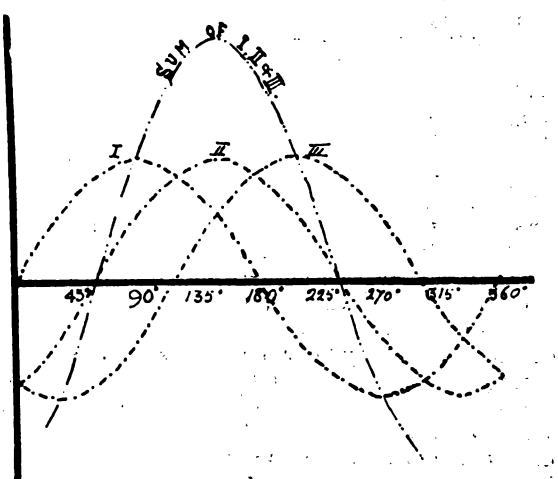

FIG. 3.

the mesh was decidedly inductive. As soon as one of the three transformers is cut out of circuit, the closed secondary mesh no longer exists, and the alternator would naturally give out its full voltage again.—Q.

Answer to No. 251 (*awarded* 5*s.*).—I take it from the question that the connections of the system with the one transformer wrongly joined up would appear as in the figure: A representing the alternator, P the 2,500 bars, S the 320-volt bars, V the 'bus bar voltmeter, B C D the primaries, and *b c d* the secondaries of the three transformers, of which *d* is reversed with reference to D. As the three transformers are connected in mesh, each, independently of its transforming action, has a definite part to play, due to its position between the other two. Referring to the figure, the coil *d* has at one period a current trying to flow through it in what we may call a positive direction

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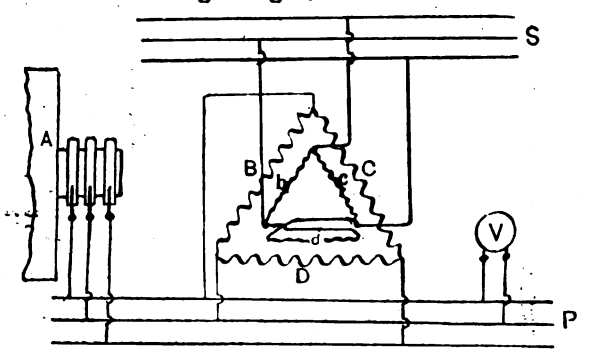
(owing to the fact that it forms a connecting link between *b* and *c*, which are under the inductive influence of the currents flowing in B and C), and at the same time the current flowing in D tends to produce a flow in the negative or opposite direction in *d*. The result of this is that the resultant of the currents in *d* is distorted from the phase it should occupy between *b* and *c*, and its reaction upon its primary, D, throws that also out of its proper phase between B and C; as a consequence there would be a large wattless current and a damping back of the voltage on the 'bus bars, thus accounting for the voltmeter reading being 1,000 volts below the normal.



Should this be the correct solution of the problem, it is easy to understand the second effect, that when either of the transformers is switched out the volts rise to 2,500. Let us suppose that it is C *c* that is thus put out of circuit. Now, there will be no current in *d* due to its position between *b* and *c*, because between the points *b c* and *c d* there is an open circuit, so that, although *d* is wrongly connected, it will exercise no out-of-phase reaction on D, because the only current in it will be that due to the induction of D itself. Similarly we might cut out either B *b* or D *d* with a like result. As, therefore, the alternator is running at proper speed and field, and the reaction of the faulty transformer is eliminated, we should naturally expect a "normal voltage" on the 'bus bars.—M J. W.

Question No. 252.—Discuss the relative advantages of the different materials available for insulating the conductors on continuous-current armatures giving 100 and 1,000 volts respectively.

Best Answer to No. 252 (*awarded* 10*s.*).—In the matter of insulating substances for most kinds of electrical work, our choice is thus far limited to materials to which the engineer is unable to give unqualified approval in all respects. Frequently, the higher we go from an electrical point of view, inferiority confronts us in either mechanical strength, durability, facility of application, retention of insulation under and after increase of temperature, imperviousness to moisture, or a combination of some of these. Breakdowns of insulation of dynamos and motors, although none too rare, are of more occasional occurrence than formerly, and the continuous-current armature has been developed by our engineers and manufacturers into a piece of apparatus that, given fair play, does its work admirably. The conductors on armatures for 100 volts require a moderate amount of insulation, and general practice indicates a choice of several kinds of material. In the first place, it is usual to give the conductor itself a covering. Single wires are coated with two layers of cotton, the average radial thickness being ·007in.; stranded cable is given a heavier covering, about ·010in. thick, or, if the cable is a large one, each wire may have a single cotton covering, the whole being then served with two or three layers. Cotton braiding is also used instead of the spiral covering, and has the advantage that it is not liable to fray at cut ends, but for small conductors occupies more space. A tape of oiled linen or other cloth is sometimes wrapped spirally round conductors of rectangular or heavy section. These forms of insulation are improved if varnished with shellac, but are easily abraded and require care in winding to prevent short-circuits.

Among the materials used for insulating the conductors from the core, layer from layer, and neighbouring conductors from each others, are paper, muslin, linen, asbestos, all usually treated with pure linseed oil, vulcanised fibre, rubber, and mica, either in its pure form or made up into various combinations with special cements, and known as micanite. It is desirable that materials be used which have as high an insulation resistance as can possibly be combined with the necessary mechanical and enduring qualities, flexibility, and moderate cost. With a pressure of 100 volts in question, oiled linen, muslin, and paper fulfil these conditions to a sufficient degree. The linen and muslin are easier to apply, and stronger, but the paper gives a higher insulation resistance. Paper and cloth together are frequently used with good results. Willesden paper is a good form to use, being strong and damp-proof. Asbestos is non-inflammable, but not a good insulator, and very absorbent; when oiled, however, these objections to some extent disappear, though its insulation resistance is very seriously affected by temperatures approaching 100deg. C. Vulcanised fibre is only a moderately good insulator, and is seriously affected by moisture. It is fairly strong, can be turned in the lathe, and is sometimes used for end insulation in low-pressure commutators. Sheet rubber is an excellent insulator, very flexible, but is injured by any great rise of temperature. Mica is the best material in some respects for armature insulation, and is used to a great extent in the best work. It possesses very high insulation, does not absorb moisture, and is quite unaffected by heat. The great disadvantage in the use of mica is due to its brittle nature precluding the employment of it in angles or positions where any great amount of bending is necessary. It is also expensive, and cannot be obtained in sheets of any great size. For insulation between conductors or single layer drum armatures, in slots on toothed armatures, or any case in which small strips suffice, mica is very suitable.

A pressure of 1,000 volts renders insulation a much more important matter than is the case with low voltage. Disruptive strength—that is, the power to resist a spark or the puncturing of the material due to the high pressure used—is necessary in addition to high insulation resistance, and the two qualities do not always go together. Mica, however, possesses both in an eminent degree, and is almost exclusively used for high-voltage work. If employed in the form of micanite, cloth, or plate, the objection to mica where flexibility is required may be overcome. In this country mica entirely holds the field as insulation between segments of commutators for all pressures, and when properly selected with reference to the particular hardness of the segments, fulfils its purpose perfectly. With moderate and high voltages mica is also necessary for end insulation of commutators. Part of a table given by Wiener in his "Dynamo-Electric Machines," which presents a fair idea of the relative values, is reproduced herewith:

Material.	Average resistivity in megohms per square inch mil, at 30deg. C.	Average specific disruptive strength. Volts per mil.
Double-cotton covering, varnished	25	275
Hard rubber	600	1,000
Linseed oil, pure oxidised	10,000	800
Mica, pure white	33,000	3,000
Micanite cloth	310,000	300
,, ,, flexible	440,000	200
,, paper	490,000	425
,, ,, flexible	500,000	300
,, plate	980,000	1,000
,, ,, flexible	320,000	900
Oiled asbestos	680	300
,, muslin, linen, etc	650	500
,, paper	1,600	700
Paraffined paper	11,800,000*	900
Rubber sheet	3,000,000	400
Shellacked cloth	30	40
Vulcanised fibre, red	470	200

* Paraffined materials are seriously affected by heat.

G. EVANS.

Answer to No. 252 (*awarded* 5*s.*).—If a single wire is used for the armature inductors, the usual insulating material is a double-cotton covering of a radial depth of seven mils; if a stranded or laminated inductor is employed, the individual strands may be bare, single, or double cotton-covered, and the whole finally braided with cotton to a radial depth of from 10 to 16 mils, dependent upon the size of the inductors. This cotton covering is usually, after winding, treated with two or more coats

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of shellac or other non-absorbent varnish; but, in addition to this, the inductors should be more efficiently insulated from the core, spider, shaft, etc., and in the case of drum armatures the various sections should be thoroughly insulated from each other, and the question arises, what is the best material to use for this purpose? The properties which a good insulating material must possess are: (1) high insulating resistance; (2) great disruptive strength—*i.e.*, ability to withstand electrical puncturing; (3) flexibility or elasticity; (4) non-hygroscopic properties—*i.e.*, it must not absorb water nor be affected by dampness; (5) capacity of resisting heat—*i.e.*, it must not become brittle nor deteriorate with heat.

The various properties of the different insulating materials may be tabulated as follows, the table being compiled from various sources and experiments (space forbids reference to the separate experimenters):

Material.	Limits in volts per mil thick.	Practical volts per mil.	Remarks.
Asbestos	100-180	125	—
Do. oiled	225 490	300	Deteriorates with high temperatures.
Cotton, S.C.C.	260-340	275	—
Do. shellacked	340 370	350	—
Do. D.C.C.	210-240	225	—
Do. shellacked	250 300	275	—
Red vulcanised fibre.	150 325	200	Hygroscopic.
Hard rubber	900-1,300	1 000	Injured by temp. above 150° F.
Pure white mica	2 000 8,000	3,000	Very brittle.
Micanite cloth	240 490	300	Not affected by temperature.
Do. flexible	175-310	200	—
Oiled cloth	450 650	500	—
Paraffined paper	800-1.000	900	—
Silk single covering	350 565	475	—
Do. shellacked	500-570	525	—
Do. double	320-420	375	—
Do. do. shellacked	420-510	450	—
Mahogany	10-25	15	—

From the above it will be seen that no one material possesses all the properties requisite, with the result that the best material is a composite one made up of layers of various materials. For insulating the slots of the armature one firm use three materials—asbestos for its non-hygroscopic quality, micanite for its disruptive strength, and presspahn to enable the coils to slide easily into their position.—F. J. A. M.

COMPANIES' MEETINGS AND REPORTS.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING.

The sixth ordinary general meeting of this Company was held on Monday at Winchester House, E.C., Lord Rathmore presiding.

In moving the adoption of the report, the **Chairman** said that he hoped the shareholders were satisfied with the position to which the Company had advanced since their last general meeting. During the year £155,608 was expended on the London stations, but at least 75 per cent. of this amount was for street work, such as mains, transformers, meters, etc., and this kind of expenditure was likely to bring in a prompt and satisfactory return. On the liabilities side of the balance-sheet, the sum of £5,000, which had hitherto appeared under the head of reserve, had now been transferred to a fund for depreciation, repairs, and renewals, and to this amount £6,500, which had been set aside from revenue account, and another £4,000 from premiums, had been added, making altogether £15,500, off which £3,584 had been written for 1899, leaving a balance of £11 915 under this new heading. The reason for adopting this change was that it was convenient to know exactly their position in regard to the amount they had to spend. Passing to the general revenue account, he called attention to the substantial amount of profit which had been derived from the Company's two London stations, which formed the chief part of their business—the part which they looked to in the long run for their main return in the way of substantial profits. Since the beginning of the current year the Company had received applications from their northern districts for the equivalent of 8,185 8-c.p. lamps, and from their southern district applications for the equivalent of 6,005, making together applications for 14,190 8 c.p. lamps, while the sales of current showed an increase of 75 per cent. over the increase of last year. Some of the expenditure on the northern stations was at present unproductive, and some of it—as in the case of their expenditure in Western Holborn, St. Giles's, and Camberwell—where they only recently commenced to supply, had not yet had time to show fully what might be expected in the way of profits, but he regarded the prospects of these new investments powers as extremely satisfactory and encouraging. They had had very few mishaps to interfere with the supply of current, and they had had no complaints respecting the quality of light they supplied, or if there had been any complaint, it had proved on investigation to be neither serious nor well founded. As far as could be judged, he believed that their Company were becoming more and more popular with their customers. The districts of which the Company had the lighting exceeded by nearly 50 per cent. the extent of the districts owned by any other supply company in the county of London. He thought that there could scarcely be room for any reasonable doubt that the electric motor was gradually supplanting other forms of motive power for mechanical purposes, and in these circumstances he thought it very satisfactory that the Company should have instituted, and should already have for use as the demand came on, a special plant for current or power purposes equal to 2,000 h.p. Another satisfactory circumstance was that the average works costs had been reduced from 3·8d. per unit in 1898 to 2·432d. per unit in 1899, and this notwithstanding the increased cost of coal. The directors also expected a still further improvement in this direction in the current year. One part of the Company's policy at the outset was to erect these two great stations in London, one for the north and the other for the south side of the River Thames. The plan was to make large stations which would be capable of supplying many other districts than the immediate localities in which the stations were built; and he might say, in passing, that this was a policy which had been vindicated by time, and that throughout the country it was generally admitted that in the end it was wiser and more economical to build a large station at first than to try and do the same work by a number of small ones. Another part of their original programme was to invest a certain amount of capital in obtaining an interest in certain provincial stations. They realised two or three years ago, on terms satisfactory to themselves and to the new Bournemouth Electric Light Company, part of the investment formerly held by them in the old Bournemouth Company; and they had recently disposed of their interest in the Richmond Company to the Bournemouth Company, in which they still held a very large stake. The Dover Company, in which their Company had half the capital, was already paying 3 per cent. They would have seen by the report that Mr. Lawson's resignation as engineer and manager had been accepted, and that the Board had appointed Mr. Charles Sparks as chief engineer.

Mr. J. B. Braithwaite, jun., seconded the adoption of the report, which was unanimously adopted.

LONDON ELECTRIC SUPPLY.

The ordinary general meeting of this Company was held on Wednesday last at Cannon-street Hotel, E.C., Lord Wantage presiding.

The Chairman, in moving the adoption of the report, stated that the lamp connections had only increased by 18,587 lamps, or less than half the number they had expected. This was due to the difficulties consequent upon the delay in the delivery of the new machinery and the completion of other contracts. The excuses offered by the contractors were that materials and coal were unobtainable. Coming to the accounts, he stated that the capital expenditure for the year had been £52,735, the addition to the loan capital being £9,870, this being the deposit on the issue of £50,000 4 per cent. debenture stock. This was largely oversubscribed. They had spent £24,065 on plant and machinery, and on mains £12,599. They had laid 22,251 yards of new trunk and distributing mains, and the total reached about 106 miles. The gross revenue had increased by £5,801, but the expenditure showed an increase of £8,807. One cause of the additional expenditure was the inability to obtain Welsh coal, the Government having requisitioned almost the entire output. The balance to the credit of net revenue account was £25,412 which, after deducting interest on debentures and the interim dividend on the preference shares, left £9,936 to be dealt with. The payment of the preference dividend at the rate of 6 per cent. per annum for the six months to Dec. 31, 1899, absorbed £7,467, provision for special rebates £1,000, and the carry-forward £1,460. The directors intended during the present year to add considerably to the plant, machinery, etc., and this would necessitate the raising of additional capital.

The motion was seconded by **Sir W. H. Preece.**

Mr. Pyke said he thought that better results could have been obtained if more business-like methods had prevailed in the management of the business.

Mr. Young said he thought the Board had done as well as they possibly could under the circumstances.

The motion was then unanimously carried.

A further resolution to extend the borrowing powers of the Company beyond the present amount of £250,000 was also passed.

NORWICH ELECTRICITY.

The ordinary general meeting of this Company was held on the 27th inst. at the offices of the Company, Queen-street, Mr. F. W Harmer presiding.

The report (published in our issue of the 9th inst.) was read by the Secretary.

The Chairman, in moving the adoption of the report, gave some particulars as to the rapid development of the Company's operations during the past six years, and expressed his great confidence in the continued prosperity of the Company.

Sir Charles Gilman having seconded, the motion was carried, and a dividend of 6 per cent., free of income tax, was declared.

Sir C. R. Gilman and Mr. E. Wild were re-elected directors and Mr. James Mottram auditor for the ensuing year.

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NATIONAL ELECTRIC WIRING.

Directors: R. Stewart Bain, Esq., C.A. (chairman); B. Bernheim, Esq.; W. R. Davies, Esq.; George Ellis, Esq., J.P.; James T. Jervis, Esq., M.I.C.E., F.R.G.S.; J. W. Swan, Esq., F.R.S. Manager and secretary: W. B. Cownie.

Report of the directors (with abstract of accounts) to be submitted to the shareholders at their ordinary general meeting to be held at Faraday House, Charing Cross-road, W.C., on April 2 at 12 noon:

The gross profit for the period under review is £5,648. 11s. 3d., from which has to be deducted expenses of administration, provision for bad and doubtful debts, etc., amounting to £3,862. 18s. 1d., leaving a balance of £1,785. 13s. 2d. To this has to be added the balance carried forward at Dec. 31, 1898—viz., £1,222. 8s. 3d., making a total of £3,008. 1s. 5d. After deducting depreciation, etc., and a provision to cover possible loss on contracts in course of settlement, the balance to be dealt with is £1,782. 17s. 5d., and the directors, having regard to the large increase in the Company's business within the last four or five months of the year, and generally to the satisfactory way in which orders are still coming in, recommend a dividend of 3 per cent. for the year. This will involve an amount of £1,501. 16s., leaving a balance of £281. 1s. 5d. to be carried forward to the credit of the current year. The directors have pleasure in stating that the business shows every sign of a steady increase. During the year 1,970 installations, with an aggregate of 51,774 lamps of 8 c.p., have been completed, of which 838 installations, with an aggregate of 24,654 8-c.p. lamps, were free wiring, and 1,132 installations, with an aggregate of 27,120 8-c.p. lamps, were contract; while the orders in hand at the close of the year numbered 395 installations, with an aggregate of 13,012 8-c.p. lamps. During the year free wiring contracts have been entered into with the following Corporations: Gloucester, Rathmines and Rathcar, Pembroke (Dublin), Coventry, Bangor, Greenock, Belfast, Stirling, Crewe, and others; and also with the following supply companies: the Newmarket Electric Light Company, Limited, the Crystal Palace District Electric Supply Company, Limited, the Woolwich Electric Light Company, Limited, the Northampton Electric Light Company, Limited, the Salisbury Electric Light Company, Limited, and others. Negotiations with other supply authorities having large lighting areas are in progress. Mr. George Ellis, J.P., and Mr. J. W. Swan, in accordance with the articles of association, retire at this meeting, but are eligible, and offer themselves for re-election. Messrs. Monkhouse, Stoneham, and Co., the auditors, also retire at this meeting, but offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Management expenditure at head office and branches	2,930	8	0
Directors' fees, £1,200; less relinquished, £600	600	0	0
Auditors' fees	42	0	0
Bad debts and allowances written off, and provision for doubtful debts	245	2	1
Income tax	45	8	0
Balance carried down	1,785	13	2
	£5 648	11	3
Special provision to cover possible allowances on contracts in course of settlement	650	0	0
Amount written off: free-wired installations, £337. 2s. 10d.; fixtures, fittings, plant, and tools, £95. 4s; advertising, £59. 0s. 1d.; preliminary expenses, £83. 17s. 1d.	575	4	0
Balance	1,782	17	5
	£3,008	1	5
Cr.	£	s.	d.
Revenue from free-wired installations	1,439	18	11
Profit on contracts and sales	3,368	11	10
Interest, discount, and commission	736	11	8
Sundry receipts	96	12	10
Transfer fees	6	16	0
	£5,648	11	3
Balance brought down	1,785	13	2
Ditto carried forward at Dec. 31, 1898	1,222	8	3
	£3,008	1	5

W. T. GLOVER AND CO.

The second ordinary annual meeting of this Company was held at Manchester on Friday last, Mr. Henry Edmunds presiding.

The **Chairman**, in moving the adoption of the report, said the net profit for the year had been £23,333, as against £17,103 for the previous year. The increased assets of the Company included the money expended on the new works and the electric lighting and power station at Trafford Park, where plant for the manufacture of cables was being laid down. The entire expense of the Trafford power and lighting scheme had so far been borne by the Company, and the expense was justified because they would be in a position to supply the various works which were growing there with electric power, electric light, and heating gas. The capital in that branch of the business had so far been unproductive, but it was hoped that in the coming year it would earn interest and profit for the Company. Though the Company had a large stock-in-trade, it was not larger than was necessary for the increasing business, and a great deal of the stock which had been acquired during the past year had risen in value in consequence of the rise of the market prices of raw materials. The Chairman congratulated the shareholders upon the healthy condition of the Company, and moved the adoption of the report and accounts.

Mr. H. P. Holt seconded the resolution, which was carried.

A 5 per cent. dividend on preference shares, 4½ per cent. on first mortgage debentures, 10 per cent. on ordinary shares, and 10 per cent. on new ordinary shares on amounts called up was adopted.

An extraordinary general meeting of the Company was afterwards held to make a technical alteration in the articles of association.

LIVERPOOL DISTRICT LIGHTING.

Mr. A. H. Holme presided on the 28th inst. at the annual meeting of the Liverpool District Lighting Company, Limited, at Hackins Hey.

The **Chairman**, in moving the adoption of the report, said the position of the Company was better than last year. The debit balance was entirely wiped off, and they had increased their supply of electricity to a large extent. A large amount had been written off for depreciation, though their mains, wires, and machinery were, taken as a whole, more valuable now than when they were laid. There had been an increase in the number of lights by about 50 per cent. The proceeds of the sale to the Garston Electrical Company would be utilised in providing new mains and machinery at Waterloo, where both were wanted.

Mr. H. Congleton seconded, and the report was adopted.

Messrs. Th. A. von Sobbe and R. A. Beaver, retiring directors, were re-elected, and the retiring auditor, Mr. W. L. Jackson, was reappointed.

At an extraordinary meeting of the Company subsequently held it was resolved: "That the agreement for the sale to the Garston and District Electric Lighting Company, Limited, of the undertaking of this Company, authorised by the Allerton, Woolton, Childwall, and Garston Electric Lighting Order, 1896, and of the assets of the Company connected therewith, be carried into effect subject to such alterations as Parliament or the Board of Trade may think fit to make or require therein."

BRIGHTON AND ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD.

The report of the directors for the year ending Dec. 31, 1899, states that the directors regret that they are unable to announce any dividend either on the preference or ordinary shares. The working expenses have been reduced, as anticipated, by obtaining electric power from the Brighton Corporation; but unfortunately the traffic receipts have fallen off by £346. 17s., so that the net profit is not quite so good as in the previous year, being £565. 8s. 2d., against £584. 12s. 5d. in 1898. This sum is barely sufficient to pay the interest on loans and debentures, which amounted last year to £617. 17s. 7d. The new marine palace and pier, now in course of construction, may fairly be expected to attract considerable numbers to the eastern part of the town, which ought to be of great benefit to the seashore railway. It will readily be seen that a very slight increase in traffic will enable the Company to pay a dividend on the preference shares. Mr. E. J. W. Sang, one of the directors, retires by rotation, and, being eligible, offers himself for re-election. Mr. F. G. Clark, auditor, also retires by rotation, and, being eligible, offers himself for re-election.

DIRECT SPANISH TELEGRAPH.

The ordinary general meeting of this Company was held on Tuesday at Winchester House.

The **Marquis of Tweeddale**, who presided, said that since peace had been established between the United States and Spain the Company was now almost entirely dependent on commercial messages. This accounted for the decrease in revenue, while parts of the increase in expenditure was due to increased salaries rendered necessary by the larger number of messages which had been dealt with.

The report (noted in our last issue) was adopted and the dividend approved.

SWANSEA TRAMWAYS.

At the general meeting of the shareholders on Wednesday, **Mr. Emile Garcke**, who presided, moved the adoption of the report and accounts and the payment of a dividend of 3s. per share upon the ordinary capital. The net profit for the half-year amounted to £3,056, which was about £2,000 better than in the corresponding period of the previous year. The Chairman said he was assured by their engineers that they would be in a position to invite the Board of Trade to make the inspection in the course of next month, and he hoped there would then be no obstacle to working the lines electrically. It was intended to equip the Swansea and Mumbles Railway for electrical working.

DOVER ELECTRICITY SUPPLY.

The annual meeting of this Company was held on Wednesday at the Park-street station.

Sir William Crundall, J.P., who presided, said that during 1899 the output of electricity was 20 per cent. more than in 1898, and from Jan. 1 last up to date they had practically twice as many

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applications for lights and customers as they had during the corresponding period last year. Up to the middle of March their takings had been £933, as against £761 in the middle of March last.

The report was adopted, and a dividend of 3 per cent. was declared, and the directors were authorised to increase the capital of the Company by the issue of £25,000 in 5 per cent. preference shares.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Paris.—The Postal Department, rue de Grenelle No. 103, invite tenders for 762,000 porcelain insulators. Tenders by April 5.

Paris.—The Postal Department, rue de Grenelle No. 103, invite tenders for 460,000 kilos bronze or copper wire, and 270,000 copper joint pieces. Tenders by April 12.

Maidstone.—The Corporation invite tenders for the supply and erection of steam and water pipes and valves. Tenders by April 3. Details in our advertisement columns.

Halifax.—Tenders are invited for the various works required in the installation of electricity for the lighting of the Victoria Concert Hall and premises at Halifax, York.

Edinburgh.—The Corporation invite tenders for the supply of steam coal, arc lamp carbons, and cast-iron pipes, pavement box frames, etc. Tenders by April 7. Details in our advertisement columns.

Salford.—The Corporation invite tenders for the supply and delivery and erection of ash conveyor and two electrically-driven travelling cranes. Tenders by April 9. Details in our advertisement columns.

Southampton.—The Harbour Board invite tenders for supplying and fixing a motor-transformer, with accessories, upon the Board's premises, Town Quay, Southampton. Tenders by April 7. Details in our advertisement columns.

Mexborough.—Tenders are to be obtained shortly by the Urban District Council for a dust destructor, which is to be utilised for the purpose of creating heat and providing power for the proposed electric lighting installation for the town.

Wilna (Russia).—The Municipal Authorities invite tenders for the concession for the erection of a station and the supply of current in the town. Tenders by April 13. Particulars may be obtained from Mr. Rudolph Mosse, Cologne.

Morpeth.—The Visiting Committee of the County of Northumberland Lunatic Asylum, near Morpeth, invite tenders for a complete electric light installation for their asylum. Tenders by April 7. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of telephone cables (including drawing into conduits and jointing of same) and telephone instruments (wall and table). Tenders by April 18. Details in our advertisement columns.

Manchester.—The Directors of the Lancashire and Yorkshire Railway invite tenders for the supply of the company's ordinary requirements of stores during the 12 months ending April 30, 1901. Tenders by April 9. Full particulars appear in our advertisement columns.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and erection of the following: boilers and accessories—viz, six Lancashire and four water-tube boilers and two economisers; polyphase generators—viz., two 1,000-kw. and two 500-kw. low-speed generators. Tenders by April 26. Details in our advertisement columns.

Maidstone.—The Urban District Council invite tenders for the erection and construction of the necessary buildings and chimney shaft, together with roads, fences, boundary walls, etc, for the electricity station and destructor house in the Fairmeadow, Maidstone. Tenders to be sent to Mr. Herbert Monckton, town clerk, 72, King-street, Maidstone, by April 9.

Wimbledon.—The Urban District Council invite tenders for the supply of 5,000 16-c.p. and 1,000 32-c.p. incandescent electric lamps, packed and delivered free at Wimbledon in such quantities as may be required during year ending March 31, 1901. Tenders, endorsed "Incandescent Lamps," to be delivered to Mr. R. H. Butterworth, clerk, Council Offices, Wimbledon, not later than April 9.

Cardiff.—The Corporation invite tenders for the wiring and fitting up for electric light the new fish market in the Hayes, Cardiff. Plans may be seen and specifications and particulars obtained at the office of the Electrical Engineer, Eldon road, Cardiff, after the 15th inst., on deposit of £1. 1s., which will be returned upon the receipt of a bona fide tender. Tenders by April 3.

Barking.—The Urban District Council invite tenders as follows: (Contract No. 1) for the supply, construction, and erection of about 365 tons of cast iron and 235 tons of steel in an opening bridge over Barking Creek, 45ft. in clear opening, and to carry a double line of railway, together with two shore spans of 45ft. each, and the embanked approaches, and with all the electrical and other machinery and appliances incidental thereto and required for opening and closing the bridge by electrical power supplied from the generating station of the Council; (No. 2.) the construction of 73 chains of 3ft. 6in. gauge single-line railway (83lb. tramway rails) and 38 chains of double-line railway, with granite sett paving on concrete, electrical rail bonding, etc. Tenders before 12 noon on May 7.

RESULTS OF TENDERS.

Blackpool.—Mr. E. Tempest's tender has been accepted for the labour required in laying the new tram-track from Central-drive to Cow Gap-lane.

Wigan.—The Corporation have accepted the tender of J. W. Wild, of Wigan, for Portland cement, and that of Blackwell and Co., Limited, for base castings, steel poles, etc.

Croydon.—The Town Council have accepted the tender of C. and T. Weir, Limited, at £475, for three single direct-acting feed pumps, and a feed-pump economiser at £23.

Hull.—The Electric Lighting Committee have accepted the tender of Clayton, Son, and Co., Limited, Hunslet, Leeds, for the supply of two Lancashire boilers for electric lighting purposes, at a cost of £1,305. 15s.

Shoreditch.—The Vestry have received tenders from Babcock and Wilcox for additional engines at £1,650, and the Haythorne Tubular Boiler Syndicate at £2 400. The Vestry have resolved that, subject to the approval of the Vestry's engineer, Babcock and Wilcox's tender be accepted.

Leeds.—The numerous tenders which the Tramways Committee have received for the supply of additional engines and dynamos at the generating station have been further considered by the Works Sub-Committee. The list is being reduced by selection, and in due course enquiries will be made with a view to placing one or more orders.

Vienna.—The Municipal Authorities have decided to place with the Schuckert Company, of Nuremberg, the contracts for the erection of electrical generating stations required for the Vienna electric light and traction schemes. It is proposed to at present instal eight generating sets with an output of 3,000 h.p. each, of which 15,000 h.p. will be used for tramway purposes. The estimated value of the contracts is over £1,250,000.

Rotherham.—The following tenders have been accepted; Tetlow Bros., Hollinwood, near Manchester, boilers, £1,240; W. H. Allen and Co., Bedford, engines, dynamos, etc., £7,702; Electrical Power Storage Company, Limited, London, batteries, £812. 10s.; J. White and Co., Glasgow, switchboard, etc., £1,290. 18s. 9d.; Callender's Cable Construction Company, London, mains, £4,092. 12s. 11d. The total is £15,138. 1s. 8d.

Gloucester.—The following tenders have been accepted: National Electric Wiring Company, Limited, at £360. 5s., for wiring the Guildhall, and for providing and fixing the fittings for same at £366; Beaven and Son, Gloucester, at £188, for wiring the public baths, and for providing and fixing the fittings at £67. 19s. 3d.; Alger and Sons, Newport, Mon., at £92, for wiring the electricity works, and their alternative tender to supply fittings, to be selected by the committee, from the catalogue of the General Electric Company at 15 per cent. less than the catalogue price.

BUSINESS NOTES.

TRACTION.

Hastings.—Mr. Murphy's Hastings Electric Tramways Bill is before a committee of the House of Commons.

Burnley Corporation Tramways Bill.—This Bill has passed Lord Clifford's committee at the House of Lords.

Ashton.—A ratepayers' meeting last week decided not to oppose the South Lancashire Tramways Company's Bill.

Airdrie and Coatbridge Tramways Bill.—This Bill is still before Mr. Jeffrey's committee of the House of Commons.

Leicester.—The deputation from the Tramways Committee have now visited Sheffield, Leeds, Edinburgh, and Glasgow, where they inspected the various systems of traction adopted.

Lowestoft.—The Council have adopted the draft agreement from the East Anglian Light Railways Company concerning the latest arrangements made between them and the Council.

Grimsby.—The recent unofficial poll of the town with regard to the tramways has resulted as follows: in favour of municipalisation, 5,089; against, 1,059; papers not filled in, 1,336; spoilt papers, 99.

Lastingham and Rosedale Light Railway.—The Light Railway Commissioners have made an order for the construction of a light railway in the North Riding of the county of York, from Sinnington to Rosedale.

Carlisle.—The Rural District Council have decided to join with the City and County Councils in any action which may be considered necessary to secure the carrying out of the tramway scheme in its entirety.

Greenwich.—The Vestry have passed a vote in support of the proposed scheme of the London County Council for the extension of the tramway service from Blackheath-road across Blackheath to Shooter's Hill-road.

Ipswich.—A committee of the House of Lords has passed a Bill authorising the Corporation to borrow £153,000. Of this sum it is proposed to expend £110,000 upon the construction of 7 miles 3 furlongs of tramways.

Wembley.—The Urban District Council have decided to instruct the clerk to employ counsel to oppose the County Council's scheme in order to obtain the Council's requirements as far as possible, or to come to the best terms possible.

Weston-super-Mare.—The Urban District Council have consented to a provisional tramways order now being promoted in the

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present session of Parliament by the Weston-super-Mare and District Electric Light Company, Limited.

Paisley.—At a meeting of the Council on the 26th inst., it was agreed to send a deputation to places where electric tramways are in operation for the purpose of getting information regarding the management and equipment of the respective systems.

Blackpool.—The Highway Committee propose to wood-pave the whole of the roadway in Claremont-park while the work of laying the new tramway is in progress. The tram track and a narrow strip alongside is to be wood-paved in any event.

Cleckheaton.—The objections to the British Electric Traction Company's light railway scheme between Dewsbury and Cleckheaton has been withdrawn in consideration of the company having undertaken to purchase electrical energy from the Council.

Middlesex Electric Trams.—The Light Railway Commissioners heard further evidence on the 26th inst., and adjourned till after Easter, when Mr. Cripps, Q.C., will reply on behalf of the promoters, and the Commissioners will give their decision.

Spen Valley.—April 9 has been fixed for the Light Railway Commissioners' enquiry into the application of the British Electric Traction Company for an order to make extensions in their Spen Valley electric tramways scheme. The enquiry is to take place at Leeds.

Mersey Railway.—The report adopted by the Mersey Railway Company on the 26th inst. stated that the directors had now a practical scheme before them, and they had received 270 proxies for and 1 against the same. It was proposed to adopt the third-rail system.

Lincoln Corporation Tramways Bill.—This Bill, to give further powers to the Corporation to make new tramways within and without the city, and to work the tramways by electric traction, has passed Lord Morley's committee at the House of Lords, and has been reported for third reading.

Kingston Electric Tramways Bill.—The Select Committee of the House of Lords on Wednesday threw out the portion of the Kingston-upon-Thames Corporation Bill which dealt with the tramways. The County Councils of Surrey and Middlesex and owners of property on the Surbiton-road opposed the Bill.

Deptford and Greenwich Tramways.—The County Council have resolved to hold a statutory meeting to consider whether it shall exercise its right to require the London, Deptford, and Greenwich Tramways Company to sell the undertaking authorised by the Southwark and Deptford Tramways Acts, 1879 and 1899.

Renfrewshire.—The Upper District Sub-Committee of the Renfrew County Council on Parliamentary Bills have fixed upon certain clauses in the Glasgow Tramways Bill. One of these states that the motive power to be used by the proprietors of the tramway for the time being shall be electricity, and that steam or mechanical power shall be prohibited.

Glasgow District Tramways Bill.—Lord Morley's committee of the House of Lords have agreed to allow this Bill to proceed on condition that the portion of tramway within the jurisdiction of the County Council of Dumbartonshire is struck out. The object of this Bill is to authorise two systems of tramway, one on the south side and the other on the north side of the Clyde.

Windermere.—With regard to the proposed light railway for Windermere, it has been suggested that a conference be arranged between the engineer and the company and the county surveyor and committee with regard to the requirements of the Westmorland County Council, as embodied in the clause proposed to be inserted for the protection of the County Council in the light railways order.

Darlington.—The difference between the Darlington Corporation and the Imperial Tramways Company with regard to supplying an electric tramway service for the borough remains still unsettled. We understand that the General Purposes Committee have decided that the tramway company must carry out the whole of their original scheme without delay, or that the proposals of the company will not be entertained at all.

Huddersfield.—The committee of the House of Commons which had to deal with the Huddersfield Tramways Bill have passed the preamble, except the part relating to outside tramways. The scheme included a change from steam to electricity in the working of the tramways, extensions in the borough, and the construction of lines to Holmfirth, Newmill, Brockholes, Honley, Rastrick, Brighouse, Elland, Mirfield, and Kirkburton.

Reading Tramways Bill.—This Bill has been before Mr. Hobhouse's committee. At the end of the enquiry the Chairman said: "We have decided to pass the preamble of this Bill. We will insert a clause for the protection of the tramway company, similar to Clause 20 in the provisional order of 1899, but limit it to the junctions. When we come to the borrowing powers sought for by the Bill, we shall cut down the period asked for."

Bridlington and Flamborough Light Railway.—A start has now been made with this line. The owners of several shops on the east side of Clough Bridge have received notice that the properties scheduled will be required for the widening of the street. Probably the Corporation will be approached with a view to obtaining the motive power in connection with the electric light installation, for which a provisional order will have to be obtained.

Newport.—The Lighting and Traffic Committee proposed at the last meeting of the Town Council the adoption of the overhead trolley system for the tramways about to be constructed along the Corporation-road, but an amendment to refer the matter back was carried. Mr. G. H. Llewellyn, chairman of the Electricity Committee, quoted Prof. Silvanus Thompson on the merits of the surface-contact system, which is being tried at Paris, Tours, and Monaco. Enquiries are to be made as to the success of this system.

New St. Helens and District Tramways Co.—We have been furnished with a return showing that from July 20, 1899, to Dec. 31, 1899, with an average of eight cars running, the miles run by this Company were 124,752, and the Board of Trade units used for the same period were 110,754. From Jan. 1, 1900, to March 21 the miles run were 70 785 and the units used 63 226, making a total from July 20, 1899, to March 21, 1900, of 195,537 miles and 173 980 units, with an average of eight cars running to Feb. 5 last and ten since.

Lancaster.—The shareholders of the Lancaster and District Tramways Company on Saturday afternoon almost unanimously rejected the offer of the Corporation of 15s. per share for ordinary shares and £1 per share for preference shares, to acquire the tramways between Lancaster and Morecambe, the meeting resolving to accept nothing less than 20s. per share all round. The Town Council have decided to drop out of their parliamentary Bill the clause relating to purchase, and to confine themselves to the scheme for an electric tram system in the borough limits.

Stoke-upon-Trent.—There seems to be some difficulty about the electric traction company's offices. At last week's meeting of the General Purposes Committee the borough surveyor reported that he had received a letter from Mr. J. Angus, on behalf of the Potteries Electric Traction Company, to the effect that his company could not agree to the suggested alteration to the plan submitted by them for the erection of offices, etc., at the junction of Church-street and Bowstead-street. It was recommended that a reply be sent to the effect that the alterations suggested had been agreed to by them, and, moreover, the committee had only approved of the plan on the understanding that the building was set back to the agreed line.

Hendon.—At a meeting of the Hendon Rural District Council last week notice was received that a public enquiry would be held at the Council-chamber, Watford, to consider the expediency of granting the application which had been made for an order authorising the County of Hertford Light Railway. The Clerk said he had written to the Hertfordshire County Council stating that the Council would withdraw their opposition to the scheme on condition that an undertaking was given that the roads along the line of route should be lighted, and he would be glad to know whether the County Council accepted the conditions. Up to then, however, the letter had not been acknowledged. The surveyor was asked to attend the enquiry on behalf of the Council.

Plumstead.—In reply to a letter from the London County Council inviting suggestions with regard to the construction of light railways in the parish, the Vestry agreed to inform the Council that in their opinion it is desirable (*a*) that the light railway proposed to be constructed by the Council from Deptford across Blackheath to Shooter's Hill and Woolwich should have a branch to go down Herbert-road and along Plumstead Common-road to Wickham-lane, and thence to the existing terminus of the tramway in High-street; (*b*) that a branch line should be taken from Plumstead Common-road and down to the bottom of Griffin-road; (*c*) that the existing line at High-street should be extended to Abbey Wood, along the new roads now in course of formation.

Great Horseless Carriage Co.—Lords Justices A. L. Smith, Collins, and Romer, in the Court of Appeal, on Tuesday concluded the hearing of the case of Frankenburg *v.* the Great Horseless Carriage Company, Limited, on the appeal of the Company from an order refusing to dismiss the action as against the Company. The plaintiff (Mr. Frankenburg), who was a shareholder in the Company, claimed rescission of his contract to take his shares, and for the return of the money he paid for them—namely, £1,000—on the ground of alleged misrepresentations of fact and misleading concealment in the prospectus. The Company claimed to have the action dismissed, as it had gone into voluntary liquidation before the action was commenced, and also because the action was frivolous and vexatious. The appeal was dismissed with costs.

Cardiff.—The Tramways Committee had under their consideration on Friday a letter from the Electrical Power Distribution Company, Limited, who have taken over the powers granted under the electric lighting provisional order for Penarth, suggesting an electric tramway between Cardiff and Penarth, and stated that the portion of the line within the Cardiff boundary might either be built by the Corporation or by the company. In the latter case it would be turned over to the Corporation upon reasonable terms as soon as the other lines within the borough were working. It was decided to reply that the Corporation were opposed to a private company constructing a tramway to Penarth. An application from the Provincial Tramways Company for permission to relay the old tramway in Working-street, thus providing a double set of rails between St. John's-square and the Royal-arcade, was referred to a sub-committee.

Bath.—With regard to the Council's attitude concerning the proposed tramways, *Keene's Bath Journal* says: "From the first the Council have refused to recognise any other principle than that they themselves should obtain the order. Their method is now, however, more conciliatory, inasmuch as they ask for the terms upon which outside bodies would be willing to co-operate with them in obtaining the order with the view of its immediate transference. The Council cannot be accused now of playing the part of the dog in the manger. They are acting like prudent men anxious to make the best bargain they can for the citizens, and the character of the overtures made to the committee is of good augury for the future. We have now every reason, I think, to rejoice that the Light Railway Commissioners adopted the line

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they did at the recent enquiry. The ratepayers will undoubtedly benefit by the action they then took."

Halifax Tramways.—The accounts for the current financial year and the estimates for the year which will shortly begin have been published. The tramway traffic receipts are estimated at £30,500, the expenditure at £26,953, and the balance surplus at £3,547, £1,500 of which is appropriated in relief of rates. The repair of cars and motors has cost £2,999. The current has cost £7,390. The local papers are afraid that the extension of the Halifax tramways to places outside the borough will not be sanctioned under the Bill presently to be examined by Parliament. This is on account of the prospective Municipal Trading Committee. The Tramways Committee have instructed the town clerk to communicate with other authorities promoting similar Bills before Parliament, with the object of a joint meeting being held in London, so that some definite course of action might be agreed upon. The representatives of these towns in the House of Commons, it was suggested, should be invited to be present.

Lee.—The District Board of Works have adopted a report of a joint meeting of their committee with Eltham with reference to the London County Council Light Railway Orders and the Improvements Bill. The committee recommend that in the event of the County Council not consenting to the widenings and to bind itself to repave the paths, the clerk be instructed to continue the opposition of the Board to the Bill in Parliament, and the light railway orders (Eltham, Lee, and Shooter's Hill) unless and until the Board otherwise resolves. But if these points be conceded, other details as to the orders and Bill be left to the discretion of the clerk to consent or oppose; that the clerk be authorised, in lieu of a clause prohibiting overhead electric traction, to consent to a clause that overhead traction shall not be used without the consent of the road authority. The London County Council have been informed of this decision. No reply has yet been received, and the clerk has been authorised to act according to the recommendations expressed in the report.

Paddington.—The Vestry last week agreed to a report of the committee stating that the omnibus and underground railway service in Paddington is sufficiently adequate to render it inadvisable to lay down tramways or light railways in the parish, and recommending that the London County Council be so informed. With regard to the London County Tramways (No. 2) Bill, the committee recommended that the Vestry concur with the Vestry of Bermondsey in opposing, on the ground that the powers of the local authorities would be seriously encroached upon, and further that the members for Paddington be asked to give the opposition their support. Eventually the subject was referred to a joint committee. The Works Committee also recommended that the application of the inhabitants of Harrow-road for the substitution of Jarrah wood blocks in lieu of the present pitching stones between the tramrails in Harrow-road, be not entertained, inasmuch as the work could only be carried out at considerable cost to the parish. This matter was referred back for further consideration.

Kingston.—The Town Council have agreed to an arrangement in regard to the proposed tramway from Surbiton Station to the borough boundary which contains the following provisions: (1) the Surbiton Council to construct the line from Surbiton Station to the borough boundary and to borrow capital for the purpose; (2) the Corporation to take a lease of the line for the period for which the money is to be borrowed (probably 40 years) with a proviso for determination of the arrangement by either party at the expiration of 25 years; (3) the rent to be paid by the Corporation to the Surbiton Council to consist of the amount to be annually paid by Surbiton as principal and interest on the loan for their tramway, together with the cost of maintenance. The Corporation also to pay to the Surbiton Council such proportion of the net profits as shall correspond with the length which the Surbiton line will bear to the route from Surbiton Station to the end of Park-road and Richmond-road respectively; (4) the electric current for the Surbiton line to be supplied by the Surbiton Council or their contractors upon their desiring so to do, the cost to be charged to the Corporation for the current for their lines.

Croydon.—A report has been adopted of the Tramway Committee recommending the adoption of Mr. Monkhouse's revised drawing of the proposed car, and it has been also agreed that the safety fenders to be attached to the cars should be similar to those in use at Dover, and that the centre of the track should be laid with soft wood, then one row of hard wood each side of the rail toothed in with granite setts and the remainder of the road paved with macadam. The committee have arranged that the poles in London-road should not be placed opposite each other, it being proposed to use them for arc lighting purposes. Mr. Monkhouse has been instructed to prepare specifications for the proposed utilisation of the existing depôt at Thornton Heath for car sheds, etc., and a plan of suggested arc lights to be placed on the poles in London-road. It having been reported that the Electricity Committee were desirous of laying electric cables in Church-street, and that the National Telephone Company were also desirous of laying underground telephone wires in the same street, the committee authorised the work of laying the tramway feeders to be carried out in conjunction with the laying of the electric cables and telephone wires.

Birmingham.—We are indebted to the *Birmingham Daily Post* for the report of last week's meeting of the Public Works Committee, at which various details with respect to remodelling the Bristol-road tramways on an electrical overhead system were discussed. The Tramways Sub Committee reported that, subject to confirmation by the committee and the City Council, they had made the following arrangements with Mr. Ross, as representing the City of Birmingham Tramways Company, for the equipment of the Bristol-road tramways with the electric overhead system: (1) the Corporation to consent to the company equipping the Bristol-road route as an electric overhead system, the system and details of construction to be approved by the Corporation, and the work carried out to their satisfaction; (2) the company to equip the line with completely new rolling-stock, the type, size, and details of the cars to be approved by the Corporation; (3) the company to run a minimum five minutes' service of cars between the hours of 8 a.m. and 8 p.m., and from 8 to 10 30 p.m. a minimum 15 minutes' service; (4) the route from Selly Oak to the city terminus in Suffolk-street, or Navigation-street, to be divided into two penny stages, to be agreed between the Corporation and the company; (5) the Corporation to purchase the rolling-stock at the expiration of the lease, the price to be paid to be settled by valuation; (6) the Corporation to purchase the buried feeders, if in good order, at their cost; (7) if the Corporation continue the overhead system, it shall purchase the overhead construction, poles, and bonding, the amount to be settled by valuation; (8) if the Corporation does not continue overhead traction, the company to remove the poles and overhead construction, and the Corporation to hand back the copper bonds; (9) the company to run four workmen's cars each way before 7 a.m., and after 6 p.m. at a penny for the whole distance; (10) all the rights, privileges, and obligations, both of the Corporation and the company, to remain undisturbed; (11) the Corporation to undertake to embody an agreement embracing the above conditions in an Act to be promoted by the Corporation, at a time convenient to them. These proposals were discussed by the committee at considerable length. It will be remembered that at a meeting of the City Council on June 7, 1898, a resolution was passed, on the motion of Alderman Dr. Barratt, instructing the committee not to reopen negotiations with the company, and the committee therefore were of opinion that that resolution precluded them from considering the proposals and from making any recommendations thereon. It was, however, resolved to present the proposals to the Council at its next meeting, and to ask for the 1898 resolution to be rescinded in order that they or any other proposals may be reported upon. In the event of the resolution being rescinded the whole subject will be brought forward for discussion at a second meeting of the Council, to be held in April. In the same issue we notice a voluminous correspondence of advocates of either the conduit or the overhead systems. Notice has been given to move the following resolution at the meeting of the City Council on Tuesday next: "That in the opinion of this Council it is desirable that a clear and definite statement of its policy in regard to the tramways of the city should be expressed. This Council therefore confirms its decision as hitherto determined on the unanimous recommendation of the Public Works Committee—viz.: (*a*) to municipalise the working of existing tramways at the earliest opportunity; (*b*) to refuse any extension of the present leases; (*c*) to prohibit the erection of overhead wires in any part of the city, 'less objectionable and equally efficient methods of applying electricity to the working of tramways being available, and at a reasonable cost.' Whilst contemplating the early acquisition of parliamentary powers, and the construction and working of new lines, extensions, and connections for through traffic, also the ultimate control of a complete and homogeneous system of tramways, this Council is of opinion that the convenience of the public would be greatly enhanced by the introduction of improved methods of operating existing tramways before the expiration of the current leases. This Council, recognising the financial impracticability of the present lessees installing new systems unaided, hereby authorises its Public Works Committee to negotiate and report as to the possibility of the Corporation bearing an equitable share of the cost of improvements."

LIGHTING AND GENERAL.

Bray.—Lighting extensions are proposed to the extent of about £7,000.

Stoke-on-Trent.—The Council have bought a site for an electric light station, etc.

Ryton.—The Urban District Council have decided to support the Tyneside Electric Power Bill.

Removal.—The Stewart Electrical Syndicate, Limited, have removed to 57, New Compton-street.

Rugby.—We understand that the question of electric lighting will come before the Council in a short time.

Leyton.—The Guardians have adjourned for three months the question of changing the system of lighting the workhouse.

Crompton.—The District Council and also a ratepayers' meeting have decided to oppose the Lancashire Electric Power Company's Bill.

Willans and Robinson, Limited.—The transfer books are closed, prior to the ordinary general meeting, until the 11th prox., inclusive.

Redcar.—The Board of Trade have issued a provisional order empowering the Council to lay down electric lighting plant at a cost of about £10,000.

Annual Dinner.—The staff of the engineering department, Postal Telegraphs, Liverpool, held their annual dinner at the Stork Hotel on Saturday last.

Clerkenwell.—The Vestry are asking the electric lighting company for a reduction in price. The charge in Clerkenwell is 7d., as against 4½d. in the City.

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Rotherham.—Mr. E. A. Sandford Fawcett held an enquiry on the 28th inst. into the proposal of the Corporation to borrow £27,969 for electric lighting.

Swindon.—At the joint meeting of the Old Swindon and the New Swindon Urban District Councils last week it was decided to purchase a site for the electric light station for £3,000.

Rathmines.—Mr. P. C. Cowan has held an enquiry into an application of the Rathmines and Rathgar Urban District Council for sanction to a loan of £21,000 for electric light extensions.

Todmorden.—Messrs. Medhurst and Page, of Manchester, have been appointed to report on electric supply works for the purpose of lighting, electric traction, and motive power within the borough.

Nuneaton.—The question of obtaining further expert advice as to the purchase of the electric undertaking and on the extension proposed to be carried out has been left to the Electric Committee.

Wokingham.—An application from the National Telephone Company, for the erection of poles in London-road and Wokingham-road to extend the telephone line to Woodlea, has been granted.

Catalogue.—We have received from Messrs. J. H. Heathman and Co. a copy of their price-list of fire-extinguishing appliances. These include fire-engines, hand pumps, hand grenades, rope fire-escapes, etc.

Hammersmith.—The Vestry have now received the formal consent of the London County Council to the borrowing of £44,548, being the amount required for purposes under the electric lighting undertaking.

Heckmondwike.—With regard to the proposed amalgamation scheme, we learn that Heckmondwike is to take one-fourth share in the electric lighting works, and defray one-fourth of the annual cost of the works.

Trowbridge.—In a recent report to the Town Council the borough surveyor recommends an instalment of electric lighting by the local authority, the cost being estimated at about £10,000 for 4,000 lamps of 8 c.p.

Rotherhithe.—The Vestry are still complaining on account of insufficient supply of electricity, and last week they decided that the company be again asked to make a reduction in consequence of the inadequacy of the supply.

Stock Exchange.—The Smithfield Markets Electric Supply Company's 12,000 ordinary shares of £5 each, fully paid, Nos. 1 to 12,000, and £50,000 4 per cent. debenture stock, are now quoted in the official list.

Cleethorpes.—The Board of Trade have issued a provisional order to the Urban District Council authorising them to supply electric energy for public and private purposes within the area under the jurisdiction of Council.

Personal.—Mr. G. Batcliffe Hulme, secretary of the Blackheath and Greenwich Electric Light Company, has been appointed district superintendent of the British Electric Traction Company for the North Lancashire district.

Eastern Extension Telegraph Co.—The directors have declared a dividend for the quarter ended Dec. 31 of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making 7 per cent. for the year, payable 26th prox.

Alloa.—The British Electric Plant Company, Limited, have obtained a piece of ground in the Longcarse district of the town. The promoters are contemplating the erection of works and the placing of machinery and plant, at a cost of something like £60,000.

Patents.—A notice will be found in our advertisement columns to the effect that Mr. V. A. Fynn, of Trafalgar Works, Bradford, has applied for leave to amend the specification of letters patent No. 24,472 of 1895 for improvements in dynamo-electric machines.

Cupar.—A special committee of the Fife and Kinross Lunacy Board have decided to ask for power to obtain estimates from electrical engineering firms for the installation of electricity at the Cupar Asylum. It is expected that it will be introduced within seven months.

Barnard Castle.—A satisfactory understanding has been come to with regard to the electric lighting, the general terms approved by the Council as to the introduction of the light by the Northern Counties' Electric Supply Company, Newcastle, having been accepted by the undertakers.

Newcastle.—The Watch Committee of Newcastle Corporation on the 27th inst. resolved that immediate application be made to the Local Government Board for permission to borrow the sum of £10,000 for the purpose of fitting up the electric light in those streets through which the tramlines run.

Appointments Vacant.—The Bexhill Urban District Council require the services of a fitter-driver, a stoker, and a mainsman. Particulars of these and various other vacancies will be found in our advertisement columns.—The Battersea Vestry will shortly invite applications for the appointment of an engineer, to reside within the parish.

New Issues.—The following issues were made this week: Calcutta Tramways—£250,000 4½ per cent. first debenture stock at the price of £98 per cent., the amount being part of an authorised issue of £350,000; Metropolitan Electric Supply—£125,000 3½ per cent. mortgage debenture stock, being the balance of an authorised issue of £250,000 of such capital.

Barking.—The lighting by electricity has resulted in much work, and a further loan of £850 has been applied for. The Council have asked Mr. Louis Sinclair, M.P., to vote against the Power Distribution Bills. The surveyor is arranging an exhibition of electrical apparatus in order to attract new consumers. The Council is going to bear the cost of the current consumed at the same.

Accumulator Plates.—The Epstein Electric Accumulator Syndicate, Limited, have granted to Messrs. W. C. Rooper and Robins, electrical engineers, of Stafford, the sole license to make and sell Epstein accumulator plates and storage batteries. Messrs. W. C. Rooper and Robins will manufacture the plates by Mr. Epstein's original process, with the assistance of many of his staff, at their new works at Stafford.

Totnes.—The Town Council have informed the Board of Trade that a draft provisional order, proposed to be issued by them to the Totnes Electricity Supply Company, Limited, is in accordance with the terms agreed upon between the company and the Council, with the exception that the clause referring to terms for public lighting has been omitted. The company have intimated their willingness to insert the clause.

Wakefield.—On account of the complaints received from consumers regarding the demand indicators, the Council have resolved that demand indicators be abolished, and that as from Jan. 1 last the charge for electricity be 4½d. per unit to all consumers, and that a discount of 2½ per cent. be allowed to all consumers on all accounts paid within 21 days of demand, and that accounts be made up and collected half-yearly as heretofore.

Natural Causes.—At the Bournemouth County Court on the 22nd inst. Judge Philbrick had before him an action in which the National Telephone Company sued a local butcher for telephone rent. A counterclaim was set up for damage sustained through the defendant being unable to use the telephone for a period owing to a breakdown occasioned by a snowstorm. The judge held that the loss suffered was occasioned by the forces of nature, for which the company could not be held responsible in law, and judgment was given for the company on the claim and counterclaim.

West Ham.—The proposed electric lighting of the workhouse and school premises again formed part of the last report of the Works Committee of the Guardians. The estimated cost will be £1,114, whilst the cost of the present lighting for the last year was £1,157. A comparison between the proposed instalment and cost for the workhouse against the cost of the installation at Bethnal Green Infirmary showed that with over double the amount of aggregate candle power provided the infirmary cost was £5,755 against £7,000 proposed at West Ham. This was explained by the fact that the West Ham Workhouse was a very straggling group of buildings, necessitating more work.

Lowestoft.—The electric light charges are still occupying the attention of the General Purposes Committee. The electric cables under the harbour are to be laid at a depth of about 18ft. 3in. from high-water mark as a minimum. Mr. Hawtayne has been asked to report on the subject of the establishment of a municipal telephone exchange. The deputation from the Council to ascertain the prices charged and arrangements made for electric lighting is to visit the following towns: Brighton (visiting also the Hove works), Dover, Canterbury (if time), Chester, Blackpool, Cheltenham, Leeds (if time), and Harrow, Barking, or Woodford. The current will probably be available in Lowestoft in the autumn.

Automatic Telephone Co.—In the Court of Appeal recently, before the Master of the Rolls and Lords Justices Rigby and Vaughan Williams, the case of Alexander *v.* the Automatic Telephone Company, Limited, was heard on appeal by the plaintiffs from a judgment of Mr. Justice Cozens-Hardy. The action was brought by Mr. M. J. Alexander and Mr. J. D. Gibbs, suing on behalf of themselves and other shareholders in the Company, against the Company and three of its directors, Mr. Max Margowski, Dr. H. G. Sworn, and Mr. J. W. Cohen, in effect asking for a declaration that they were bound to pay at the date of the action the application and allotment money due on the shares held by them. There were two points taken by the plaintiffs in the court below: first, that the application and allotment money had become due; and, secondly, that the directors in not calling for it had exercised a discretion in the matter which was not *bonâ fide*. The Company had been formed to work an invention in connection with telephones. The case was argued at considerable length by Mr. Rawlinson, Q.C., for the plaintiffs, and by Mr. Rufus Isaacs, Q.C., Mr. Astbury, Q.C., Mr. Hamilton, Q.C., and Mr. Newell for the defendants, and in the result their Lordships reserved judgment.

Stirling.—Last week saw the opening of the Corporation's electric light station. The buildings were thrown open for the inspection of the public on Thursday and Friday evening. The contractors were: brickwork, Mr. Hamilton, Hamilton; joiners, Short and Fairful; plumber, R. Frater; plasterer, R. Foster; painter, J. Dowell; ironwork, J. Davie and Son; slater, J. Blair; lightning conductor, Dixon and Corbett, Glasgow; boilers, Messrs. Anderton, Accrington; engines, dynamos, etc., Mather and Platt, Manchester; battery, Pritchetts and Gold, London; mines and cables, Callender's Cable and Construction Company, Limited; switchboard, etc., James White, Glasgow; arc lamps, Brockie-Pell; lamp-posts and brackets, W. M Farlane and Co., Glasgow; meters, Messrs. Ferranti, London. The estimated cost of the various branches of the undertaking are: buildings, £3,500; boilers, £1,250; engines, dynamos, steam-piping, pumps, and economiser, £5,700; switchboard, £1,280; mains and cables, £7,370. With other contingencies, such as cost of order, extensions, fees, etc., the total expenditure is not likely to exceed £25,000, and this sum has been borrowed from the Public Works Loan Commissioners for a period of 30 years at the low rate of 2¾ per cent. The plans were prepared by Mr. W. Thompson, sanitary inspector, and the buildings have been erected under his charge.

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Pembroke (Ireland).—Mr. Sidney L. R. Price, of the Ayr Corporation electricity works, has been appointed resident electrical engineer to the Pembroke Urban District Council's electricity works at Bathavenue, co. Dublin.

Boston.—The application of the National Telephone Company for permission to erect poles for a telephone from Swineshead Abbey to Sykemouth Farm, both in the parish of Swineshead, has been granted subject to agreement.

Maryport.—The provisional order conferring powers for electric lighting has been made by the Board of Trade, as approved by the County Council, with the addition of a clause for the protection of fisheries, provided the water is taken from the river.

Exeter.—During the parliamentary enquiry into the Exeter Corporation Bill before Mr. Schwann's committee it was stated that the districts proposed to be taken in would also have the advantage of the Corporation's electric lighting works.

Rowley Regis.—At the last meeting of the District Council the clerk was instructed to ascertain the terms upon which the Oldbury Council had agreed to take the electric light from the Midland Electric Corporation, and report at the next meeting of the committee.

Ramsgate.—A lengthy discussion took place at the last meeting of the Chamber of Commerce on what was called the bungled service of the telephone system. Eventually it was resolved to point out to the company the state of affairs, and to ask them to provide a remedy.

Auchterarder.—The Town Commissioners have agreed to object to the erection of telegraph poles on or alongside the highway, which forms the main street of the burgh, but they will assist the Post Office as far as they can to obtain wayleave for telegraphic lines keeping clear of the streets.

Inverbervie.—The gas company appear to be in difficulties, owing to the introduction of the electric light in all the principal works, the increased price of coal, and a lessened consumption owing to the cheapness of paraffin, etc. We would advise the Corporation to buy the undertaking.

Audenshaw.—At the last meeting of the District Council a letter was received from the Manchester Electric Department stating that the electric supply would be available in the Audenshaw district in 18 months from now. The District Council are opposing the Lancashire Electric Power Bill.

Bath.—The increase in the price of coal and the cost of management again formed the topic of discussion at the last meeting of the Electric Lighting Committee. Mr. Metzger was instructed to visit, accompanied by members of the Works Committee, the tinworks at Lydney, where a mechanical stoker and forced draught is working.

Cuba Submarine Telegraph Co.—This Company has presented to the United States a claim for £800 for the damage done to the Company's lines when they were cut by the American vessels in the Spanish-American war. They also claim the subsidy of £2,000 a year which it received from the Spanish Government, and which was to be paid up to 1910.

Dublin Electric Lighting Bill.—The Standing Orders Committee of the House of Lords (Lord Morley presiding) last week considered the allegations of non-compliance with Standing Orders in the case of the Dublin Electric Lighting Bill. Finally the chairman said the committee would dispense with the Standing Orders. The Bill will therefore proceed.

Whitechapel.—At Monday's meeting of the Vestry the Electrical Committee presented a lengthy report dealing with various matters connected with the installation of the electric light in the district. It was agreed to adopt the committee's recommendation that the sum of £14,830 be now borrowed from the London County Council, at 3½ per cent., for the erection of the new destructor.

Monmouth.—The supplementary estimates for completing the drainage and electric light passed by the Town Council last week amount to £29,000. There is a great difference between the actual cost and the original estimates. Mr. Lailey has fixed the sum for the combined scheme at £15,000, and Messrs. Bramwell and Harris at £18,000. With the first loan of £20,000, the total will amount to £49,000.

Bermondsey.—The Electric Lighting Committee's report states that each tenant of the houses on the Limasol-street site has been informed that they were tenants of the Vestry, and that the Vestry would pull down the houses, awarding compensation on the terms indicated to each; that the staff had been instructed to collect the rents, and that the tenants had been served on the 19th inst. with legal notice to quit.

Elland.—The Board of Trade has granted the application of the Elland District Council for an electric lighting provisional order. In regard to the maximum prices to be charged, the order says, "where the undertakers charge any consumer by the actual amount of energy supplied to him, they shall be entitled to charge him at the following rates per quarter: for any amount up to 20 units 13s. 4d., and for each unit over 20 units 8d."

Newbury.—The Town Council have adopted a report of the Gas Committee which contained the following minute: "The question of electric lighting, which came before the committee at their last meeting, and was referred back to the committee by the Council, was again discussed, and the committee recommend that steps be taken to obtain offers for the purchase of the Council's electric lighting provisional order, and that the town clerk inform the Board of Trade to this effect."

London Gazette.—The last day for receiving proofs in the estate of S. G. Trehearne and A. H. Crump, trading as Trehearne, Son, and Crump, 155, Fenchurch-street, London, is April 9, 1900; B. T. Norton, trustee, 9, Old Jewry-chambers, E.C. The last day for receiving proofs in the estate of J. H. Clarke, 30, Bold-street, Southport, Lancs., is April 7, 1900; Nathan Yates, trustee, 4 and 6, Wood-street, Bolton, and *re* B. Wild, 52, Forest-road, Southport, Lancs., on the same date and same trustee.

Islington.—The Vestry have referred to the Electric Lighting Committee a report with regard to the electric lighting loans of £56,000 and £13,000, stating that the matter had been carefully considered by the Finance Committee of the County Council, but they were unable to take any further steps in the matter until the Vestry had supplied the details of the information for which they had been asked. It was the opinion of the committee that they would not be doing their duty if they sanctioned the applications without being satisfied that the amounts proposed to be borrowed were reasonable.

Aberdeen.—We understand that next financial year electric lighting extensions, costing £1,200, will be carried out on Union-terrace, Guild-street from College-street to the foot of Market-street, Exchange-street, Hadden street, Mariscbal-street, and George-street from Fraser-street to Split-the-Wind. In view of the proposed extensions which will be necessary in the next few years, the Finance Committee have indicated that they are prepared to transfer certain property at Dee village for an electric lighting station to the Gas and Electric Lighting Committee for £8,000 subject to the approval of the Town Council.

Rochdale.—At the last meeting of the Guardians the Electric Lighting Committee reported in favour of Mr. Barton being allowed to substitute his own dynamos for those contracted for on giving a proper guarantee (1) to take them out again if they should prove unsatisfactory after due trial, and (2) then put in those specified for in the original contract. The Board, however, refused to grant the concession asked for. As it stands, therefore, the contractor will have to abide by his contract. The Board also decided not to make any further payment to the consulting engineer at present, as only half of the contract had been completed.

Glasgow Telephones.—The Corporation have decided to lease from Messrs. G. and J. Maclachlan, for a period of 28 years, the two topmost storeys of a building which is in course of erection at the corner of Renfield-street and West Regent-street, Glasgow. The premises so leased are to be used as the exchange in connection with the Corporation telephone system. It is expected that the building will be ready by Sept. 1. The rates for the Corporation telephones will be £5. 5s. per annum, or, on the toll system, £3. 10s. per installation, with a penny per call extra. Intending subscribers will have the option of choosing whichever system they prefer.—*The Scotsman.*

Paisley.—At a special meeting of the Town Council on Monday the financial statement of the revenue and expenditure in connection with the electric lighting works for the year ending December last was approved of. The loan capital amounts to £60,000, of which borrowing powers have been exercised to the extent of £51,520. During the past year the general working expenses amounted to £1,475. 3s. 7½d., interest paid for borrowed money to £1,039. 11s. 4d., and with £681 passed to sinking fund, making a total general expenditure of £3,195. 14s. 11½d. The revenue amounted to £1,307. 14s. 1d., comprising £1,037. 13s. 7d. to sale of current per meter, and £270. 0s. 6d. to sale for public lighting. The deficiency of revenue of £1,888. 0s. 10½d. is chargeable to the gas corporation.

Mangotsfield.—The Parish Council have approached the electric light department of the Bristol Corporation, and they have also conferred with Mr. Faraday Proctor. They have also considered the question of having an electric light installation of their own. The Warmley District Council are making enquiries as to the cost of an installation for the Warmley District Council area. It is proposed to employ an expert in order to obtain some idea as to the cost of acquiring generating plant, etc., sufficient for them to be able to supply private consumers as well as lighting the parish. It may be possible to utilise the waters of the Frome as a motive power for lighting the district. At the next parish meeting the chairman will give particulars as to the cost of the various kinds of public lighting suitable for the parish, and leave the meeting to decide what shall be done.

South Wales Electrical Power Bill.—At a conference at Cardiff on the 23rd inst. between representatives of the Councils of Swansea and Newport, the Urban Council of Barry, and the Parliamentary Committee of the Cardiff Council in reference to the powers sought in Parliament by the South Wales Electrical Power Distribution Company, with a view of deciding upon the advisability of joint opposition, it was decided to take joint action in opposing the measure. At a meeting of the Bridgend Council on Tuesday evening, the Clerk said he believed that the Bill would ultimately pass; and as there did not appear to be much probability of the negotiations with the English Industrials, Limited, for the sale of the Bridgend electric lighting order being completed, the Council might take their energy from the South Wales Company, and simply go to the bare cost of laying the mains in the district, and distributing the power at a profit.

Kingston.—The Town Council have, on account of replies received by local builders, rescinded their resolution in regard to the insertion in the contract for the proposed extensions at the electric light works the usual clause as to the payment of the London district rate of wages, and the observance of such hours of labour as were generally accepted as fair in the borough. An order is to be given for two boilers for the electric works at an estimated cost of £2,700, subject to the subsequent confirmation of the Local Government Board. The borough electrical engineer

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is preparing a list showing the streets where electric incandescent lamps could be substituted for the present non-incandescent gas lamps. Agreements have been sealed with Messrs. Carter and Ashworth in regard to the supply of electric current to Westfield, Portsmouth-road, by the Corporation, and with the Surbiton Urban District Council. The plans of the proposed extensions to the electric works will be completed in about a week, and the surveyor has been instructed to prepare the quantities.

Shannon Water and Electric Power.—This Bill has been committed to the committee of both Houses which is to consider the four other private Bills promoted this session relating to electric power. A long discussion took place at last week's meeting of the Limerick Corporation. A number of clauses proposed to be inserted in the Bill for the protection of the interests of the Corporation were discussed. As the Corporation have previously assented to the Bill, Clause 6, which we quote in full, is of peculiar interest: "The company shall not erect or lay down any mains, cables, or works for the distribution of electrical energy in any street or road within the borough of Limerick, nor shall they enter into any agreements with any company or person for the supply of, nor shall they supply to such company or person, electrical energy for any public or private purposes within the said borough of Limerick." After considerable debate, it was decided to refer the matter to a committee of the whole House, who could appoint a sub-committee to go into the remaining clauses in detail and report to the Council.

Walsall.—Mr. H. P. Boulnois held an enquiry last Friday into the application of the Corporation for powers to borrow £15,000 for the extension of the municipal electric lighting undertaking. It was stated that the outstanding loans on Sept. 29 for electric lighting were £24,402, and the total outstanding loans of the borough amounted to £330,899. The high-tension continuous-current system, with transformers, was used. The works were first established in 1895, but the demand for current last year exceeded that of the previous year by 50 per cent. The Corporation reduced their price for motor purposes, and it is believed that during the present year there would be a considerably increased demand in consequence. The capacity of the present plant is 330 kw., and when extended it will be increased to 560. The works included in the estimate for the loan comprise an extension of the engine-room, with additional office accommodation, a 250-h.p. generator and steam-engine, with condensing plant, additional boiler, two additional transformer stations, with the necessary transformers, and high-tension feeders and wires.

Bristol.—Lieut.-Colonel A. C. Smith held an enquiry last week into the Town Council's application to borrow £145,150 for the extension of the existing electric installation. Mr. W. H. Wise said the present scheme had been in operation about seven years, and during the last six years the demand for current had increased from 14,000 to 81,000 lamps. The increase during the last year was more than in any previous year—18 100 lamps. The present application dealt with the extension of the premises at Temple Bank and the erection of the works and plant at Avon Bank. They had not been able to obtain sufficient land to carry out all extensions at the former site. The charge upon the rates for electric lighting purposes did not produce any charge as against the ratepayers, as the concern was worked at a profit. Up to March 25 last year their gross receipts were £26,223, and the gross expenditure £13,992, leaving a balance of £12,630. After paying back the instalment of loan and interest they had in hand £2 000 clear. They believed that the extensions would be sufficient for the next three years. Mr. Faraday Proctor, the city electrical engineer, said they estimated to generate 1,840 kw. at Avon Bank, which was equal to 60,000. It was also pointed out that the electric light had not been a charge upon the rates for the past five or six years. The proposed loan was for private lamps only.

Gloucester.—At Tuesday's meeting the City Council adopted the following scale of charges for the supply of electricity for motors or other power purposes: 4½d. per unit for any number of units up the equivalent of 100 hours' use per quarter of the maximum demand recorded by the demand indicator; 1½d. per unit for all consumption during the quarter beyond the above. Mr. Hammond reported that the contract for the electricity works buildings provided for a temporary end against the proposed refuse destructor works, and the specification for the refuse destructor works provided for taking down the temporary end and substituting a permanent brick partition, and suggested that the Corporation might avoid inconvenience and save some expense by omitting the temporary end and at once building the brick partition. It was recommended that this should be done, and that Mr. H. A. Dancey, the architect, should be directed to communicate with Messrs. Gurney and Sons, the contractors, as to carrying out the work. At a subsequent meeting it was reported that Messrs. Gurney could not carry out the works referred to at the schedule prices, but would be willing to do so if allowed 15 per cent. above them. It was resolved that this be done. After considering five selected applications for the appointment of charge engineer, Mr. A. C. Healey, Gloucester, was appointed at a salary of 35s. per week, the engagement to be terminated by a week's notice on either side or by the Corporation giving a week's salary in lieu of notice, the duties to be such as may from time to time be arranged by the chief engineer or by the Electricity Supply Committee.

London County Council.—At the meeting of the Council on Tuesday the Finance Committee reported that they had considered an application from the Shoreditch Vestry for sanction to the borrowing of a sum of £96,000, repayable within 42 years, in respect of the cost of erecting and equipping a new electric lighting station. The sum required for building works was £32,095, but, as the drawings were not yet completed, they proposed at present to sanction £28,000. The amount for engineering works was £63,905, but, as the Vestry had not yet decided the type of boiler to be employed and the arrangement of steam and other piping, they proposed that £42,000 should be sanctioned on account of engineering works. They recommended accordingly. This was agreed to. With regard to the action by the Greenwich District Board already referred to by us, the Highways Committee recommended that the solicitor do take proceedings against the London Electric Supply Corporation to recover penalties in respect of its default in not having maintained a constant supply of electrical energy in the area included in the London Electric Supply Corporation Electric Lighting Order, 1889. Sanction to applications was recommended from the London Electric Supply Corporation of intention to lay mains along Westminster Bridge-road and Westminster Bridge and across the end of Victoria-embankment; the County of London and Brush Provincial Electric Lighting Company, under the Wandsworth Order, 1892, of intention to lay low-tension mains along both sides of Balham Station Approach, Pendennis-road, and Farm-avenue; and from the Hammersmith Vestry to lay an electric light main across a portion of Ravenscourt Park to the public library (subject to the work being carried out under the supervision and the ground being reinstated to the satisfaction of the chief officer of the Parks Department) The Council approved of the further application of the St. James's and Pall Mall Electric Lighting Company for the construction of an extension to the generating station, and works at Carnaby-street, Regent-street, St. James's, to abut Garton-street and Marshall-street (subject to certain conditions).

Croydon. — The Lighting and Electricity Committee have reported as follows: "Before the mains extension is carried along Brigstock-road the cable will be laid along Melfort-road to the end of the continuous line of houses then built. The estimate for public street-lighting has been reduced in respect of arc lighting by the sum of £1.000. The sub-committee appointed to consider the question of charges for electric current have made an enquiry as to the causes of the numerous complaints and questions relating to the charges for last quarter, and find they are due to (*a*) the difficulty of understanding the system, and not allowing for the fact that only half-an-hour maximum was charged in the summer quarters, and hence 1½ hours had to be charged in the winter quarters; (*b*) the inevitable difference in price charged to each consumer; (*c*) the fact of the consumption of current being heavier than for the corresponding quarter of last year, due to darker weather having prevailed; (*d*) with regard to the complaints as to the light, there must be slight variation of pressure from time to time, but (except in the case of accident) the pressure at the station has been kept normal. With a view to answering these complaints as far as possible, an explanatory circular will be sent to all consumers. The circular contains also a notification that each reading of the demand indicator is now put on the meter cards and that the indicator will be temporarily disconnected (free of charge) for occasional extra lighting if desired, but not for more than one night a month. Also that the indicator measures the quantity only, and is unaffected by variation of pressure. The sub-committee further agreed that the maximum demand system, with charges of 7d. and 2d., as sanctioned by the Council in June last, is in all respects the fairest to the consumer, and they recommended that the present method of calculating the maximum hour by taking half an hour in the summer quarters and 1½ hours in the winter quarters, being the fairest to the consumer, be continued, as each quarter's account is then complete in itself, not being dependent on any other quarter. With regard to the complaints made by consumers that they had been misled into expecting a larger reduction than they obtained, they recommended that, on the completion of the first 12 months' working under the present system, any consumer not in arrears with the payment of his account, who has been the loser by the method of calculating the maximum hour, may have his account recalculated on the basis of 365 hours' use of the maximum current, and shall be credited with any amount he may have paid in excess." This report has been adopted.

LEGAL INTELLIGENCE.

NATIONAL TELEPHONE COMPANY, LIMITED v. CONSTABLES OF ST. PETER PORT, GUERNSEY.

This was an appeal heard before the Judicial Committee of the Privy Council from a judgment of the Court of Judgments in the island of Guernsey of June 15, 1897, affirming a decision of the Royal Court.

Mr. Asquith, Q.C., Mr. Forbes Lankester, and Mr. Roskill appeared for the appellants; and Mr. Rawlinson, Q.C., and Mr. Robert Younger, Q.C., represented the respondents.

The arguments were heard in November before a Board composed of the Lord Chancellor, Lord Macnaghten, Lord Morris, Lord Shand, Lord Davey, Lord Brampton, and Lord Robertson, when judgment was reserved.

Lord Davey, in delivering their Lordships' judgment, said the suit was instituted by the representative of the appellant company against the respondents, the Constables of St. Peter Port. The action was brought claiming a sum of £250 from the respondents, in that they had *mal a propos et contre droit* cut, or caused to be cut, the telephone wires belonging to the appellants which the company had stretched across the high road known as "La Grande Rue," in the parish of St. Peter Port. The respondents pleaded three exceptions to the appellants' claim: (1) that by a certain

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indenture made between the Postmaster-General and the appellants, and dated March 25, 1896, the right of the appellants to carry on their business was restricted to specified areas, called "exchange areas," of which in June, 1896, Guernsey was not one; (2) that the appellants' memorandum of association gave them no power to carry on their business in Guernsey; and (3) that the appellants had no right by custom to carry wires over the said street without the permission of the respondents, who had expressly refused the same. Those exceptions were allowed by the Royal Court and the action was rejected with costs, and that judgment was affirmed by the Court of Judgments. The appellants before their Lordships did not contest the first and second exceptions. It was admitted that at the date of the action the Telegraph Acts of the United Kingdom did not enable the Postmaster-General to confer upon the company the privileges contained in his license within the island of Guernsey, and his license did not, in fact, do so, the island not being an "exchange area." It was also admitted that the company was not then authorised by its memorandum of association to carry on business within the island. The latter point did not appear to their Lordships to be material. If the business was *ultra vires* of the company, that was a question for the shareholders or for the Attorney-General, and not one which the constables had any interest to raise. The appellants, however, denied that the Constables had by law any such power as that claimed by the third exception, and they further said that, if there be any rule of law which required their previous consent to be obtained to the stretching of wires across the streets, it did not follow that the Constables had a right to take the law into their own hands and of their own motion cut the wires, for which proceedings (they said) a special power must be shown. Their Lordships thought that there were not sufficient materials before them to enable them to say that the Constables had not such a power as was claimed and was declared by the Guernsey Court to be vested in them—viz, to prohibit the wires being stretched across the public streets, and to remove them if placed there without their consent. It must be admitted that such a power was not expressly conferred on the Constables by the "Ordonnance Générale relative aux routes rues et chemins" of 1840, and was not to be found in that document unless it be contained in the general power of "surveillance" of the highways, but their Lordships did not think it necessary, in the view which they took of the case, to express any decided opinion on that point. It was important to observe what was the substance, or, in the language of English pleaders, the gist of the action. The complainants alleged a statutory right to place their wires across the street, and complained of the interference by the respondents with their statutory right. The defence pleaded by the first exception was that the appellants had no such right. If so, the action failed. It was true that the declaration averred that the wires were "cut," but there was no allegation of unnecessary damage to the wires in removing them, and the action did not appear to be so framed as to enable the complainant to recover for such unnecessary damage (if any). Their Lordships thought that an action would not lie against the present respondents for the mere removal of the appellants' goods from a public place in which they had no right to place them. That appeared to be the case in those pleadings, for no other right but the alleged statutory right was averred. The appellants had not brought before their Lordships any rule or practice in the Guernsey system of pleading which would justify them in putting on the pleadings any interpretation different from that which the Court seemed to have adopted. Their Lordships would therefore humbly advise her Majesty that the appeal should be dismissed. The appellants would pay the costs of it.

For the text of this judgment we are indebted to the *Times*.

PROVISIONAL PATENTS, 1900.

MARCH 19.

5146. Improvements in or connected with fittings for electric lighting. Frederick Shaw and Frederick Greenfield, 24, Temple-row, Birmingham.

5154. Improvements in electric traction. Samuel Green Bennett, Clyde House, Heath Town, Wolverhampton.

5167. Improvements in and relating to alternating-current electromotors. Joseph Yates, Walter Yates, and John Bradbury Bent, 70, Market-street, Manchester. (Complete specification.)

5178. Improved means for connecting electric cables. Charles Aubrey Day, 321, High Holborn, London. (James Gilbert White, United States.) (Complete specification.)

5183. Improvements in electric locks. Henry Edward Newton, 6, Bream's-buildings, Chancery-lane, London. (Henry Guy Carleton, United States.) (Complete specification.)

5184. Improvements relating to electric tramways. Frank Boulton Aspinall and Arthur James Ireland, 6, Bream's-building, Chancery-lane, London.

5187. An automatic telephone-call recorder. Arthur Edward Lamkin, 53, Chancery-lane, London.

5191. Improvements in electric heating systems for cars. The Westinghouse Brake Company, Limited, 322, High Holborn, London. (Frank C. Newell, United States.)

5196. Improvements in simultaneous electric telegraphy and telephony. Charles Adam Randall, 98, Prince of Wales-mansions, London.

5216. Improved manufacture of filaments for electric incandescent lamps. Alfred Julius Boult, 111, Hatton-garden, London. (André Blondel, France.) (Complete specification.)

5221. Improvements in the distribution and collection of current for electric traction. George Davis, 38, Margravine-gardens, West Kensington, London.

MARCH 20.

5232. Improvements in storage batteries. Patrick Kennedy, 52, Chancery-lane, London. (Complete specification.)

5252. Improvements in apparatus for controlling and regulating electric motors. Lloyd Higginbottom, John Henry Hindle, and Thomas Mannock, Crown Ironworks, Hyde-road, West Gorton, Manchester.

5257. Improvements in apparatus for winding or producing coils, bobbins, helices, or the like, such as are used for electrical purposes. William George Heys, 70, Market-street, Manchester. (John Scott, Richard Varley, and James Chris Anderson, United States.) (Complete specification.)

5274. An improved process of and apparatus for the electro-deposition of metals. William Young Buck, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5293. Improvements in or connected with lead presses for making plates for electric accumulators and the like. William Phillips Thompson, 6, Lord-street, Liverpool. (Accumulatoren und Electricitäte Werke Act.-Ges., vorm. W. A. Boese und Co., Germany.) (Complete specification.)

5294. Improvements in electric bells. William Richard Wynne, 322, High Holborn, London.

5321. Improvements in plates for storage batteries. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Charles August Lindstrom, John Hewitt, and Thomas Hewitt, United States.) (Complete specification.)

MARCH 21.

5327. Improved system of distribution and collection of current for electric traction. George Davis, 38, Margravine-gardens, West Kensington, London.

5353. Improvements in electric traction. Edward Henry Tyler, 15, Kirkstall-road, Streatham Hill, London.

5356. Improvements in or relating to electric cables. Robert Kaye Gray, 111, Hatton-garden, London.

5361. An improvement in lamp caps for bayonet-socket electric lampholders. E. Graham Sheppard and Nernst Electric Light, Limited, 82, Victoria-street, London.

5376. Improvements in electrodes for electrolytic purposes. Edward Hopkinson and Andrew Thomas Smith, jun., 55, Chancery-lane, London.

5382. Improvements in step-by-step printing telegraph instruments. Louis Marino Casella, 1, Queen Victoria-street, London.

5387. Improvements in apparatus for wireless telegraphy. Guglielmo Marconi, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

5393. Improvements in trolley poles and standards for electric traction. Robert Price Strachan, 70, Chancery-lane, London.

5394. An improved method of insulating electrical conductors. Ernst Nappert, 11, Southampton-buildings, Chancery-lane, London. (Oscar Schaefer, Germany.) (Complete specification.)

MARCH 22.

5402. Improvements in and connected with primary and secondary galvanic cells. Edward John Wade, 18, Bournevale-road, Streatham, London.

5430. Cable suspenders for multiple switchboards or similar apparatus. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actien-Gesellschaft Mix und Genest, Germany.)

5431. Improvements in and connected with multiple switchboards for telephone exchanges. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actien-Gesellschaft Mix und Genest, Germany.)

5443. Magnetic chucks. Oakley Smith Walker, 40, Chancery-lane, London. (Complete specification.)

MARCH 23.

5482. Improvements in driving vehicles by electricity. James Enright, 202, Holland-row, Kensington, London.

5496. A process for depositing pure tin by electrolysis. Ernest Quintaine, 8, Quality-court, Chancery-lane, London. (Complete specification.)

5512. Electrical balance or contact device suitable for operating various kinds of mechanism when the equilibrium of a voltmeter or other sensitive instrument is disturbed. Alfred Warwick Gattie, 37, Essex-street, Strand, London.

5521. Improvements in the manufacture of primary batteries. Maurice Leclanché, 45, Southampton-buildings, Chancery-lane, London.

5528. Improvements in electric accumulators. Luis Gumiel, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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MARCH 24.

5561. **Transformer of alternating currents into continuous currents of equal or different tension.** Raymond Rougé and Georges Faget, 52, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 27, 1899, being date of application in France.)

5562. **Improvements in apparatus for transforming single and multiphase alternating currents into continuous currents and inversely.** Raymond Rougé and Georges Faget, 52, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Nov. 14, 1899, being date of application in France.)

5569. **Improvements in or connected with electric storage batteries.** William Phillips Thompson, 6, Lord-street, Liverpool. (Elmer Ambrose Sperry, United States.) (Complete specification.)

5585. **Improvements relating to the measurement of electric power and energy in three-phase alternating-current systems.** Riccardo Arno, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Aug. 26, 1899, being date of application in Italy.)

5593. **Improvements in electricity meters.** Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk-street, Strand, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published April 14, 1900.

1899.

1434. **Electric telegraph apparatus.** Brown.

4360. **Apparatus for use in electric traction on the conduit system.** Vedovelli and Priestly.

6064. **Electric relays.** Wise. (Crehore and Squier.)

6159. **Facsimile telegraph apparatus.** Boult. (Lany.)

6160. **Facsimile telegraph apparatus.** Boult. (Lany.)

6205. **Electric meter vehicles.** Loir.

7479. **Secondary batteries.** Justice. (Preiss Electric Storage Syndicate, Limited.)

7892. **Electrical batteries.** Jungner.

8997. **Apparatus for regulating the arc in electric arc lamps.** Chatterley.

9240. **Safety devices for use in connection with electrical distributing systems.** Partridge and London Electric Supply Corporation, Limited.

9468. **Arc lamps.** Bohle, Bohle, and Phillips.

9484. **Electric arc lamps.** Stockwell.

10233. **Coin-operated mechanism specially applicable for electric and other meters.** Du Bois and Mutual Electric Trust, Limited.

10839. **Automatic electric cut-out devices for electric cooking apparatus.** Schindler.

11325. **Electric traction.** Bochet.

11381. **Electrical apparatus for effecting rotation at a distance.** Croneau.

13650. **Bonds for electric tramways and railways.** Kenway.

25403. **Electric low-water alarm for steam generators.** Mathews.

25768. **Electric lifts or elevators.** Rowntree.

1900.

2150. **Telephone transmitters.** Dallaire.

3166. **Automatic electric circuit-breaker.** Reed, Reed, and Farrar.

3197. **Isolated alternating low-tension systems of electrical distribution.** Reed, Reed, and Farrar.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Mar. 24	3 907	3,390	+ 517	47,257	44,793
Blackpool-Fleetwood	,, 24	187	174	+ 13	1,872	2,087
Bradford City Trams	,, 25	350	241	+ 109	28,059c	—
Bristol Tramways Co.	,, 23	2,400	2 321	+ 79	—	—
City & South London	,, 25	1,353	1,108	+ 245	14,579	13,349
Dover Tramways ...	,, 24	137	124	+ 13	1,723	1,696
Dublin U.T., elec. cars	,, 23	2,778	872	+1,906	—	—
Dublin S.D. Electric	,, 23	565	601	- 36	—	—
Halifax Corporation	,, 18	537	315	+ 222	29,185a	10,399b
Hull Corporat'n E.S.	,, 24	694	—	—	—	25,194c
Liverpool Corporat'n	Feb. 24d	6,882	5,723	+1,159	52,098	46,118
Liverpool Overhead	Mar. 25	1,219	1,269	- 50	16,860	15,620
Sheffield Corporation	,, 25	1,815	—	—	—	—
South Staffordshire	,, 23	607	542	+ 165	7,209	7,092

a Since April 1, 1899. b Since June 29, 1898.
c Total receipts. d Partly electrical. e Since July 5, 1899.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Tuesday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	11/16-13/16
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 6½
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	½-1
—— 6 per cent. Cum. Pref., 1-50,000	1	..	½-1
—— 4½ per cent. First Mortgage Debentures	108	..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	4½-5½
Brush Electrical Engineering, Ordinary	2	..	1½-2½
—— Non. Cum., 6 per cent. Pref.	2	..	2½-2¾
—— 4½ per cent. Debenture Stock	100	..	108-113
—— 4½ per cent. 2nd Debenture Stock	100	..	103-105
Callender's Cable, Debentures	100	—	112-116
—— Ordinary	5	..	14½-15½
—— 5 per cent. Pref.	5	..	5½-6
Crompton and Co.	3	..	3½ 4
—— 5 per cent. Debentures	—	..	98-101
Edison and Swan United, Ordinary	2	..	2-2½
—— 5 per cent. Debentures	5	..	3½-4½
—— 4 per cent. Deb. Stock, Red.	100	..	98-99
Electric Construction	2	..	2½-2¾
—— 7 per cent. Cumulative Pref.	2	..	2½-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	104-107
Giffre Electro-Chemical and Power, Ordinary	1	—	½-1
W. T. Henley's Telegraph Works, Ordinary	5	—	13½-14½
—— 4½ per cent. Preference	5	..	5½-5¾
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	11-12
—— 4 per cent. Debentures	100	..	99-103 xd
Telegraph Construction and Maintenance	12	..	36-40
—— 5 per cent. Bonds	100	—	102-105
Telegraph Manufacturing, Ordinary	5	—	9-10
—— 5 per cent. Cum. Pref.	5	..	5½-6
Will'ans and Robinson, Ordinary, 1-80,000	5	..	11-12
—— 6 per cent. Cum. Pref., 30,001-60,000	5	..	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
Bournemouth and Poole, Ordinary	10	..	13-13
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8½-9½
Charing Cross and Strand	5	..	9½-10½
—— 30,001-50,000	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5½-6
Chelsea Electricity Supply	5	—	7-8
—— 4½ per cent. Debentures	100	—	110-112
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	13-14
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9½-10½
—— 6 per cent. Cum. Pref.	10	..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4½-5½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	10-10½
London Electric, Ordinary	3	..	1½-2½
—— 6 per cent. Pref.	5	..	4½-5½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	—	100-102
Metropolitan, Ordinary	10	..	13½-14½
—— 62,501-85,000	10	..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1½-1¾
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6½-7
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	1½	..	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100	..	104-106
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2½-2¾
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	3½-4½
St. James's and Pall Mall, Ordinary, 101-20,080	4	..	14-15
—— 40,081-52,080	5	..	14-15
—— 7 per cent. Pref.	5	..	8½-9½
Westminster, Ordinary	5	..	13½ 14½
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-Shares	5	..	4½-5½
—— ,, ,, deferred	5	..	5-5½
City and South London, Consolidated Ordinary	100	..	67-70
—— ,, ,,	5½	..	4½-5½
—— 4 per cent. Debenture Stock	100	—	125-130
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	—	13-13½
Waterloo and City, Ordinary	100	—	101-104
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17-18
Brisbane Tramway	100	..	104-106
British Electric Traction, Ordinary, 1-30,000	10	..	17-18
—— 60,001-75,000	10	..	16½-17½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	13-13½
—— 5 per cent. Perpetual Debenture Stock	100	..	126-129
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	105-108
Isle of Man Electric Power, 1-95,000	1	..	15/16-15/16
—— 6 per cent. Preference, 100,001-170,000	1	..	15/16-1 1/16
Kidderminster and District Lighting and Traction, Pref.	10	..	10-10½
New General Traction, Ordinary	5	..	3½-4½
—— 6 per cent. Cum. Pref.	5	..	5-5½
North Staffordshire Trams	6	..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	18-19
—— Preference	10	..	10½-10¾
Potteries Electric Traction, Ordinary, 28,667-40,000	10	..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	½-¾
National Telephone, Ordinary	5	..	5-5½
—— 6 per cent. Cum. First Pref.	10	..	14-15
—— 6 per cent. Cum. Second Pref.	10	..	14-15
—— 5 per cent. Non. Cum. Third Pref.	5	..	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	..	97-100
Oriental Telephone and Electric Company	1	—	¾-1

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NOTES.

Paris Congresses.—We are informed that a congress on steam engines and boilers will be held from July 16 to 18 at the Paris Exhibition. The subjects for discussion at this congress have to do with the inspection and supervision of all machinery using steam.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, Sir J. Crichton-Browne in the chair, when the following were elected members: Mr. R. T. Glazebrook, Mr. E. J. Humphrey, Mr. H. S. Maxim, Mr. S. W. A. Noble, Mr. W. F. Snell, Mr. W. J. Tennant.

The Hispano-American War.—We notice that on Friday last the United States House of Representatives considered the Bill for the payment to the Eastern Telegraph Company of the cost of repairing the Manila-Hong Kong cable, which was cut by Admiral Dewey prior to the destruction of the Spanish squadron at Manila. The Bill was eventually referred back to the committee.

The Chemical Society.—At the last meeting of the Chemical Society Sir H. Roscoe delivered a lecture on the work of Bunsen. He began by speaking of the work of Bunsen with respect to cacodyl compounds, in experimenting with which he lost his right eye. His work on blast furnaces, carbon-zinc batteries, photometers, calorimeters, spectrum analysis, etc., was then explained, and the lecturer afterwards gave some very interesting personal anecdotes respecting the deceased scientist.

Glasgow International Exhibition.—It is officially notified that all applications for space at the Glasgow International Exhibition, which is to be opened in May, 1901, must be lodged not later than June 1, 1900, with the general manager, Mr. H. A. Hedley. There are in all eight classes, amongst which are agriculture, mining, industrial design and manufactures, machinery and labour saving appliances in motion, locomotion and transport, marine engineering and shipbuilding, lighting and heating, science, etc.

Association of Municipal Corporations.—At the annual dinner of this association held last Friday Mr. Chaplin, M.P., referring to the question of municipal trading, said he was surprised at the attitude taken by some in the House of Commons towards the Government's proposition to appoint a committee to enquire into the principles which ought to govern municipal authorities in this respect. As to the question of housing the working classes, he thought the solution of the difficulty lay in providing cheap trams and trains.

The Metropolitan Railway.—At the extraordinary general meeting of the Metropolitan District Railway Company, in which the Bill now before Parliament was approved by the shareholders, considerable reference was made to electrical driving. We understand that some successful trials have recently been made on the section which has been equipped electrically, from Earl's Court to Kensington High-street, and that the Board of Trade inspection was to take place in the early part of this week. The result of this inspection is not to hand at the time of writing.

The Volta School at Naples.—This school, so called in remembrance of Allessandro Volta, has been formed in Naples with the purpose of producing engineers who shall be quite up to date in all that concerns the various applications of electricity. The scholars, who number about 400, provide their own tools, and go through courses in electricity, chemistry, mechanics, etc. It is stated that they easily obtain employment on leaving the school. The school is aided both by the Government and the town authorities, and the pupils pay only a nominal fee, which in special instances is dispensed with.

Indian Telegraphs.—We note with satisfaction that the authorities having charge of the telegraphic arrangements in India are endeavouring to create better intercommunication between the various towns. Thus we learn from *Indian Engineering* that automatic telegraphy has been introduced between Calcutta and Bombay with the most satisfactory results, telegrams being transmitted at the rate of 120 words per minute in each direction. Although the distance traversed is nearly 1,300 miles, it has been found possible to work direct between the two cities without requiring an intermediate repeating station.

New Provisional Orders.—The first batch of new provisional orders granted by the Board of Trade during the present session is confined entirely to local authorities. Thus the following municipal authorities will soon be entitled to supply electricity in their districts, as the Board of Trade has granted their applications for a provisional order: the Corporations of Basingstoke, Newark, and Penzance, and the Urban District Councils of Brierley Hill, Cleethorpes, Elland, Erdington, Exmouth, Farnham, Leek, Littleborough, Maryport, Nantwich, Ormskirk, Penrith, Prestwich, Redcar, Sowerby Bridge, and Whitefield.

Custom House Idiosyncrasies.—The Custom House authorities in India have been much concerned of late by the fact that telephone poles, although imported in the form of tubes, are not adapted for use as pipes. They have accordingly issued a circular to the effect that these tubes are not really tubes, as by reason of their tapered ends they are specialised for their use as standards. In consequence of this they are to be classed as telephonic instruments, apparatus, and appliances. It is interesting, however, to note that the customs do not lose by this change in the classifying of the poles, as the duty is increased thereby from 1 per cent. *ad valorem* to 5 per cent.

Bristol Engineers.—The annual meeting of the Bristol Association of Engineers, recently held in that town, resulted in the following officers and members of committee being appointed for the session: President—Mr. F. J. de Soyres; vice-president—Mr. J. R. Bennett; hon. treasurer—Mr. A. P. I. Cotterell; hon. secretary—Mr. Nicholas Watts; auditors—Messrs. T. J. Moss Flower and D. McDonald Stuart; members of committee—Messrs. H. E. Chattock, H. W. Harding, and J. McDonald. At the meeting in question a paper was read by Mr. A. P. I. Cotterell on "The Engineering Aspect of Sewage Purification."

Electric Motors.—The driving of factories by electricity is now generally adopted whenever new manufacturing undertakings are started. In this connection the question yet to be decided is the exact point at which it pays to provide an individual motor to each machine tool rather than grouping a number of tools on a countershaft. Mr. Jackson's opinion, as stated before the American Society of Mechanical Engineers, is that all large tools requiring from 5 h.p. to 7½ h.p. should have their own motors, and that smaller machines should be grouped together on a countershaft supplied with a motor of from 3 h.p. to 5 h.p.

L.C.C. Logic.—The London County Council has now gravely decided that it cannot be said to have obstructed the National Telephone Company in its endeavour to put wires underground, because the consent from the Postmaster-General had not been obtained. This latter point is the subject of a lawsuit, and hence we do not propose to discuss it, but the Telephone Company considers that it has

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had this consent for years. In any case the company has periodically endeavoured to get the consent of the London County Council for the past four or five years, and that august body has discussed the matter and refused the permission to lay wires underground. How it can then claim that the charge of obstruction is unfounded we do not see.

Adelaide.—We notice in the report of the Board of Governors of the Public Library, Museum, and Art Gallery of South Australia for 1898-9, a copy of which has been forwarded to us, that the library lighting is not all that could be desired. The librarian, Mr. J. R. G. Adams, reports the lower gallery to be now well lighted, and the upper gallery better illuminated than of old, but the Welsbach incandescent burners installed have proved their attendant disadvantages, the renewal of mantles and chimneys being found frequently necessary. In concluding his remarks upon the shortcomings of the present system of lighting, the librarian expresses a hope that the time is not far distant when the buildings will be provided with the electric light.

Boiler Inspection.—The appointment of a Select Committee by the House of Commons to look into the question of boiler accidents, and to consider the best means of ensuring a regular inspection, should result in a reduction of the number of boiler accidents. We understand, however, from a statement made by the Home Secretary, that a clause is to be introduced into the Factory Act which will ensure that every boiler used in a factory shall be provided with a proper safety valve and steam-gauge, and shall be cleaned out by a competent person once every three months. It will also be obligatory that a competent engineer shall examine the boiler once every three months, and that he shall register the result of his examination. These precautions, although entailing a certain amount of expense, are economical in the long run to boiler users.

Instantaneous Photo-Micrography.—Prof. A. C. Scott describes in the *Scientific American* an arrangement he has devised for obtaining instantaneous photographs of small living organisms. For this purpose a strong projector taking some 2,200 watts is employed for illuminating the drop of water containing the organisms to be photographed. The rays from this projector are concentrated by a condenser on the object, but it is not advisable to get the exact focus on account of the great heat which would then be generated. A prism is used for ascertaining when the organism to be photographed is in the right position in the drop, and the prism is then withdrawn, and the rays of light passing through the microscope are secured on the photographic plate. With this apparatus good photographs have been obtained with an exposure of as short a time as $\frac{1}{100}$th of a second. Some successful photographs made by this means are reproduced by our contemporary.

Viennese Motorcar Exhibition.—Exhibitions of motorcars are now taking place at frequent intervals in different parts of the world. The last place brought to notice as being about to hold an exhibition of this kind is Vienna. The exhibition is to be held under the auspices of the Austrian Automobile Club, and will open on May 31 next, continuing until June 10. The presidents at the meeting will be Prince Max Egon Fürstenberg, Mr. Paul von Schoedler, and the British Consul-General in Vienna. The exhibits are to include motorcars, parts of the same, and all appliances and accessories of the sport, and the Austro-Hungarian Consul-General in London states that valuable prizes will be awarded. An interesting point in connection with the exhibition will be that foreign goods will be admitted free of duty, and returned free of charge afterwards. We are informed that intending exhibitors or visitors should apply for particulars to the British Consul-General in Vienna.

Electrical Crystallisation.—The following is an abstract of a paper contributed by Mr. T. Tommasina to the *Comptes Rendus*. The abstract appears in the *Journal* of the Chemical Society, and is as follows: When an electric current of less than one milliampere is sent through flat zinc electrodes placed in distilled water, the electrodes being very close to each other, well-defined crystals of metallic zinc are deposited. At first no gas is evolved, but after the action has been going on for some time, there is an evolution of gas from the cathode, the electrodes become oxidised, and the deposition of the metal ceases. If the anode is removed, cleaned, and then replaced, the action begins again. With a copper plate as cathode, and a zinc anode, crystals of zinc are deposited on the copper. Similar results were obtained with silver and cadmium. If the two electrodes are too widely separated, then a kind of haze appears between them; this contains very small, metallic crystals, which are arranged in a chain-like form.

Henry's Original Apparatus.—We notice in the *Electrical Review* of New York a description by Mr. G. C. Maynard of an electromagnet made in 1831 by Prof. Henry for Yale College, and which is now in the Smithsonian Museum. The magnet, without wire, weighs some 59½lb., and was formed from a bar of Swedish iron, 3in. square and 30in. long. Before bending into the horseshoe shape, the edges were flattened so as to give it an octagonal shape. The armature is a piece from the same bar, but without the edges flattened, its length being 9½in. and the weight 23lb. The magnet winding consists of 26 strands of copper bell wire, thread covered, and 31ft. long. The aggregate length of the coils is about 728ft. The battery used to magnetise this piece of iron was a single-cell battery formed of concentric copper cylinders with cylinders of zinc plates interposed, and "so united as to form but one galvanic pair." The battery was 12in. high and 5in. in diameter, and the plate presented a surface of nearly five square feet to the liquid. The lifting power of the magnet was about a ton.

The Mersey Railway.—At the half-yearly meeting of the Mersey Railway Company, the chairman, Mr. James Falconer, informed the shareholders that a great saving could be effected by the use of electric traction. It had, he stated, the merit that the carriage accommodation could be suited to the number of passengers travelling. He quoted from estimates made by Sir W. Preece and Major Cardew as to the reduction in expenditure obtainable by the use of electric instead of steam traction. These gentlemen estimated that £11,000 or £12,000 would be saved in working expenses, and that the receipts would immediately go up £18,000, and within three years £18,000 higher, so that between the saving in working expenses and the increase in receipts their net revenue would be increased by something like £40,000 to £50,000. A gratifying feature of the proposal to convert the lines was the almost unanimous approval of the company. No opposition was anticipated from any other company, and the Liverpool Corporation electric mains could be left undisturbed. The system which it is proposed to use on this line is the third-rail.

Alternate-Current Arcs.—The conclusion of the discussion before the American Institution of Electrical Engineers on Mr. Waite's paper on "The Cost of Arc Lighting" is published in the volume of the *Transactions* which has just reached us. It will be remembered that in the paper considerable attention was drawn to the advantages of series lighting with alternating currents supplied through a constant-current transformer. The question of

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the power factor in this system formed a bone of contention in the discussion. This power factor naturally depends somewhat on the regulating range of the constant-current transformer. It was stated by one speaker that the power factor generally of the system was below 70 per cent., and that at quarter load it fell as low as 24 per cent. This would be rather serious where a number of arc lighting circuits were supplied, owing to the armature reactions which would be set up in the generators. The supporters of the system stated that they could easily obtain a power factor of 90 per cent. From the section we have seen of the constant-current transformer we very much doubt if such a result could be obtained.

Electric Traction in Bavaria.—The first standard-gauge electric railway in Bavaria was opened for traffic recently, the Lokalbahn-Aktien-Gesellschaft having introduced electric traction on to a portion of their system of railways which serves the suburbs of Munich. It is proposed to inaugurate a 15-minute service of trains between Munich and Grünwald. The motorcars employed have four axles, and provide seating accommodation for 90 passengers and standing room for a further 20. Each car is divided into three compartments, which are electrically lighted and heated. A motor capable of developing an output of 50 h.p. is placed at each end of the car, and actuates one of the axles of the corresponding bogie truck. The generating station from which is provided the necessary power is equipped with a horizontal tandem compound steam-engine of 150 h.p. output, coupled by means of belts to a continuous current dynamo giving 180 amperes at 580 volts terminal pressure. The track is equipped with overhead trolley wires, from which the current is collected by bow contacts. Messrs. Schuckert and Co., of Nürnberg, supplied the whole of the electrical equipment of the line.

Snow on Telephone Wires.—Mr. E. Pierard, a telegraph engineer of Belgium, has had an opportunity of studying this last winter the effect of snow on the telephone wires near Malines. He found, for instance, that a bronze wire 2mm. in diameter collected an ovoid of snow, whose two axes were respectively 28mm. and 36mm. The weight of the snow was, roughly, 1·78 times that of the wire. A smaller wire 1·4mm. in diameter collected an envelope of snow 4·38 times its own weight. The result of this snow collecting on the wires running from the central office in Brussels imposed an extra weight of over 30 tons on the supports over this office. In calculating the deflections produced by the heavy coats of snow, the author found that in many cases the long spans were safer than short ones. This was because the long spans sagged sufficiently to enable the central portions to find additional supports on house ridges, etc. As an example of what these sags would be with the weights mentioned above, the author found that with a span of 100 yards there was a sag of four yards, with a span of 550 yards the sag was about 25 yards. It is a wonder that the wires carried such a load without their elasticity limit being exceeded.

The Creeping of Rails.—Up to the present in this country the electrical engineer has not had the same experience as his American cousin of running electric railways and tramways over bridges erected solely for that purpose. There is also evidence from America that certain of these bridges are constructed quite as lightly as they should be, and on these a considerable amount of trouble has resulted from the creeping of the rails. From information published by Mr. N. W. Eayrs in the *Scientific American* on this action on the Eads Bridge we obtain the following surprising figures: In one month from April 15 to May 15, 1899, one of the rails on the eastward bound track crept no less than 47ft. 4in., while the smallest creeping action on one of the rails on the westward track resulted in a movement of 12ft. 7½in. The author states that all attempts to anchor these rails had to be abandoned on account of the strain, fishplates being torn in two and other troubles ensuing. He accordingly arranged an ingenious system by which a new length of rail was continuously passed into the line at an ordinary point. At the further end of the bridge a somewhat similar arrangement in the opposite direction allows the creeping rails to move out without causing a break in the track. The creeping always occurs in the direction of the traffic, and is largely dependent on the elasticity of the supports of the track.

Copper.—The New York *Sun*, in a long article reviewing the present state of the copper market, exults in the fact that English manufacturers have been compelled to buy copper in America in the early months of the present year, and that in consequence the price has gone up again. We would, however, join issue entirely with the above paper in its reflections on the English merchants and manufacturers, and in its repeated statement that the rise in the price of copper is not due to American manipulation and corners. We find, for instance, in the article the curious statement that "in England, unlike the United States, raw copper is an article of speculation; the cash article and options for the future delivery of it are dealt in much the same manner that grain, cotton, and similar commodities are in our own country." In view of the known methods by which the copper market in America has been controlled, it is curious to find the New York *Sun* stating that copper is not an article of speculation in the United States. A view of the present situation tends in our opinion to show that, while the great demand for copper has enabled the Americans to hold their own so far this year, the high price is not likely to continue. New mines starting and increased production in old mines, coupled with the well-known laws of supply and demand, will in the long run break up the corner in copper.

An Electric Lightship.—One of the most dangerous coasts in North America is that immediately round Cape Hatteras. Such is the violence of the storms around this Cape that all attempts to erect a lighthouse have been unavailing. An ordinary lightship which was tried at this spot was torn from its moorings. Owing to this, a specially constructed lightship has been designed for placing at this special place, and is being built, says the *Scientific American*, by the Fore River Engine Company, of Massachusetts. The ship will be steam propelled and electrically lighted, will be 112ft. in length, 28½ft. wide, and nearly 15ft. deep. The vessel is to have three decks, and the hull will be divided into watertight compartments. The dynamos and engines are to be placed on the main deck, and the electric plant is to be driven by two non-condensing double-cylinder engines, the steam pressure being 80lb. to the square inch. Lamps of 16 c.p. at 100 volts are to be used for lighting the ship, and the masthead cluster will consist of six 100-c.p. 100-volt lamps, these being controlled by an automatic flashing device, driven by a belt off the dynamo shaft, with a worm and worm-wheel arrangement for operating a circuit breaker. On the vessel will be two hollow masts, through which the conductors for the masthead lights are to pass. These masthead lights will be about 59ft. from the water-line, and are to be adapted for either electricity or oil.

Electric Pumping.—The small space occupied by an electrically-driven pump as compared with that required for a pumping engine 50 years ago is illustrated in the *Scientific American*, in connection with the pumping plant of Dry Dock No. 1 of the Brooklyn Naval Yard. The old

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engine, which is of the oscillating beam type, was installed in 1851 and was able to pump 22,000 gallons of water per minute. The engine occupies a lofty room 54ft. square, and the oscillating pump is supported by a framework of cast iron, consisting of a double line of Gothic columns and arches. This Gothic work about an engine seems ridiculous at the present day, but it was greatly in favour amongst certain engineers about 50 years ago. This engine, with its cylinder 50in. in diameter and with its 12ft. stroke, is provided with the old parallel motion devised by Watts. The total weight of the engine is 270 tons. The new pumping plant will consist of two 30in. direct-connected electrically-driven centrifugal pumps, capable of dealing with 60,000 gallons of water per minute. A smaller pump and motor will also be provided for the final drain of the dock. These electric pumps do not occupy a quarter of the floor space taken up by the pumping engine, and the height is, of course, very much less. The only question which arises in the comparison is as to whether the electrical pumping plant will be in as good a state of repair 50 years hence as the old pumping engine is to-day.

The Paris Exhibition.—The largest example of electrical engineering plant from England to be exhibited at the forthcoming Paris Exhibition will be a direct-current dynamo manufactured by Messrs. Siemens Bros., coupled to the largest Willans engine ever made. This engine will be capable of indicating 2,400 h.p., while the dynamo will give off some 2,700 amperes at 500 volts. Another English exhibit will be a 280-kw. Mather and Platt dynamo, which will be driven by a Galloway engine. We also understand that Messrs. Robey and Co., of Lincoln, will have on view one of their engines driving a continuous-current dynamo of 200 kw. Thus the aggregate output of the English dynamos will be 1,900 kw., which places this country third on the list. The French makers naturally come first, and their machines, of which there are to be 19, will be capable of generating over 8,000 kw. The aggregate capacity of the machines from German manufacturers will be about half of this. An analysis of all the electrical generators being fixed to supply the exhibition with light and power shows that the three-phase system will supply the most energy. Machines of over 10,000 kw. on this system are being installed, while the continuous-current system comes next with slightly over 8,000 kw. There will be a small exhibit of two-phase machinery, and the single-phase alternators will have an aggregate output of about 1,250 kw. We understand that the English plant is well forward, and that the large Willans engine may be expected to be running soon after the opening of the exhibition.

Incandescent Lamps.—There are, as Prof. Cory said at San Francisco, incandescent lamps and incandescent lamps. The economic value of a lamp depends upon a variety of considerations, some of which are not always acknowledged. However, experience either from practical or experimental use is always of value; hence when Prof. Cory says it is more economical to "burn out lamps than to burn coal," it is worth while to look a little closely into what he means. In the first place, he does not mean that his words are to be taken too literally, as may be seen from the example given. The University of Michigan uses 500 incandescent 16-c.p. lamps, and a saving of 150dol., or, roughly, £30, per annum was effected by using lamps absorbing 3·1 watts per candle instead of lamps absorbing 3·6 watts per candle. The latter lamps have the longer life, so that by using the former the cost of renewals must be larger, but, notwithstanding this, the gain is made. Neither the cost of the electrical energy nor of the lamp is given, and as these are all-important factors in the case, it will be seen that the statement must be taken to indicate individual experience, and not as a rule applicable to other places labouring under different conditions. In the case mentioned there is a saving of ·5 watt per candle, and this, multiplied by the number of hours and the total candle-power averaging per year, will give the watts saved per year. When the cost of the electrical energy per unit is known, the saving on this account is known. Against the saving must be put the cost of lamp renewals, and the balance gives the £30 mentioned.

National Physical Laboratory.—A circular letter has been issued by Mr. R. T. Glazebrook, F.R.S., as director of the National Physical Laboratory at the Old Deer Park, Richmond. In this circular he reviews the history of the National Physical Laboratory from the year 1898, when the Treasury Committee issued its recommendations for the establishment of the laboratory. It was then decided to extend the Kew Observatory, and to provide facilities for standardising and verifying instruments for testing materials and for the determining of physical constants. Mr. Glazebrook calls attention to the fact that the Executive Committee, of which the president of the Royal Society is chairman, Lord Rayleigh vice-chairman, and the permanent secretary of the Board of Trade an official member, includes representatives of the Royal Society, the Kew Committee, the Institutes of Civil, Mechanical, and Electrical Engineers, the Iron and Steel Institute, the Society of Chemical Industry, and the Institute of Naval Architects. It is the intention of the committee to continue and extend the work of testing scientific instruments hitherto carried on at the Kew Observatory, and they believe that this work will be benefited in every way by the increased facilities for experimental investigation afforded by the resources of the laboratory. The committee are glad to add that Dr. Chree, together with all the present members of the observatory staff, have consented to transfer their services to the National Physical Laboratory, so that the continuity of the work will be fully maintained. Certificates will bear the heading "National Physical Laboratory, Richmond, Surrey," and will be signed by the director. Instruments and other articles sent for testing should be addressed to the Director, National Physical Laboratory, Old Deer Park, Richmond, Surrey.

Multipolar Dynamos.—With the great demand for large generating units, the multipolar type of dynamo is now accepted in practically every central station. In the design of these machines for large outputs it becomes imperative to use a paralleling system of winding with the same number of collecting points on the commutator as there are poles to the machine. The alternate sets of brushes are then connected in parallel, usually on the frame supporting the brushes. With this arrangement any error in the centering of the armature inside the field throws an undue load on certain sections of the armature owing to the difference in the air-gap. The first outcome of this is that certain brushes are considerably overloaded, and sparking ensues, which tends to damage the commutators. Another effect is that when the armature is, by reason of a slight displacement, nearer the poles on one side, the magnetic pull on the armature on that side is greatly increased, and tends to strain the bearings in such a way as to increase the field. Various means have been suggested for overcoming these different troubles, and we notice that in America the following expedients are being tried on some 800-kw. machines in the power station of the South Side Elevated Railway of Chicago. Mr. F. C. Perkins, describing these machines in the *Electrical Review*, states that a number of points in the

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armature winding, which are normally of equal potential, are connected together by leads through which currents may pass from one section to the other. The currents are alternating, and they tend to magnetise and demagnetise the poles of the fields so as to correct the errors in centering which give rise to them. This method of connecting the armature conductors together, and not relying on the brush gear alone for paralleling sections of the armature, relieves the brushes from the large circulating currents which give trouble on the commutator. It is stated that with this construction the armatures may be considerably out of centre without injurious results occurring. It is also stated that the mechanical strain on the bearings is decreased, but we fancy that this cannot be so to any great extent.

Municipal Trading.—The recent decision of the Select Committee of the House of Commons which had before it the consideration of the Bill of the Glastonbury Corporation for the purchase of the gasworks, is of great interest. In fact, the decision gives some indication of the line which Parliament may be expected to take in the matter of large municipal trading schemes, in which the central authority proposes to carry out works in the surrounding districts. In the case now before us the Glastonbury Corporation had made arrangements with the local gas company to purchase their undertaking, which also supplied the Urban District Council of Street. The Street district had been a good customer, and would, of course, still wish to take a supply from the undertaking when in the hands of the Glastonbury Corporation. The Select Committee was asked to protect the Street Council against an undue profit being made on the undertaking in which their ratepayers would not share. The Select Committee solved the question by restricting the surplus profits which the Glastonbury Corporation could apply to their district funds to 1 per cent. per annum on the capital for the time being of the undertaking. This 1 per cent. is to be looked upon as management expenses, and all further profits are to go in reducing the price of gas. On the question of repurchase further protection was given, as it was decided that should the Urban District Council of Street decide to purchase its part of the undertaking in the future, the price to be paid should make allowance for the proportion of the sinking fund which had already been paid by the consumers in the district. The most striking feature in the above decision is the limitation of the profit which should be used for reduction of rates to 1 per cent. If this were enforced in all cases, as is only reasonable and just, a favourite argument of the strongest advocates of municipal trading would be abolished—*i.e.*, that rates would be reduced. In the case of tramway undertakings it would be, of course, difficult to so adjust the fares that only 1 per cent. profit would be made, but the same result could be arrived at approximately.

Contact Electricity.—Mr. E. Pierard contributes to the February number of the *Bulletin de la Société Belge d'Electriciens* the results of some curious experiments in telephoning without a battery or other source of electricity. In these experiments a vibrating diaphragm carrying on the back a small platinum disc was so arranged as to touch, when vibrating, the platinum point of a screw at the back of the diaphragm. When the telephone was connected to the screw and the diaphragm respectively, the apparatus was found to transmit musical sounds with distinctness. The effect in the receiving telephone could also be increased by means of an induction coil. The author proceeds to analyse the experiments in order to ascertain whether the currents resulted from a Volta effect or from a thermo-electric effect. With the first object he tried a number of diaphragms with and without the platinum contact at the back. The best results were got with a plate of argentan—an alloy of copper, nickel, and zinc. This diaphragm had a thickness of 0·194mm. Without the platinum contact at the back no sounds were audible, but as soon as this was added the diaphragm acted exceedingly well, even better than the first diaphragm, which was made of tinned iron. The addition of the platinum in the centre of the plate was proved to be not merely a mechanical advantage, by reversing the diaphragm so that the screw contact came against the surface of the alloy. A diaphragm of copper did not act so well as the above, but here again the addition of the platinum contact had an advantage. A diaphragm of zinc gave very poor results, and with a diaphragm of aluminium no sounds could be heard. An iron diaphragm also did not act well except when the platinum contact was added. To prove that it was not a thermal effect, the whole apparatus was kept at one temperature, and the sound was made by the vibration of a rod of wood, which acted just as well as when speaking or singing into the apparatus. The author, after other experiments, concluded that the action was due to contact electricity and to the small currents resulting therefrom when the connection between the two platinum points was made and broken. This is another instance of the exceedingly small currents which an ordinary telephone is able to detect.

Telegraphing and Telephoning Simultaneously over one Line.—An article is contributed to the *Elektrotechnische Zeitschrift* by Mr. F. Walloch, who discusses the progress which has been made with regard to the use of single lines for telegraphing and telephoning simultaneously. After describing the Rysselberghe system of attaining this end, and fully explaining the important part played by condensers with the aid of diagrams, Mr. Walloch goes on to describe a modification of the system recently introduced by the Telephone Works, Limited, of Hanover (formerly J. Berliner), which, it seems, has already been adapted to a number of large installations, including the Berlin fire brigade service. There are 15 brigade stations in Berlin, each of which is served by a special network of fire-alarms. From these stations underground wires radiate in all directions, each wire being connected up to a great number of alarm pillars. The alarms are arranged for automatic working, and to each is fitted a key for telegraphing to the station. As it is, however, a very great advantage to be able to maintain a good connection between the alarm pillars nearest the fire and the brigade station during the progress of the fire, exhaustive trials have been made with a specially-adapted telephone constructed by the above-mentioned firm, which have resulted in the general introduction of the same. To the Morse apparatus at the station a stand is attached, from which a micro-telephone fitted with a battery switch and a second receiver are suspended. The remaining apparatus is enclosed in a flat box and placed under the table. This box contains an induction coil, a condenser, and a circuit key. As it would be expensive to equip each of the fire-alarm posts with telephone apparatus, a portable set is used, which may be attached to either of the posts by means of a plug and socket provided for the purpose. Such a portable set is carried by each of the brigade carts, there being some 80 now in use. The brigades cycles are also equipped with sets which are very compact in design. Experience with the system has shown that the switching in of the telephone apparatus in no way influences the telegraph service. During simultaneous telegraphing and telephoning a slight knocking is perceptible in the telephone, which, however, does not destroy its audibility.

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DONCASTER ELECTRICITY SUPPLY WORKS.

Evidences of municipal enterprise in many directions, but more especially in electric lighting matters, have of late been very marked. This applies particularly to Northern England, which has added rapidly to the list of

Councillor Mark Dowson, chairman of the Electricity Committee, Doncaster, has been chairman of the Electricity Committee since it was formed, and is one of the very few Doncastrians who have had their business premises lighted by electricity from a private plant. He has always been a great supporter of the electric lighting scheme in Doncaster, and has been most untiring and energetic in furthering the undertaking.

municipal undertakings completed. A few weeks since it was York, this week it is Doncaster's—another Yorkshire town—turn to inaugurate an electricity supply within its boundaries. The ceremony, which partook almost of a private nature, took place on Monday, the 2nd inst., when the Mayor (Alderman Bentley), in the presence of the members of the Electricity Committee and a few other members of the Corporation, started the first engine at the new generating station in Grey Friars-road, Councillor Dowson, chairman of the Electricity Committee, subsequently turning on steam to the second engine, the electric light being switched on to the town by the Mayoress. Afterwards the Mayor entertained the Corporation officials and principal contractors for the work to luncheon at the Mansion House. Before entering into details of the plant installed, a few remarks bearing on the town itself and extent of the electric light and power scheme undertaken by the Corporation may be made.

Mr. Carl A. L. Prusmann, A.M.I.E.E., resident electrical engineer, Doncaster, after undergoing a college training in engineering at the Manchester Technical College, and serving his electrical and mechanical engineering apprenticeship, spent some time with the Manchester Corporation as chief electric inspector. Subsequently he occupied the position of chief assistant electrical engineer to the Bradford Corporation at a time when the new electricity works, the changing of the system of supply to one of higher voltage, the tramway scheme, and the lining out of arc lamps and motors were in hand there. Mr. Prusmann afterwards acted as electrical clerk of works to the Doncaster Corporation, from which position he was appointed to the post of resident electrical engineer in the autumn of 1899.

Doncaster is a town of great antiquity, having been a Roman station—the Danum of Antoninus. The great Roman road connecting Lincoln and York traversed the point where the town now stands. One of its most notable buildings—namely, the parish church—is erected on the site of an ancient castle, from which the town evidently acquired the former name of Doncastle, given it by the

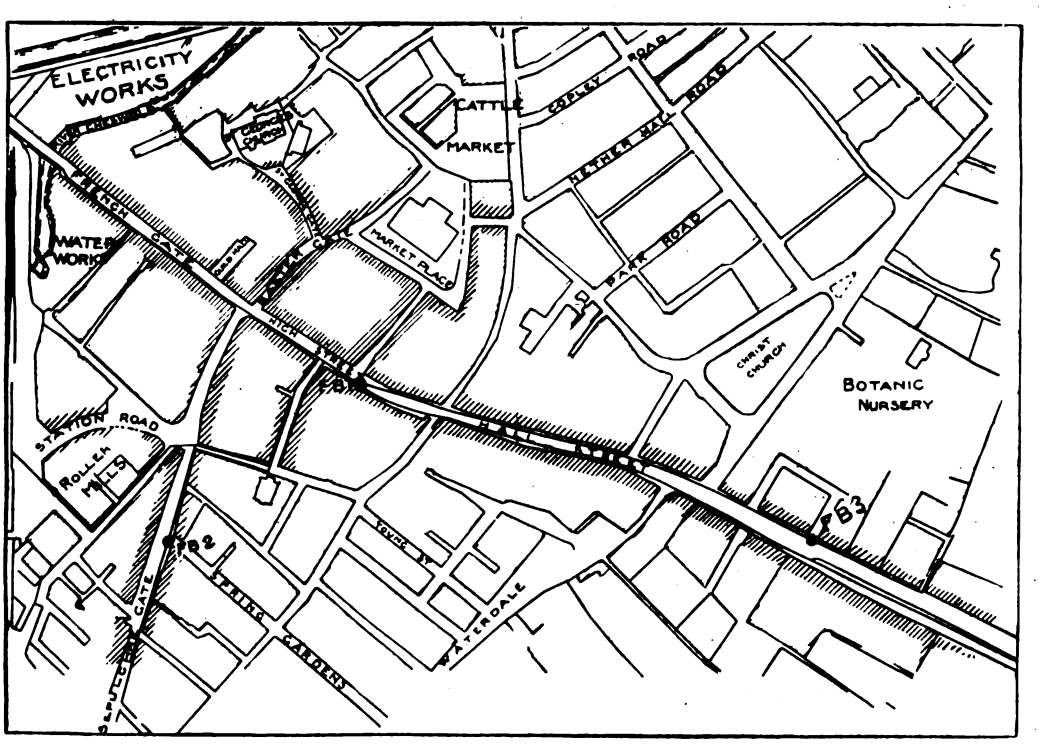

FIG. 1.—Map of Mains showing Position of Station and Feeding Points, Doncaster.

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Scots. Amongst the other buildings of note are the Mansion House, which was commenced in 1744 and completed some years later at a cost of £8,000, the town hall, and the racecourse grand stand, all erected by the Corporation. Doncaster is especially proud of its Mansion House, since there are only two other towns in England which possess similar structures—namely, London and York. The town cannot be termed a trading centre, as the shopkeepers depend chiefly on the enterprise of the Corporation, the residents, and visitors for support. It is, however, one of the largest railway centres in the kingdom, the lines of no less than seven railway companies running into it, while the works of the Great Northern Company alone employ between 7,000 and 8,000 workpeople. The Corporation own large estates and investments, including the racecourse, which yield a total revenue of about £20,000 per annum. In this respect it enjoys a unique position, since no assessments have to be paid by the townspeople for lighting or paving the streets, these items of expenditure being defrayed out of the above-mentioned revenue. Further, no constables' assessment is levied, while the amount raised by taxation for sanitary work and highways is small in comparison with other towns. No wonder, then, that the locality enjoys a high reputation as a residential centre. Indeed, considering the excellent railway communication with the surrounding towns available, it is surprising that Doncaster proper can boast but 30,000 inhabitants. This is, however, accounted for by the policy of the Corporation, whose aim is to restrict the area of the borough, thereby confining the benefit accruing from its estates to as small a population as possible. To this end the policy of Doncaster is not one of incorporation, hence the small population, because the area of the borough, excluding the racecourse property, is small, and purposely retained so.

Of the origin of the Doncaster meeting little satisfactory is known, though it seems pretty certain that it grew from small beginnings to its present-day importance. Considering the revenue obtained from this, and the other invaluable sources previously remarked upon, not to mention a ratable value of £139,778 hitherto scarcely tapped, it is hardly surprising that the Corporation is enabled to keep well abreast of the times in all matters pertaining to the well-being and comfort of its favoured townspeople. The water and gas supplies are in the hands of the Corporation, the price charged for the second commodity being at the rate of 2s. 6d. per 1,000 cubic feet, with discount. In this connection it is interesting to note that the public lighting of the town began in 1764, when the streets were illuminated with oil lamps, at a cost of £131. In 1827 the present gasworks were started by a company, afterwards bought out by the Corporation for £17,000, though the value of the works, together with the extensions which they have undergone since their acquirement, is now estimated at £66,000. But it is not our intention to trace the history of the public lighting from the earlier date. Suffice it to give a brief outline of the principal events leading up to the more recent development of lighting in Doncaster. Without doubt the action of the Corporation in undertaking its own electricity supply was stimulated by the threatened monopoly of a private concern, which styled itself the General Electric Power Distributing Company, Limited, and sought to acquire powers to generate electricity in bulk, and distribute the same over a large area, including that with which we are now immediately concerned. The severe opposition encountered quickly decided the fate of the Bill, though not before its lesson had been taken to heart by some, at any rate, of the authorities affected, including the Corporation of Doncaster, which, rightly or wrongly, as judged by their subsequent action in the matter, included lighting and power distribution amongst their special preserves. The action to which we refer was the promotion of a Bill in Parliament by the Corporation for the acquirement of a provisional electric lighting order, in response to a petition from some of the leading tradesmen in the town. As a result the order was duly obtained in July, 1898, whereupon no time was lost in furthering the scheme. Mr. James N. Shoolbred, C.E., was appointed consulting electrical engineer to the Corporation, and, acting on his advice, it was decided to adopt a low-pressure three-wire system of generation and supply as best suited to the requirements of the town. Application was accordingly made for sanction to borrow £30,000 with

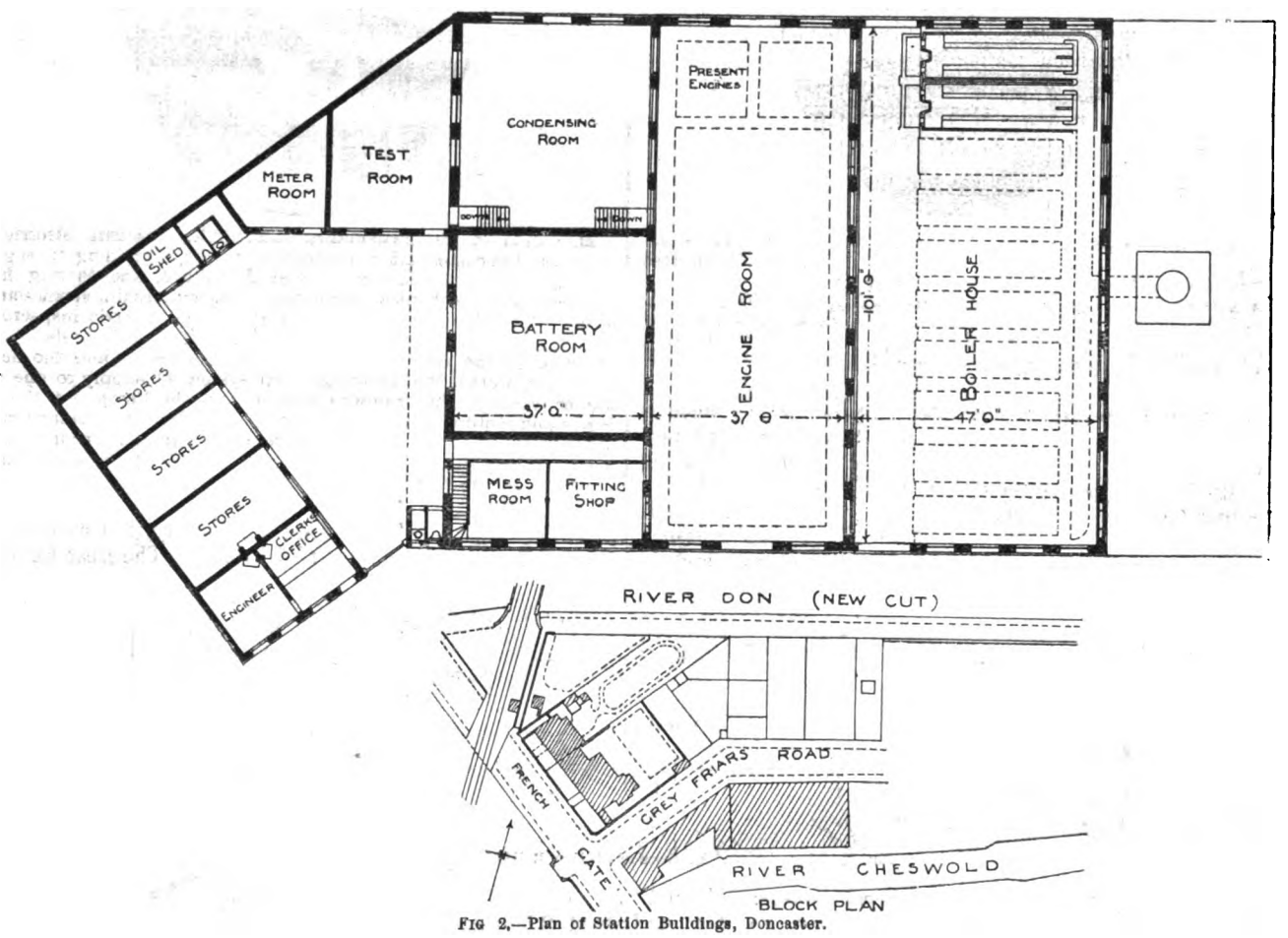

FIG 2.—Plan of Station Buildings, Doncaster.

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which to defray the initial cost of the scheme. In due course this sanction was forthcoming, and Mr. Shoolbred having in the meantime prepared detailed plans and specifications, tenders were obtained for the work.

Of course, the usual battle of sites played its little part also at Doncaster, but a selection was ultimately made in favour of Grey Friars-road. Besides being Corporation property, this site affords excellent coaling and watering facilities, adjoining, as it does, the River Don, which provides an easy means of coal transportation by barge. Being 2,450 square yards in extent, the site also affords ample room for future extensions. The question of economically delivering coal to the boiler furnaces has been carefully thought out, a wharf having been erected in a line with the stoking floor, to which the barges are moored and discharged as required by means of an electrically-driven bucket conveyor, which lifts the coal direct from the barge and conveys it to any point along the elevator platform over the boiler front, from which the fuel is fed into the shutes serving the mechanical stokers. Manual labour is thus reduced to a minimum so far as stoking is concerned. Fig. 1 shows the position of the generating station buildings relative to the area of supply. The generating station buildings, the general arrangement of which is shown in Fig. 2, were designed by the borough surveyor (Mr. William H. R. Crabtree), on lines laid down by Mr. Shoolbred. Messrs. Chas. Sprakes and Son, of Doncaster, were the successful contractors for the building work, which was commenced in May, 1899. The buildings comprise an engine-room, 101ft. by 37ft. 9in.; a boiler-house, 101ft. by 47ft.; battery-room, 36ft. by 38ft.; a condenser and tank room, 40ft. by 36ft.; and fitting shops, besides a full complement of offices, stores, etc. The engine-room wall facings are of pressed bricks, above a 7ft. 6in. dado of glazed bricks. Ample light and ventilation is obtained by means of skylights and lanterns respectively. As to the style of architecture adopted and general details of construction, Fig. 3 shows all that is necessary. The chimney shaft has a height of about 150ft., its foundation consisting of a concrete bed 24ft. square by 8ft. deep. It is built square for a height of 20ft. 6in., from which level it is carried up circular. The inside diameter of the shaft at the base is 8ft., while the diameter at the top is 6ft. The internal diameter of the flue is 6ft., this being lined from the invert at the bottom to a height of 60ft. with fireclay brick. A 3in. cavity is provided from the bottom of this flue to the height of the firebrick lining, six 3in. cast-iron pipes being built into the chimney 15ft. above its base, which serve to admit fresh air to the 3in. cavity behind the firebrick lining, while a further set of such air-pipes is provided at a further height of 25ft. From the dimensions given above it will be seen that Mr. Shoolbred has provided sufficient engine and boiler house accommodation, etc., for the probable requirements of Doncaster for some years to come, even after the station, in addition to the demand for lighting purposes, is called upon to supply current to work the seven odd miles of tramways which the Corporation are about to put down and equip for electric traction on the overhead trolley system at an estimated cost of £70,000. The present engine-room, for instance, affords accommodation for a total of about 2,500 h.p. without any extension, while the boiler-house, which is designed on the same scale and contains at present but three boilers, has a capacity for 10. This extensive provision for the future has not, of course, been obtained without a considerable initial outlay on buildings in proportion to the present capacity of the plant installed; the outlay, in fact, including the cost of the foundations, amounted to the respectable sum of £6,645.

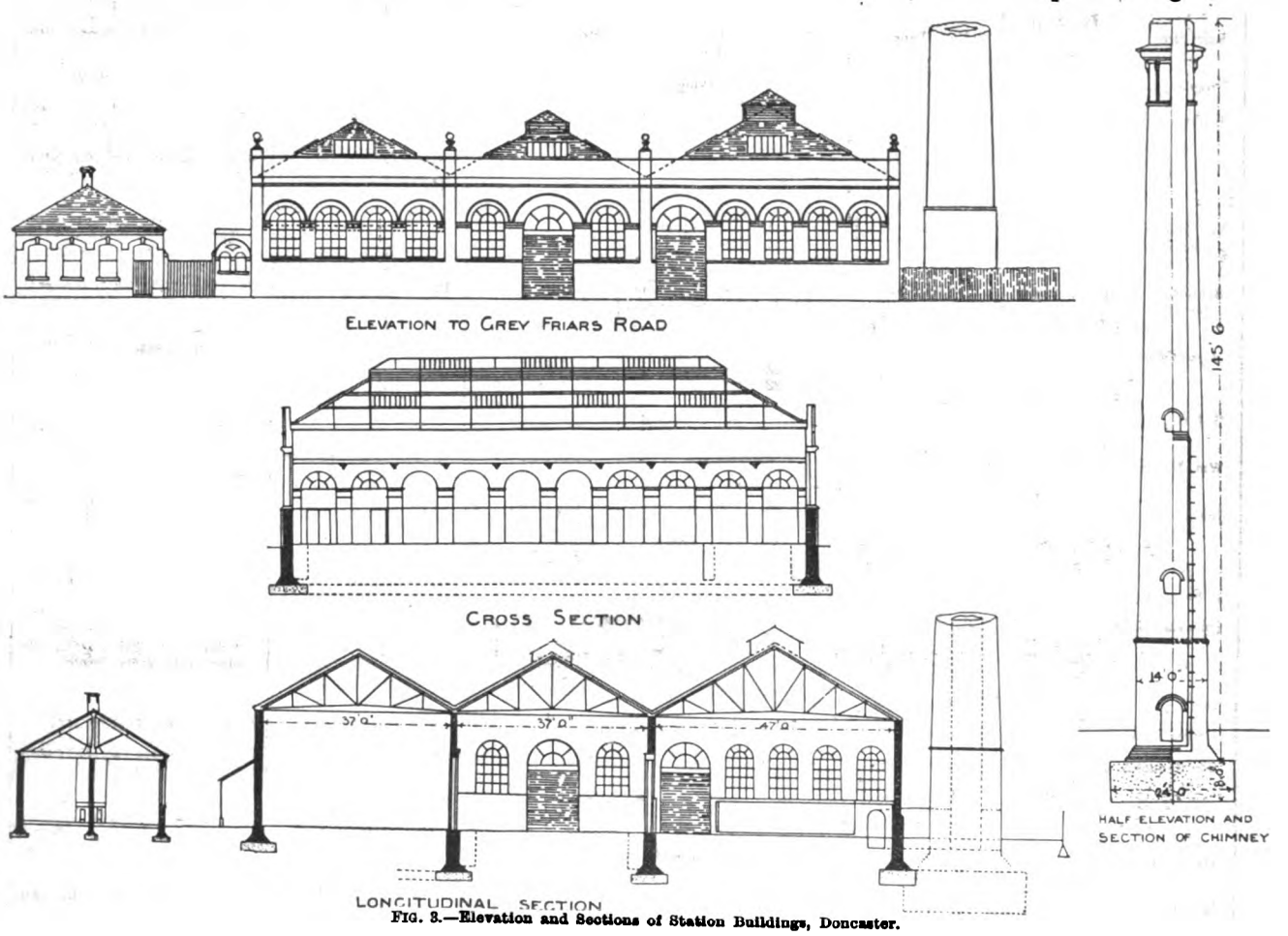

FIG. 3.—Elevation and Sections of Station Buildings, Doncaster.

(To be continued.)

ELECTRICAL DRIVING OF FACTORIES FROM THE PUBLIC POINT OF VIEW.*

BY A. H. GIBBINGS, M.I.E.E.

(Concluded from page 456.)

Instances of the nature of these investigations could, of course, be given in very great number, and each case

* Paper read before the Northern Society of Electrical Engineers, March 13, 1900.

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TABLE No. III.—TABLE SHOWING COMPARATIVE COST OF WORKING ELECTRIC MOTORS AS COMPARED WITH GAS, STEAM, AND WATER POWER.

Name	Address	Size of Motor	Purpose used for	Cost of Electricity at 1d. per unit for Six Months	Cost of Gas at 2/3 per 1,000 c.f. for Six Months	Remarks
		H.P.		£ s. d.	£ s. d.	
Jonas Sharp & Sons	49 Hall Ings	4½	Packing Press	9 17 4	—	Decidedly cheaper than steam.
Sir Jacob Behrens & Son ...	1 Colliergate	5 3	Packing Press and Crane ..	2 16 2	—	Cheaper than steam. Cannot say how much.
John Lupton & Son	9 Cheapside	1	Bottle Washing	2 2 8	5 15 10	Electricity less than half cost of gas.
S. P. Myers & Co.	5 Colliergate	8	Rolling Machine	8 12 1	—	Electricity cheaper than steam.
Collinson Bros.	Aldermanbury	3	Lathe and other Tools	3 12 0	—	Electricity cheaper than gas, and much more satisfactory in every respect.
Geo. F. Sewell	52 Godwin Street ...	4	Printing Machinery	6 4 5	12 12 11	About half cost of gas. Would have adopted Electricity years ago had it been possible.
Reiss Bros.	70 Vicar Lane	6 6	Hoist and Rolling Machine .. Crane and Packing Press	3 5 3	—	Electricity much cheaper than steam.
Brogden, Brookbank & Co. ...	Burnett Street	12	Packing Case Machinery ...	2 11 9	3 18 6	Electricity cheaper than gas.
Rosling & Appleby	Trafalgar Street	37	Engineer's Machinery	90 3 0	—	Electricity much cheaper than steam. For the same cost as steam are running twice as many machine tools with Electricity, which is more satisfactory in every way.
St. Mary's Roman Catholic Church	East Parade	3	Organ Blowing	3 2 8	—	Electricity much cheaper than water, and more satisfactory. Water never was satisfactory.
Bradford Provident Industrial Society	Sunbridge Road	6 1 3½	Boot-making and Repairing Machinery	8 15 5	—	Electricity much cheaper than gas.
Argus Office	Brown Street	1 22 22	Printing Machines	19 10 9	26 1 9	Electricity cheaper, and very satisfactory.
S. Hudson & Co.	Manningham Lane ...	1	Cycle-making Machinery ...	0 11 8	3 19 2	Electricity cheaper, and very satisfactory.
Wm. Moore	6 Mildred Court	4½	Hoist and Rolling Machine ..	2 19 3	4 19 0	Electricity cheaper, and using more power.
John Stockdale & Son	Henry Street	6 6 10 7	Circular Saws, Planing, and other Wood-working Machinery	32 12 10	—	Electricity much cheaper than steam.
J. Baxendale	Aldermanbury	3	Printing Machinery	1 16 2	5 1 3	Electricity much cheaper than gas.
John Dale & Co.	Duke Street	3 4½ 13 4	Printing Machinery	—	—	Electricity somewhat cheaper than gas, and the advantages of motors over gas engines are superior in every respect.
Job Robertshaw	21 Ivegate...	4½	Chopping Machinery	1 5 2	2 4 9	Electricity cheaper than gas.
George Seitz	29 Ivegate	2	Chopping Machinery	0 9 4	—	Electricity cheaper than water.
Ben Rhodes & Co.	Thornton Road	9 6 1 25 6	Grindstone, Sand Blast & Lathe Crane Blower Do. Running Dynamo	86 16 5	—	Electricity cheaper, and more satisfactory in every sense.
Hy. Gaskarth	11 Sunbridge Road ...	3	Printing Machines	2 12 3	3 7 3	Electricity cheaper, and more satisfactory.
John Ryder	Holywell Ash Lane ...	4½	Circular Saw	1 7 5	2 1 10	Electricity much cheaper than gas, and more convenient
I. Cautheray & Co.	Church Bank	7	Engineers and Printing Machinery	4 5 7	5 14 1	Electricity much cheaper than gas, and more satisfactory.
K. Wilkinson & Son	East Parade	7 7	Circular Saw ... . Band Saw	1 13 3 2 5 9	4 12 3 to April 24th	Electricity much cheaper than gas. Would not do without it.
Thos. Dyson	College Road	2 3	Cycle Maker	—	—	Electricity much cheaper than steam. Wish they could have had it sooner.
George G. Walker	1 Currer Street	6	Printing Machines	11 10 5	10 16 0	Electricity about the same as gas.
Pratt Brothers	Garnett Street	½ 4½	Rolling Machines, Hoists, &c. ...	4 4 5	4 16 5	Do. do. do.
Denison Bros.	Providence Street ...	3 ½	Printing Machinery	6 6 5	6 10 9	Electricity a little cheaper, and infinitely more satisfactory than gas.
Jackson Bros.	Garfield Avenue	6 6 10	Circular Saw ... . Do. Mortar Pan	14 19 2 28 12 3	—	Electricity about the same as gas.

generally presented some characteristic feature. I will, however, give a few illustrations of difficulties which had to be smoothed over. It seems a simple matter to apply a motor to an ordinary warehouse crane, but in many cases no notion existed as to the power required. Speeds of raising the load had to be taken and gear examined, and it was remarkable what a variety of ancient and power-absorbing gearing was found. In most warehouses the motor had to be controlled from each floor separately, and special devices suggested. It would have been fatal to the interest of the department to leave these arrangements to the ideas of the average wiring contractor.

With regard to more complex application, such as the driving of engineering workshops, spinning and weaving

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mills, dyeworks (with very special machinery only used intermittently), printing works, paper mills, foundries, etc., it can be readily understood that a very great variety of conditions prevailed, each of which had to have special consideration given to it. Our chief troubles, however, occurred with the smaller users. It was an ever-recurring task, for instance, to explain that the so-called nominal horse-power of a gas-engine was no criterion of its actual brake horse-power, and this task was not so easy as it appears, when the individual had firmly made up his mind that his 2 h.p. gas-engine would do the same work as a 4-h.p. motor; and his natural deduction was that his bill would be doubled in making the exchange. Another strong idea—a delusion, I need scarcely say—in the mind of the average applicant was that if so much horse-power at 1d. per unit cost so much per hour, then his bill would be nine times that amount for a nine hours' day, and so on throughout the year. I am happy to say that experience has proved otherwise in every case; but the idea of average horse-power per hour is very seldom grasped to begin with, even by those who have been power users for many years. The ever-present question of shafting or no shafting was also continually cropping up. The tendency was always to replace the then existing steam or gas engine by one motor. Our advice was often looked upon with suspicion, as coming from a very interested quarter, when we recommended the one engine to be replaced by three, four, or half a dozen motors, as the case might be. Sometimes our recommendations were entirely ignored in the first instance, but after an experience of six months the user had less confidence in his own methods of driving, and usually took our advice.

I have prepared the inserted list (Table III.) of a few of our customers, in which cases the machinery to be driven has either remained the same or the increase noted, and where the period of six months' use has enabled a comparison to be made between electricity and other previously used power agents. I am personally acquainted with the details of machinery and operation in each of the instances given in this list, and I may therefore state that some rough calculation was made in each case as to the possible economy to be effected in changing from the one form of power to the other. With the exception of the last four consumers, the economy proved in practice is far more than that anticipated, and such a result indicates conclusively that the losses due to running shafting and other gear in connection with and necessary to it, are very much greater and of more importance than it is possible to calculate. In the last four instances given in Table III., the users elected to continue to use their shafting, merely replacing the gas-engine with one electric motor. It serves to prove at least that electricity at 1d. per unit is no more expensive for power purposes than gas at 2s. 3d. per 1,000 cubic feet under similar conditions, but it is regrettable to find consumers quite satisfied to pay more for the actual power they require than there is any necessity for.

I have brought forward these few practical examples, and commented upon them, in the hope that some encouragement may be given, on the one side to the central station electrical engineer who may be fortunate enough to find that the district comprised in his electrical domain is a power-using district, and on the other side, to the power user my object has been to show how different is the teaching of practical experience in such cases from mere speculative theory. Notwithstanding the large capital outlay required for electric transmission of power in a factory compared with the capital outlay for mechanical transmission, I am convinced that the theoretical calculation of losses in the latter instance does not, in the very great majority of cases, represent the actual losses which would be found in practice, and that the difference in economy, after allowing for interest and depreciation on the capital required for electrical transmission, is greater than at first appears possible. This economy necessarily appears to turn upon what are the average hours of useful work required from each machine per day or per annum, and that in many cases they are much less in comparison with the total horse-power required than is imagined, seems conclusively proved by the facts given above.

THE ACTION OF ELECTRIC TRAMWAY CURRENTS ON SUBMARINE TELEGRAPH CABLES AND OTHER ELECTRIC CIRCUITS.*

BY PROF. ANDREW JAMIESON, F.R.S.E. (MEMBER).

Having been asked to give a short account of my visit to Cape Town last year, I have only to mention that the subject of my remarks has to deal with one of the many causes of delay in the transmission of telegrams, in order to ensure your close attention.

Present and Future Cable Routes to the Cape.

By referring to the map, it will be seen that there are at present two telegraph routes to the Cape from this country, the one and the older route being termed the "Eastern and South African," and the other the "West African." Both routes are worked by, and have their basis in, the first portion of the Eastern Telegraph Company's system. Messages for the Cape by the Eastern lines go from London, *vid* Porthcurno, Lisbon, Gibraltar, Malta, Alexandria, Suez, and Aden, where they branch off down to Zanzibar, Mozambique, Delagoa Bay (Lorenço Marques), and Durban. From thence they are transmitted by the Government land lines to Cape Town, etc. The cables from Aden to Durban were laid in 1879, at the time of the Zulu War, and only one section thereof has since been duplicated—viz., that between Zanzibar and Mozambique, in 1885. I have always been particularly interested in this 1897 cable, since I had to effect the first repair upon it, just south of Mozambique, in the spring of 1880, owing to its having been broken by a submarine earthquake! The West Coast route returns to Great Britain *vid* Mossamedes, Loanda, and many other places, such as Lagos, Bathurst, St. Vincent, Madeira, and Lisbon. With the view of providing additional security to submarine telegraph communication between this country and South Africa, landing rights at Cape Town have been obtained from the Government by the Eastern Telegraph Company for a third cable. The first section, from Cape Town to St. Helena, was completed on Nov. 26, and a further section to the Island of Ascension on Dec. 16 last year. The continuing cables to be laid to St. Vincent, Madeira, and Great Britain are now being manufactured. It is further expected that this much more direct cable will be extended from the Cape to Australia, and that the tariff will be considerably reduced.

Object of Visiting Cape Town.

At the end of last July I was requested to proceed to Cape Town for the purpose of acting as one of the advisers to the Cape Electric Tramways Company in an action brought against it by the Eastern Telegraph Company. This action was raised owing to disturbances in the working of the submarine cables landed at Cape Town by the operations of the neighbouring electric tramways. I had an able colleague in Mr. Frank Jacob, the chief electrician and technical adviser to Messrs. Siemens Bros. and Co., of London. On the outward voyage we had the advantage of studying the many Bills and Acts of the Cape Parliament relating to telegraphs and tramways, as well as Mr. A. P. Trotter's paper which was read before the Institution of Electrical Engineers in 1897. (See *Proceedings* of the Institution of Electrical Engineers, London, vol. xxvi., p. 501, for Mr. Trotter's paper on "Disturbance of Submarine Cable Working by Electric Tramways.") Upon our arrival at Cape Town, we found that although the submarine telegraph and tramway companies had willingly afforded every facility to experts for carrying out numerous and varied experiments, and although the former company had spent considerable sums of money in devising and executing plans for eliminating the vexatious electrical interferences, no perfect system had yet been adopted for thoroughly cancelling the disturbances, and, consequently, a considerable difficulty was still frequently experienced in deciphering the telegraphic signals.

How Submarine Cable Signal Currents are Transmitted, Received, and Returned to the Sending Station.

Looking at Fig. 1, it will be seen that the + and − elec-

* Paper read before the Institution of Engineers and Shipbuilders in Scotland, February, 1900.

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trical impulses which are set free from the sending battery by manipulating the double-current key, charge (say + in the first case) the home side of the sending condensers, thereby inducing a – charge from the other side of the same and from the conductor of the cable. This naturally repels a + charge along the conductor of the cable to the receiving end, and charges the cable side of the receiving condensers +, inducing – on the opposite plates of the same, and repelling a + charge through the delicate Kelvin siphon recorder to the metal sheathing of the shore end. This current, as shown in Fig. 1, finds its way back to the sending-station battery, not only along the sheathing of the cable,

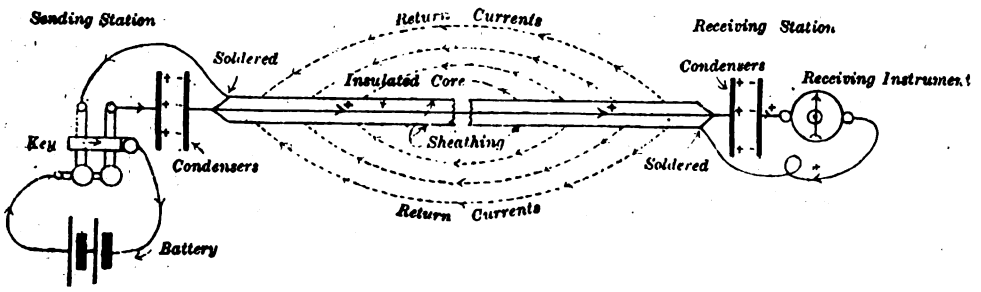

FIG. 1.—The Ordinary Connections for the Working of Submarine Cables.

but also very largely, if not almost entirely, through the sea-water and the earth. The splitting up of the return current in this manner is due to the shore ends making intimate electrical contact with the water and earth.

Many electricians used to fancy, and even now fancy, that the return current passes back to the sending station entirely by the cable sheathing. I have, however, often proved that this is not the case, by alternately connecting and separating the sheathing at an intermediate station, without affecting the strength of the signals at either of the distant ends! It is important to note that the sending and receiving currents act by induction in and from the sending and receiving condensers. These condensers serve the double purpose of cutting off the interfering effects due to "earth currents," and of sharpening or defining the

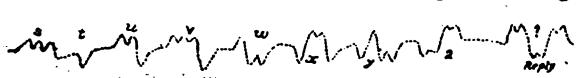

FIG. 2.—Good Siphon Recorder Signals.

receiving signals (see Fig. 2), thus enabling a greater speed of working to be attained than would be the case without them.

RELATIVE POSITIONS OF THE SUBMARINE CABLES AND ELECTRIC TRAMWAY LINES, ETC., AT CAPE TOWN.

From Fig. 3 it will be seen that the Cape Town shore end of the main submarine cable to Mossamedes (which was laid in 1889, and is 1,383 nautical miles in length) passes round the south-eastern curve of Table Bay in order to avoid the anchorage. Further, that a part of the electric tramway lines (which are worked on the overhead trolley-wire system, with the return circuit through the rails) pass from the power-house towards Wynberg on the one side, as well as to and through Cape Town on the other side, and lie almost parallel to the submarine cable. In fact, the first mile of the shore end is only at a mean distance of about half a mile from the tramway line; whilst the subterranean line from the cable telegraph office along Adderley-street to the cable-house, a distance of 430 yards, lies for a certain distance thereof quite close and parallel to the tramway rails. Ever since the opening of the electric tramway service on Aug. 6, 1896, the received signals at Cape Town from Mossamedes or from Loanda, a further distance of 530 nautical miles, have been seriously interfered with by the working currents of the tramway system.

At first, the tramway lines only extended from the suburb of Mowbray to the corner of Darling-street and Adderley-street; but now they are in full swing from the power-house to Wynberg, a distance of seven miles to the left, and through Cape Town to Sea Point, a distance of five miles to the right. These extensions, combined with the greatly increased traffic and consequently increased strength of the working currents, have naturally augmented the amount and frequency of the disturbances. The submarine telegraph company having been unprepared for such disturbances to its receiving signals, had its cables joined up exactly as depicted in Fig. 1. At first, the company was evidently under the impression that the erratic kicks, vibrations, and splashes, produced on the recorder slip, as seen in Fig. 4, were due to the local earth on the shore end being within the range of the stray currents

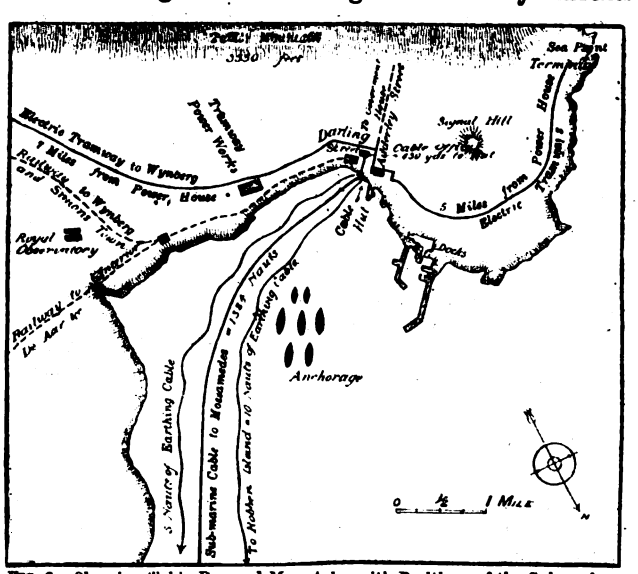

FIG. 3.—Showing Table Bay and Mountain, with Positions of the Submarine Cable to Mossamedes and the Tramway Lines.

from the tramway rails. Consequently, many "earths" were sought beyond this supposed sphere of action, by running land lines, "such as a telephone line to the top of Signal Hill, a telegraph line ending at an earth-plate in the sea near Sea Point, an earth at the observatory 3½ miles from Cape Town, an earth at Durban-road some 12 miles from Cape Town," etc., without finding any reduction in the disturbances. In fact, the ordinary earth of the shore end gave better results than any of these land-line earths. As these various earths had failed, more definite experiments were tried at night, when it was found that the amplitude of the kicks, shown on the recorder slip, were in proportion to the distance of the experimental car from the power station (but greater when on the Cape Town side), and that the direction of the kick was reversed whenever the said car passed from the one to the other side of the power-house. I may here remark that the current required to

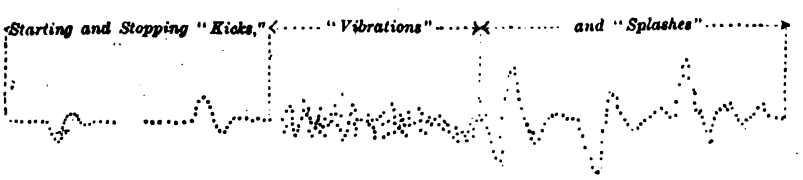

FIG.

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pass through the coil of Lord Kelvin's siphon recorder, in order to give well-defined receiving signals, is only about from $\frac{1}{20}$th to $\frac{1}{80}$th of a milliampere; and consequently the currents delivered from the tramway power station to any one section of the tramway lines is often 10 million times as great as that which creates the disturbances indicated by Fig. 4.

The Various Probable Actions of the Tramway Currents on the Submarine Cable.

1. *Electrolysis.*—The well-known action of electrolysis on neighbouring underground conductors, such as gas and

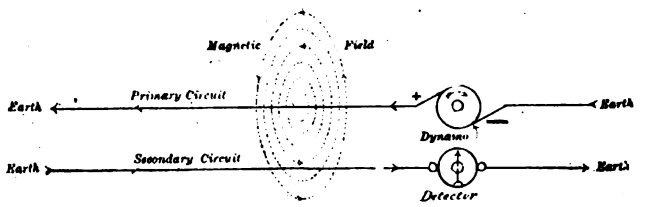

Fig. 5.—Direct Electro Magnetic Induction.

water pipes, whenever the fall of pressure along the rails exceeds a certain value, may be at once dismissed as having no effect upon the case in question. The underground cast-iron pipe containing the 430 yards of insulated conductor from the cable office to the cable hut never showed any signs of electrolysis, and no such action has been observed as taking place in the sheathing of the submarine cable.

2. *Affecting the Potential of the Earth Connection to the Receiving Instrument.*—At first sight, the possible action of erratic stray currents from the tramway system more or less continuously altering the potential of the receiving instrument's earth connection, is a fascinating idea to many; and this idea, as will be seen later on, is still entertained by certain cable electricians. But from the many attempts and failures of the Eastern Telegraph Company to obtain satisfactory results from a land or sea "earth" connection placed in various positions, and at varying distances up to 12 miles from the receiving instruments, this action may also be dismissed as having no particular bearing upon the disturbances in question.

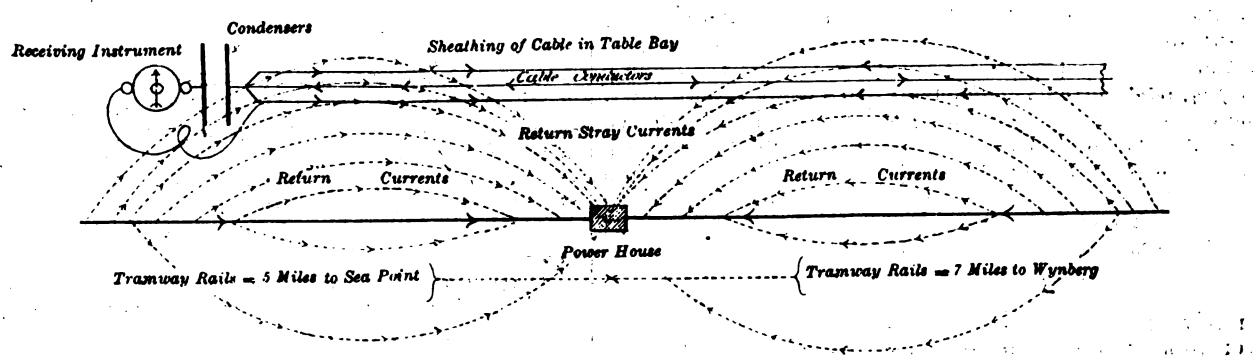

Fig. 6.—Stray Currents from Electric Tramway Rails inducing Disturbing Currents in a Parallel Submarine Cable.

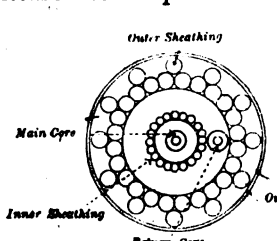

Fig. 7.—Coney Island Twin-Core Shore End.

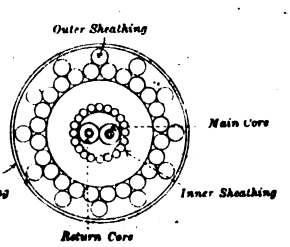

Fig. 8.—Twisted Twin-Core Anti-Inductive Shore End.

3. *Direct Electromagnetic Induction.*—Although the well-known effect of electromagnetic induction, as shown by Fig. 5, and which was first proved and announced by Faraday in 1831, always takes place between a circuit wherein the current is suddenly altering in strength and any other closed parallel or approximately parallel conducting circuit, yet I doubt if the chief cause of the observed disturbances can be attributed to what may be termed direct electromagnetic induction. By this term I mean the effect which would be directly or, at first hand, communicated to the insulated conductor of the submarine or underground cables from the erratic currents passing along the trolley wires in one direction and returning by the rails, or by results due to the difference between these respective currents at any time. In the first place, the underground cable is contained in a strong cast-iron pipe, and, although this pipe is much nearer to the tramway rails than to the trolley wires along the seaward end of Adderley-street, yet any direct electromagnetic action due to the difference between the respective currents in them and their respective distances from the pipe would naturally result in producing inductive currents in the pipe to a greater degree than in the, so far, magnetically-shielded insulated conductor. A secondary inductive effect would no doubt be produced upon this insulated wire by the more direct induced currents in the cast-iron pipe. These secondary currents would, however, be opposite in direction to any direct electromagnetic induction that might reach the wire. Again, the sheathing of the shore end of the submarine cable being not only double, but the outer armour being so heavy and compact (see Figs. 7 and 8), the insulated conductor contained therein would also be very much shielded from any direct electromagnetic effect. Besides which the mean parallel distance for the first mile between the cable and the tramway is fully half a mile, and thereafter the cable diverges, not only in distance, but also in direction from the tramway route; therefore, I do not think the chief or most prevalent cause of the interferences to the receiving signals can be attributed under these circumstances to what we have called "direct electromagnetic induction." I do not for a moment doubt that direct electromagnetic induction would take place through air, or earth, or sea, or all combined at much greater distances, and even under less favourable conditions, with respect to parallelism and to sudden alterations in the strength of the primary currents than in the case in question, if only the cast-iron pipe surrounding the underground core and the heavy iron armour of the shore end were absent. These iron covers, however, in my opinion, not only to a great extent act as a magnetic shield, but, moreover, the electromagnetic currents produced in them so act upon the insulated conductors contained therein as to produce a current opposite in direction and in effect to any direct electromagnetic induction in the cable conductor. No doubt the "splashes" or more violent "kicks" of the siphon in the Kelvin recorder, which were still observable up to the time of my leaving the Cape, may be attributed to the sudden closing or to the sudden freeing of a number of the motor circuits. For whenever the prearranged limits of the automatic cut-out switches are exceeded, due to a congregation of cars (say, near the corner at the meeting of Darling and Adderley streets, or elsewhere not far from the cable) being started more or less simultaneously, then electromagnetic induction has the best chance of exhibiting its effects. One day while standing near the switchboard in the power-house I noticed that certain of the automatic cut-out switches broke their circuits half a dozen times within a quarter of an hour at the pre-adjusted limit of 350 amperes; and, of course, they had also to be switched on again before the cars on that section or sections could start. Such sudden stoppage and starting a current of 350 amperes at 500 volts does undoubtedly cause direct electromagnet induction in all neighbouring parallel electrical circuits, whether they are in the air, as in the case of bare or specially insulated wires, or buried

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in the earth, or laid in the form of a submarine armoured cable in the sea. These sudden electromagnetic disturbances are, however, distinguishable from another and more frequent source of interference which might now be considered.

4. *Disturbances due to Leakage or Stray Return Currents from the Tramway Rails.*—In Fig. 6, I have depicted graphically by dotted curved lines the "stray shunted" currents as they leave the tramway rails and find their way back to the negative poles of the dynamos in the tramway power-house. When the length and the electrical resistance of the rails is taken into consideration, as well as the very heavy traffic which at times prevails in each of the two main sections to Wynberg and to Sea Point, there is no difficulty in believing that the limits of the fall of potential along the rails, as set down by the Board of Trade, are at times exceeded. The seven-mile route from the power-house to Wynberg is only a single line with numerous "turn-outs," whilst that to Sea Point is a double one. The rails in each case are 81lb. to the yard, with double flexible Chicago copper bonds past the fishplates at the rail joints. Cross bonds are also introduced between each pair of rails at certain distances apart. The consequence is that when the traffic is heavy some 30 to 40 per cent. of the return current finds a way back to the power-house through the earth and the sea. Since the hard rocky nature of the Table Mountain side offers a greater resistance than that of the damp low-lying shore side, the major portion of the stray currents naturally follow the latter course. These stray currents freely pass through the Observatory grounds, a mile or more distant from the tramway line to Wynberg, and Dr. David Gill, the Astronomer Royal at the Cape, informed me that ever since the electric tramway first passed the Observatory, he had not been able to carry out a single delicate magnetic experiment within the grounds. These varying stray currents undoubtedly find a ready path to and along the heavy low-resistance sheathing of the submarine cable on their way back to the power-house, and in doing so they produce by induction, correspondingly erratic currents in the cable conductor, which of necessity interfere with the weak receiving currents during their arrival at the Cape telegraph office. No wonder, then, that such interferences mystified and defied the most skilled telegraphists to decipher the messages, so long as the tramways were working, and so long as no proper anti-inductive method had been applied to cancel their baneful effects. It will be readily understood that the tramway company, having received full Government and municipal permission to adopt the overhead trolley system, with the rails for the return currents to the power-house, and seeing that under such working conditions it could not possibly introduce any known and commercially satisfactory means of preventing the natural interferences, it was willing to help the cable company as far as possible to effect the desired remedy.

Anti-Inductive Earthing Cables Laid by the Eastern Telegraph Company.

In the end of January, 1897, the Eastern Telegraph Company laid a short cable of about five nauts, as nearly as possible over the shore end of their main cable (Fig. 3), and connected it to the earth side of the telegraph office recorder by means of a second underground cable inserted in another cast-iron pipe which lay parallel and close to the first pipe and cable. The sea end of the conductor of this short cable was earthed by soldering it to its sheathing, the soldered joint being protected from the sea-water. By this it was hoped that a "sea earth" would be found, beyond the range of the tramway stray currents, to neutralise all inductive effects upon their main cable. So long as the tramway traffic remained light, and until the tramways were extended from Adderley-street to Sea Point on the one side, and from Mowbray to Wynberg on the other side, the telegraph company's staff was able to receive messages by aid of this short cable. There cannot be the slightest doubt, however, that it could not be laid precisely over and parallel to the main cable from a telegraph steamer, for the main cable lay at such a depth as to be entirely out of sight. The short cable might, therefore, be hundreds of feet away from the original one at various places without anyone being aware of the fact. Further, since the sheathing of this short cable was not of precisely the same kind and weight as that of the main cable shore end, the induction upon its conductor, however evoked, would not be equal to the induction in the conductor of the main cable. Consequently, the induced currents through them would not exactly balance each other as they arrived at the opposite terminals of the receiving instrument. In other words, the balance was not perfect. It was, however, so very much better than with any of the previously mentioned plans, that members of the staff were able to receive messages until the extension of the tramways took place. After that, the cable company found it necessary to incur the still further expense of laying another cable of 11 nauts in a similar manner and earthing the same at Robben Island. It was also connected to the siphon recorder through an underground insulated line in the same way as had been done with the five-naut cable (Fig. 3). With this second short cable the messages have been received ever since. But as I found in the beginning of September, 1899 (when I inspected the receiving signals and the specimens complained of which had been entered in the cable office diary), the telegraph staff were still frequently bothered with "kicks" and "splashes." Upon joining up the five-naut earthing cable to the recorder instead of the 11-naut one, I at once perceived that the interferences became much more pronounced; and with the earth side of the recorder connected directly to the sheathing of the main cable as in Fig. 1, these interferences became so bad that I could scarcely read a single word.

Previous Anti-Induction Earthing Cables.

I could give a large number of previous instances of interruption to sea and land telegraphy and to telephony due to faulty earth connections, leakage from other sources through earth-plates and between circuits, direct electromagnetic induction from lightning, and lighting and transmission of power circuits; but this is the first instance in which I have personally observed indirect or secondary induction from stray shunted tramway currents in the case of a submarine cable. The Eastern Extension Telegraph Company had experienced similar interferences from the electric tramway lines at Madras in the working of its submarine cables landed there; but it overcame them in a so far satisfactory manner by running a parallel underground cable as well as one out to sea for a few miles. Here, however, the tramway lines were not nearly so favourably situated with respect to parallelism to the cables, and hence the disturbing effects were not so pronounced as at the Cape. Messrs. Siemens Bros. and Co. had previously laid down a double-cored underground land line and shore-end cable at Coney Island to enable the Commercial Cable Company to bring its lines direct to the New York office, and at the same time be free from interferences due to the neighbouring electric tramways. A cross-section of the cable laid by Messrs. Siemens is illustrated by Fig. 7, where it will be observed that the second or return core is placed between the inner or light sheathing and the outer or heavy stranded armour. Here, again, the submarine portion was not nearly so parallel to the tramway lines as at Cape Town.

Proposed Remedies for Induction and Stray Current Interferences.

Taking into consideration all the circumstances at Cape Town, I reported to the commission, before which I recently gave evidence, that nothing short of a symmetrically arranged and specially made "twin twisted core with double armouring" would do for the shore end, and that it would not require to be more than from two to three nauts (see Fig. 8). (The author showed a specimen of this cable, which was kindly lent to him by Messrs. Siemens Bros. and Co. for the meeting.) One core of this special cable would require to be jointed to the core of the main cable in the bay, the sheathings thoroughly well spliced together, and the conductor of the second core soldered to the outer sheathing of the main cable, and there sealed from the sea-water. The ends of these two cores at the cable hut would require to be connected to corresponding ends of an

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armoured "double twisted core" encased in one thick cast-iron pipe placed underground between the cable hut and the telegraph office, and the conductors connected to the signalling condensers and the receiving instrument (as shown in Fig. 9, in which the sending battery, switch, and keys have been omitted). Only thereby could all inductive effects from whatever source and however caused be equally and simultaneously evoked in the main and the short earthing conductors. (Since reading this paper the author has been informed that the recently-laid shore end of the new cable from Cape Town to St. Helena has been made and connected in the above-mentioned way.) Further, I strongly recommended the tramway company to obtain and place in circuit, with separate return feeders from different points along the rails, a sufficient number of negative boosters (or sucking dynamos), in order to reduce

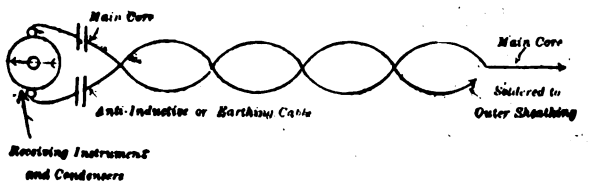

FIG. 9.—Anti-Inductive and Earthing Cable.

the return currents in the rails at these points to zero potential, and thus prevent the fall of pressure along any portion thereof ever exceeding the limits of the Board of Trade rules. This would naturally stop electrolytic action on neighbouring pipes, and greatly reduce the potential, the strength, the range of stray currents, and hence the chance of their reaching the sheathing of the submarine cable and of acting inductively upon its conductor. Finally, I believe that land telegraph, telephone, and other electric circuits can be protected from all interfering influences of electric tramways by employing twisted forward and return insulated conductors, and that electrolysis may be prevented by employing heavy well-bonded rails with return feeders and sucking dynamos, whenever the fall of pressure along any section tends to exceed five volts.

THE LJUNGSTROM CRANKLESS ENGINE.

The designer of this engine, which has recently been put on trial at the College of Science, Newcastle-on Tyne, has departed from the usual conditions which the designers of rotary steam-engines try to conform to. Instead of avoiding a reciprocating motion, Mr. Ljungstrom multiplies the number of cylinders and allows the pistons in these cylinders to bear against a fixed elliptical track. In this way he is able to avoid the use of cranks and connecting rods. The engine is, in fact, an extraordinary development of the old oscillating steam-engine. The similarity is in that the trunnion containing the steam and exhaust ports is fixed, while the cylinder revolves round the trunnion instead of oscillating through a determined angle. In Fig. 1 we give a view of one of these Ljungstrom engines with the side cover taken off so as to expose the working parts. A number of these working parts are also shown in the foreground. Fig. 2 shows the same engine put together and arranged for driving by means of a belt. Referring to Fig. 1, the star-shaped casting marked B contains the four radial cylinders. The pistons, C, working in these cylinders have rollers mounted in their outer ends, which are shown in the plan and marked D. These bear against the elliptical track, which forms part of the case of the engine. The valve gearing is fixed as shown at H, the steam admission being made at one end of the fixed spindle, while the exhaust is taken from the other. This stationary valve communicates with the steam-ports in the cylinder, marked F, the four cylinders revolving when the engine is working. The centrifugal force keeps the pistons with their rollers always in contact with the track, E, which, in consequence of its elliptical shape, forces the pistons to move in and out twice for each revolution of the engine. The turning force is obtained from the side thrust of the pistons when forced by the steam pressure against the outgoing curves of the track. The handle (seen in Fig. 2) is used to move the fixed valve spindle through a certain range, which allows of the direction of rotation being reversed. The cut-off of steam in the cylinder depends chiefly on the width of the slots, I, in the valve, but it can also be regulated slightly by a motion of the above handle. It follows, in consequence, that the governing of this engine will have to be effected by means of a throttle valve reducing the steam pressure before admission. The designer proposes, however, where great economy is required, that several of these engines should be connected in series so as to reduce the variation in temperature in any one engine. In this way double or triple expansion could be obtained, as is done in the Parsons turbines, by making the one engine work on the exhaust steam from the one before. Prof. Weighton made a series of experiments with this engine, from which it was found that the most economical cut-off was at about one-fourth of the stroke. Experiments were made with cut-offs varying from about one-sixth up to one-third. In the engine experimented with there were four cylinders, each $2\frac{3}{4}$in. in diameter, and the pistons had $\frac{13}{16}$in. stroke. The accompanying table gives the steam consumption per horse-power hour of four consecutive trials at practically constant speed.

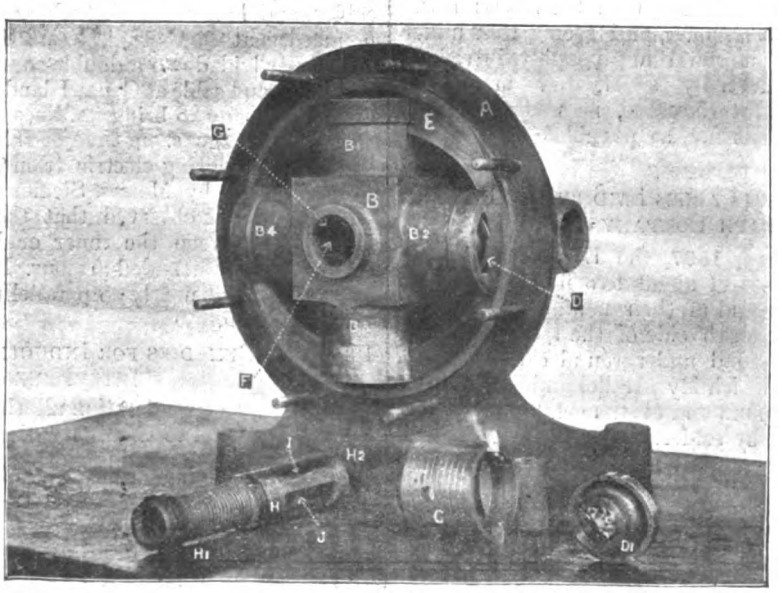

FIG. 1.—View of the Ljungstrom Crankless Engine with the Covers Off and Parts Removed.

It will be seen that practically 15 b.h.p. was taken from the small machine with a steam consumption of 38lb. per brake horse-power hour. The engine was worked non-condensing, and Prof. Weighton comments on the fact that

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very little oil was required. The steam consumption is exceptionally low for such a small engine. The clearance in the steam-cylinders of the 16-h.p. engine experimented with was not 5 per cent. of the total volume. If the above results are plotted with brake horse-power and water consumption as abscissæ and ordinates respectively, a straight line is obtained, which shows that

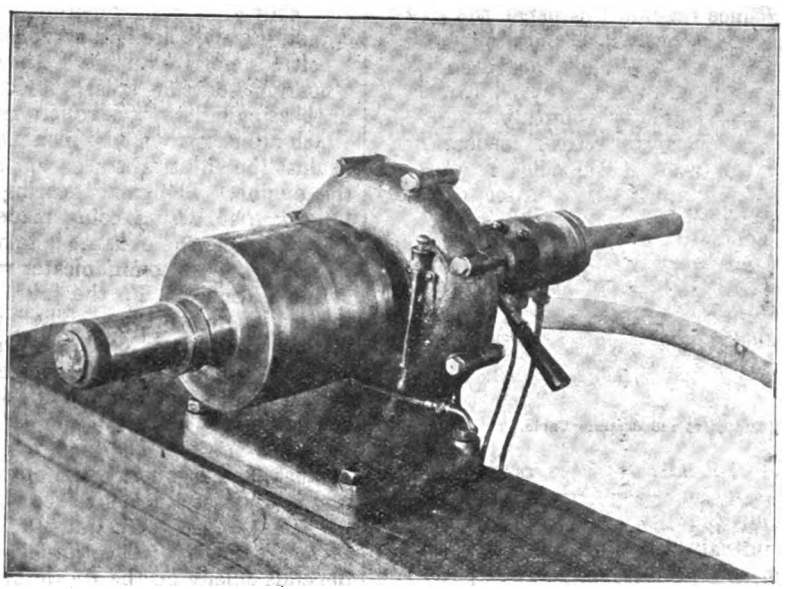

FIG. 2.—A 16-h.p. Ljungstrom Engine.

about 90lb. of steam per hour are required at no load. This is only some 16 per cent of the full load consumption, which is remarkably good. Considerable mechanical ingenuity is displayed in the design of this engine, and it will be interesting to see whether it will obtain a commercial trial in this country. We understand than any further information concerning the same can be obtained from Messrs. Danford and Elliott, Maritime-buildings, Queen-street, Newcastle-on-Tyne.

RESULTS OF TESTS MADE ON LJUNGSTROM'S SINGLE ACTING HIGH SPEED STEAM MOTOR MOTOR WORKING WITHOUT A VACUUM SIZE OF MOTOR: FOUR CYLINDERS, EACH 2⅜IN DIAMETER, 1¾IN. STROKE

Steam pressure at engine.	Revolutions per minute.	B.H.P.	Water used per hour. Pounds.	Water used per B.H.P. per hour.
70	1,616	4·63	239	51·74
100	1,609	7·35	327	44·5
143	1,600	11·43	449	39·29
188	1,588	14·96	569	38·09

AMERICAN CENTRAL-STATION DESIGN.

A typical example of the practice in designing large electrical generating stations in the United States is furnished by the illustrations we give herewith, and for which we are indebted to the *American Electrician*. The station in question is being erected for the Metropolitan Street Railway Company of New York, which company has recently adopted the open-conduit system of electric traction on their lines. This new central generating station is situated on the water-front of the East River, and covers a whole city square.

The building, when completed, is to contain 11 vertical

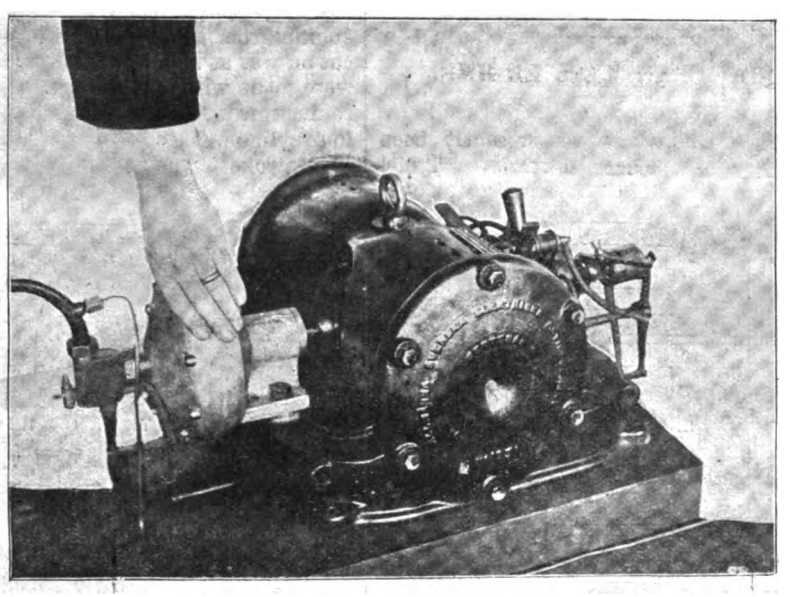

FIG. 3.—View of the Engine coupled to a Dynamo to show the relative size.

cross-compound engines rated at 4,500 h.p. each, and capable of giving 6,000 h.p., each engine being coupled direct to a 3,500-kw. three-phase alternator. The high pressure of 6,000 volts is delivered direct from the windings of these alternators to sub stations, where it is stepped down and passed through rotary converters, which deliver direct current for the car motors. It is claimed that this station will have the largest capacity of any electrical or single steam plant in the world. There are at present three generating units completed, two more being in course of erection and the other six still in the shops. In the new power station there is to be no mechanical apparatus for inducing draught, and there are no economisers. The auxiliaries are to be driven by steam-engines, the exhaust from which is to be

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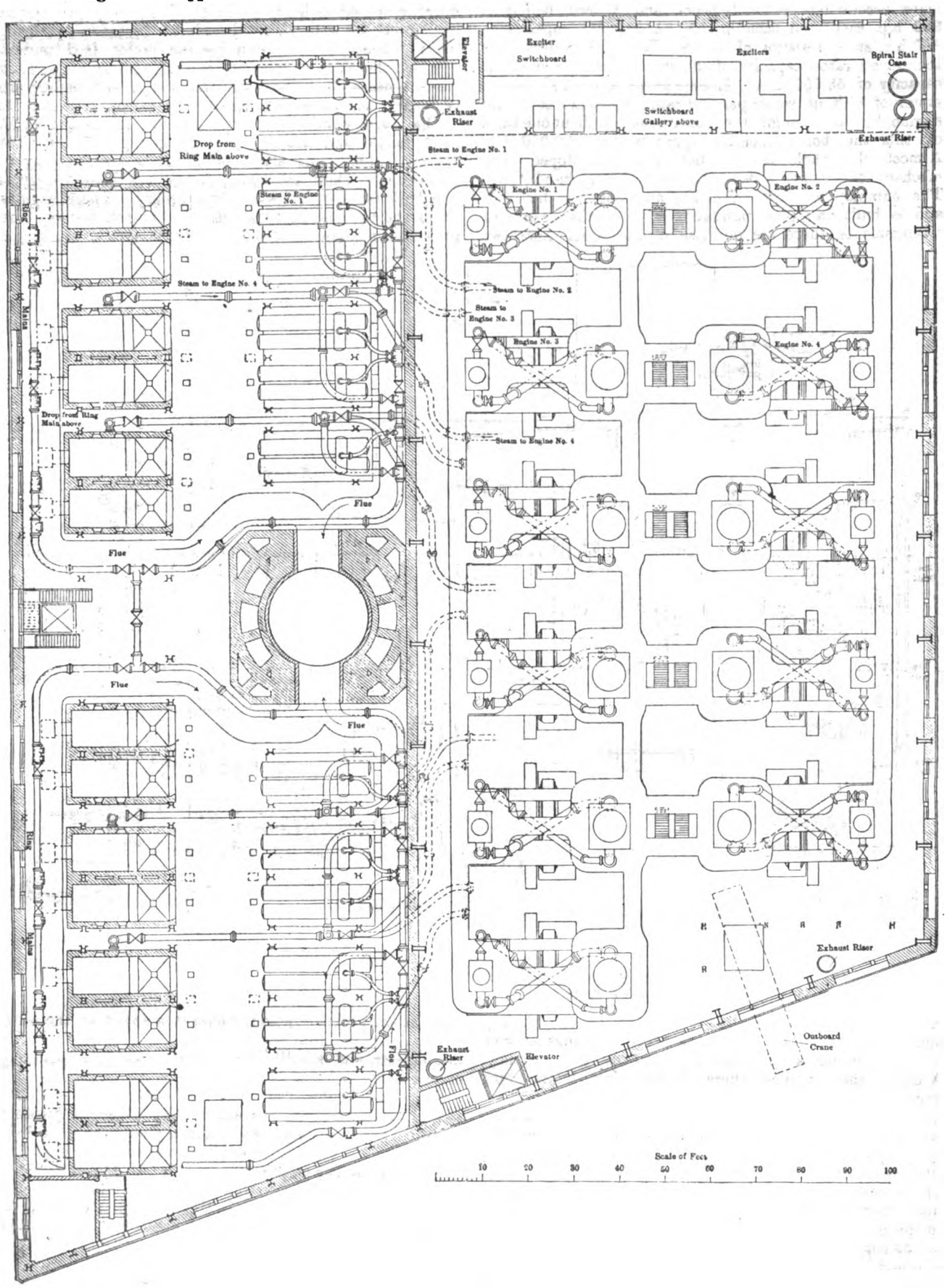
used in secondary feed-water heaters, primary heaters taking the exhaust steam between the main engines and their condensers. Three floors of boiler-rooms are provided, the coal bunkers being over the upper one. The building itself is constructed on the steel skeleton system. The arrangements for the handling of the coal are very complete. In the first place, coal barges can dock immediately in front of the building, and the coal is hoisted from them, by means of a jib crane, in buckets holding 1½ tons. The coal then passes through a receiving hopper and crushing machine into Mead conveyors, which take it up to the bunkers. This conveying apparatus is in duplicate, and instead of going down to the basement to collect ashes on the way back, the conveyors double back over the bunkers. Separate conveyors are provided for the ashes. There are two coal-bins over the boiler-room, and they are separated by the chimney. Each has a storage capacity of nearly 5,000 tons, giving a total capacity of 10,000 tons. The



Plan of Boiler and Generator Rooms, New York Metropolitan Power Station.

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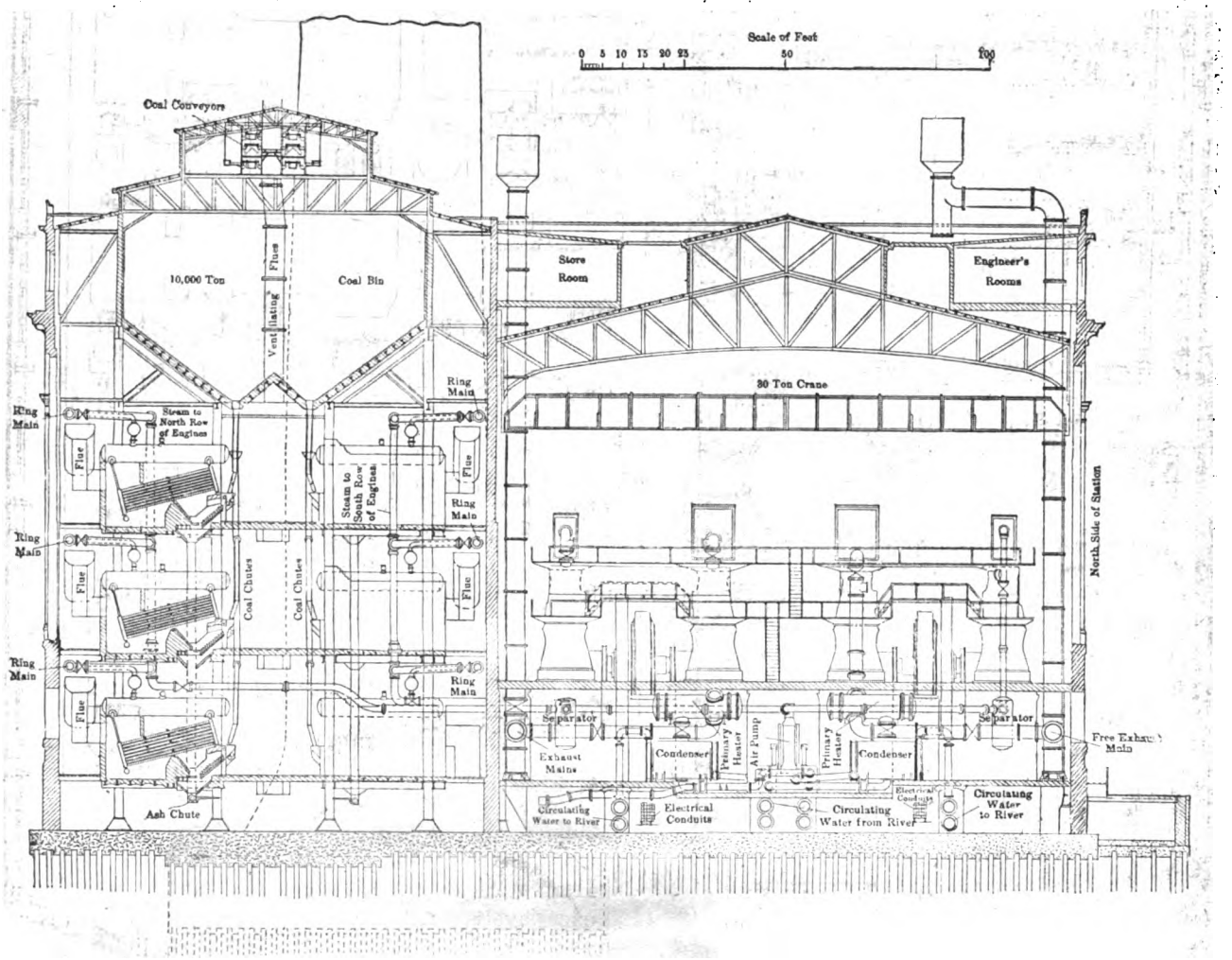
floors of the bins are of a flat W shape, the downward points discharging into the chutes, which carry the coal directly into the hoppers of the mechanical stokers for the three boiler floors. The walls of the bins are of concrete, and consequently non-inflammable. Each of the three boiler floors accommodates 29 Babcock and Wilcox boilers of 250 h.p. each, and each having an overload capacity of 400 h.p. at a pressure of 160lb. These 87 boilers have therefore a rated capacity of 20,000 h.p. and an overload capacity of 35,000 h.p. These figures are based on the rating of 30lb. of water per indicated horse-power of the engine, but as the engines will only consume about one-third of this the boiler capacity approximates 100,000 h.p. Almost the whole of the boilers are equipped with mechanical stokers, a few, however, being hand fired. The chimney is 353ft. in height and 22ft. in diameter, and is built on a pile foundation. As to the steam-pipe arrangements, there are on each of the boiler tiers two ring mains, one surrounding the boilers west of the chimney and the other those to the east. The two rings are connected together at a point in front of the chimney. Around the engines there is no ring main, each engine having only one pipe from the boiler-rooms. This pipe passes down through the boiler-rooms to the basement and thence to the separator of the engine, being connected to the ring mains on the way. Thus the ring mains on the separate levels can be tied together by 11 vertical risers, each of which carries steam from the mains to one of the engines. The valve stems of all valves in the ring mains and in the branches from the boilers and to the engines are brought up through gratings on the level of the boiler-room floor above, these gratings forming a continuous passageway under the flues, by which any valve can be immediately reached, and doing away with the necessity of gearing the valves to wheels at the floor levels below. The exhaust from each engines passes down through a primary feed water heater to a condenser in the basement. From the primary heater the exhaust can be discharged to exhaust mains running along the walls of the basement, which discharge into risers which carry the exhaust above the roof. The circulating water is brought in from the river through four 30in. pipes running in the sub-basement under the air-pumps. It is taken from these pipes into the circulating pumps. From the air-pumps the condensed water is carried to hot-wells in the basement, each engine having one hot-well. From these it is collected in equalising tanks, whence it is drawn by the boiler feed pumps. Between the tanks and the pumps the water passes through primary heaters, and between the pumps and boilers are secondary heaters, which take the non-condensed exhaust of the steam auxiliaries. The engines are of the E. P. Allis make, and are capable of giving 4,500 h.p. at quarter cut-off, but are able to work continuously at 6,000 h.p. They are stated to be the largest engines ever built for driving electrical machinery. These engines are of the two-bearing type with overhanging cranks. The shaft of the engine is 30in. in diameter at the crank, and 37in. at the central portion, where it is keyed to the generator spider and the flywheel hub. The flywheel is 28ft. in diameter, and is built up of cast-steel sections consisting of one spoke and part of the rim. The hub of the flywheel, the generator spider, and the two cranks were forced on the shaft by an hydraulic apparatus giving 11,000lb. pressure per square inch. The height of the engines over all is 38ft. The would-be critic of the station will naturally object to the position of the engineers' rooms, which appear to be a long way from the driving floors. The placing of the boilers in three floors saves greatly in space, and is advisable for other reasons. It will be interesting to learn the cost of generating per unit in these large works.



Sectional Elevation of the Boiler and Engine Rooms of the Power House of the New York Metropolitan Power Station.

Arrival of Electrical Volunteers at Cape Town. We note in the daily Press that the "Tagus," with the first detachment of Electrical Volunteers for service in South Africa, arrived safely at Cape Town on Wednesday, the 4th inst.

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THE
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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E C. Anonymous communications will not be noticed.*

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COAL.

There is an exhilaration about fair competition good for everybody engaged in it. Wits are set to work to see wherein expenses can be lessened, either by better organisation or by improvement of apparatus. There is no doubt but that gas and electricity are competitors. The indication of trade gossip is that there will in the near future be a general increase in the price of gas arising from the increase in the price of coal. That is the text; what is the moral? In the first place, it is doubtful if electricity will gain any advantage. The coal used in the stations will be increased in price as contracts drop in, and although, as Mr. Siemens has again and again insisted, the cost of generation only partly depends upon the cost of fuel, it does partly depend, hence the influence of fuel cost. The remedy in gasworks has already begun, and the consumer will pay the piper. We doubt if so simple a remedy is possible generally for electric works. Where the gasworks, again, can manage without raising price, they can recoup the increased cost by greater attention to the manufacture of residuals and the increased income derived thereby. At present there are no residuals from electric central stations. Their income is practically derived from selling energy and the hire of meters. Now, let us hark back a quarter of a century, and recollect the coal consumption per indicated horse-power by the average engine throughout the country and compare it with the average consumption of to-day. It will be well within the mark to say that the average has decreased by at least one-third. Putting this another way, the total coal consumption of to-day for steam purposes will supply horse-power very largely in excess of what a like quantity would twenty-five years ago. Similar improvement is taking place and is promised in central-station work. The coal consumption per kilowatt sold is continually decreasing, and there is great room for further decrease, not perhaps in the way ordinarily attached to such words, but indirectly by equalising the load. This is one reason why we constantly harp upon a trial of the suggested large central stations. Here the design is to obtain a load without an excessively prominent peak, such as is always to hand in a smaller station with lighting only to provide. It is expected that these huge stations will have a large load all day, and if this should be so, the coal consumption per kilowatt generated or sold would be largely decreased. Take it that one or two of the best of existing stations situated favourably burn from five to six pounds of coal per kilowatt-hour sold, we may venture to assume that on the average throughout the whole country the consumption will be not less than ten pounds. A good many trials have shown that the best engines will develop one horse-power per two pounds of coal, in some cases even under this, so that given the most favourable conditions as against those that prevail, we see what room there is for economy of coal consumption. The most favourable conditions will never be obtained, yet there clearly exists a good margin for improved conditions. As has been said, this

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economy comes directly from the equalisation of load. There does not seem to be so much room for economy from improvement of apparatus. No doubt there is room, but not to so great an extent. In this question of competition, then, the economy of coal consumption depends almost entirely upon the equalisation of load. While upon this question of competition, it may be well to refer to the "salvation of gas," as it is called by those interested in the matter—the Welsbach burner or mantle. Sanitation is a word to conjure with nowadays, likewise ventilation, but gas supporters do not seem very anxious to discuss these matters where gas is concerned. With an open gas burner a certain vitiation of the atmosphere takes place due to three causes—one, complete combustion, giving rise to carbon dioxide; then incomplete combustion, giving rise to carbon monoxide; and, lastly, non-combustion, giving rise to a mixture of the gas with the air. We know the evil effects of this state of things, but when a mantle is used it is stated that still more dangerous compounds are sent into the atmosphere. If this is so (and we see no reason to doubt it), sooner or later—probably later—opinion will veer round to the illuminant that, at any rate, is innoxious. We commenced with coal; we have seen how increased cost may operate; and we trust, though these things are common property to the profession, that nothing which works for good in the competition will be overlooked.

FORTHCOMING EVENTS.

FRIDAY, APRIL 6.

Institution of Civil Engineers.—At 2.30 p.m., students' visit to the works of the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown. At 8 p.m., students' meeting. Paper on "Experiments on Struts with and without Lateral Loading," by Mr. H. E. Wimperis, Wh.Sc.

Institution of Junior Engineers.—At 8 p.m., ordinary meeting. Paper on "A Comparison of Railway Bridge Structures of Moderate Dimensions and of Methods of Determining their Working Loads," by Mr. Eustace W. Porter, A.M.I.C.E.

Royal Institution.—At 9 p.m., discourse on "Solid Hydrogen," by Prof. Dewar, M.A.

British Insulated Wire Company.—At 6.30 p.m., at the Adelphi Hotel, Liverpool, annual staff dinner.

SATURDAY, APRIL 7.

Royal Institution.—At 3 p.m., Lecture V. of six on "Polarised Light," by Lord Rayleigh, M.A.

Glasgow and West of Scotland Technical College Scientific Society.—At 7 30 p.m., annual general meeting.

MONDAY, APRIL 9.

Institution of Mechanical Engineers.—At 7.30 p.m., graduates' meeting. Paper on "Suggested Improvements in 30 Knot Destroyers," by Mr. R J. Wilson.

TUESDAY, APRIL 10.

Institution of Civil Engineers.—At 8 p.m., ordinary meeting. Papers on "The Development of the Manufacture and Use of Rails in Great Britain," by Sir Lowthian Bell, Bart.; and "The Wear of Steel Rails in Tunnels," by Mr. Thomas Andrews.

WEDNESDAY, APRIL 11.

Crystal Palace School of Engineering.—At 12 noon, award of certificates to students in the Lecture Theatre.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

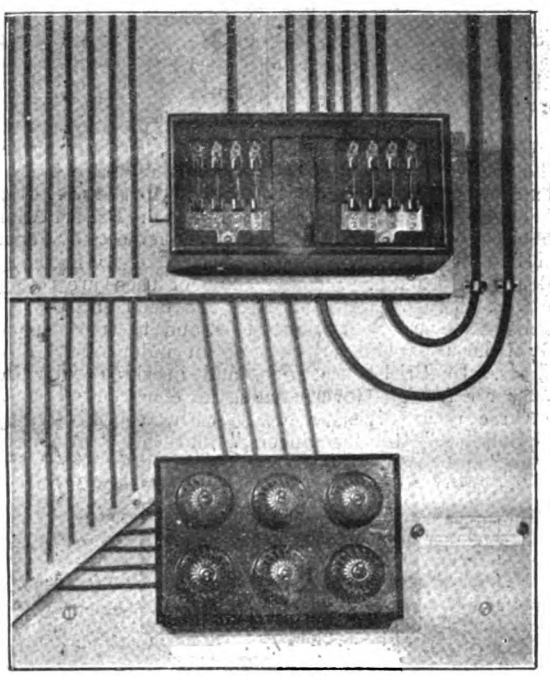
"STORAGE BATTERY PROBLEMS."

SIR,—Will you permit me to point out a few errors in your report of my remarks in the discussion of Mr. Wade's paper on "Storage Battery Problems" at the Institution of Electrical Engineers. What I said was that when sulphuric acid is electrolysed (not electrified) in the discharge, hydrogen is given off at the peroxide plate, and sulphion, SO_4 (not oxygen), at the spongy-lead plate. I pointed out that as this SO_4 is carried to the spongy-lead plate electrolytically, this plate is not sulphated at the expense of the acid *in its pores*, though, of course, it is sulphated at the expense of the acid in the cell. I also suggested that the peroxide plate is reduced by the hydrogen ions to sesquioxide, Pb_2O_3 (which is converted into a basic sesquisulphate by the chemical action on it of the sulphuric acid), and pointed out that this would account perfectly simply, without the necessity for Mr. Wade's complicated polymeric formulæ, for the fact that the maximum capacity obtainable from the active material on a plate is only one-half of that which would be obtained by discharging it right down to $PbSO_4$.—Yours, etc.,

Hampstead, N.W., April 4, 1900. J. C. ALLINGHAM.

ELECTRIC WIRING.

Mr. John Pindar has given us some photographs and a description of an arrangement of wiring which he has



Sample of Mr. Pindar's System of Wiring.

adopted generally in all installations entrusted to his care, for the running of wires immediately round the switch and distribution boards. This system of wiring can be readily understood from an inspection of the photograph we reproduce herewith, which was taken at the premises of Messrs. Melles and Co., of Cripplegate-buildings, Wood-street. The arrangement consists in isolating entirely the positive from the negative conductors behind the fuse and switch boards. In order to do this Mr. Pindar arranges two broad cable-ways up the side of the wall immediately above the fuseboard, and places the whole of the positive conductors in one of the ways so formed, and the negative conductors in the other. He secures the wires by means of wood cleats, so that they are at least 1in. from the wall. The whole of the woodwork and the wall behind is painted with five coats of asbestos paint, so as to be quite fireproof. At the top of the cleat work, where the wires have to be distributed to various centres, he arranges them on two planes, so that the positive conductors cross over the negative conductors with a considerable space between them. After this point the wires are run in casing in the ordinary way, but we understand that no grouping of wires has been allowed by Mr. Pindar, who is responsible both as consulting and installing engineer in this case. Another feature in this installation is that no more than three lights

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are in any case connected on to one circuit from the distributing board. The supply terminals, the meter, the main switch, and the main switchboard, and cut-outs have been placed in a brick chamber carefully fireproofed, so that the installation may be looked upon as absolutely safe. All the mains from the switchboard and fuseboard to the distributing boards are run on cleats, as shown in the illustration, and afterwards cased over. Mr. Pindar, whose address is 174, Regent's Park-road, N.W., has also recently carried out a large installation at the Commercial Travellers' School at Pinner, Middlesex, on the same lines. The chief objection which can be raised against the system of cleating is the great space occupied, and also the question of straining the wires to keep them away from the walls. These objections are overcome by Mr. Pindar, who insists on having the space he requires allowed him in the building. Every electric lighting contractor is not so fortunate in this respect.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Electrical Equipment of Ships of War.

BY C. E. GROVE, MEMBER.

INTRODUCTORY.

This subject, already a great one, is rapidly growing, and the use of electricity on ships of war is yearly being extended in all the navies of the world. While, therefore, the bulk of the paper records what has already been accomplished, regard has been paid throughout to certain imminent developments which in many departments o'ershadow present-day practice.

The methods followed in the English navy have to so large an extent constituted a guide and pattern to the world that the basis of the present paper lies naturally in the British Admiralty practice. In certain navies, however, important departures from British practice now exist, and tend to become more marked with the flux of time; some of these are referred to hereafter. The author's intention has been entirely to avoid administrative and tactical questions, and to treat the subject solely from the point of view of an independent electrical engineer. In British warships, and in ships built in this country for foreign Governments, the constructive work falls into three main divisions, dealt with respectively by the "shipbuilders," the "engineers," and the "ordnance contractors," and part of the electrical work falls into each division. In the present paper this distinction is ignored, and the electrical equipment treated as a unity.

PART I.—GENERAL EQUIPMENT.

Dynamos.

The first important step in the use of electricity on board ships of war dates from the introduction of the dynamo. In 1876 a Wilde alternate-current magneto machine, belt driven, was installed in H.M.S. "Minotaur," to work a searchlight projector. This machine gave place to the continuous-current Gramme dynamo so soon as the latter had assumed practical form; and this again was superseded in due course by the two-pole drum-wound direct-coupled compound steam dynamo, which until about 1895 was standard in our navy. The size of unit varies in our navy by steps of 100 amperes from a machine giving 100 amperes in the case of torpedo-boat destroyers, small gunboats, and the like, to a machine of 600 amperes as now used in all modern battleships and large cruisers. The standard voltage is 80 in all cases, this having been settled long ago as a convenient compromise between the pressure required for working searchlights and

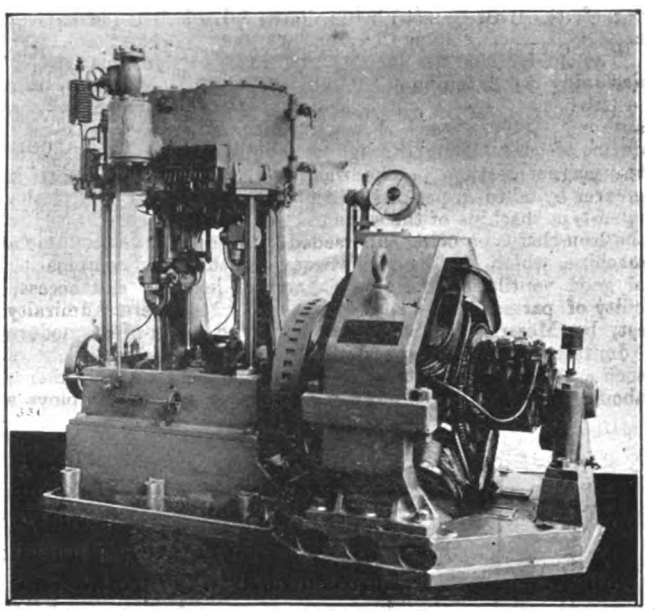
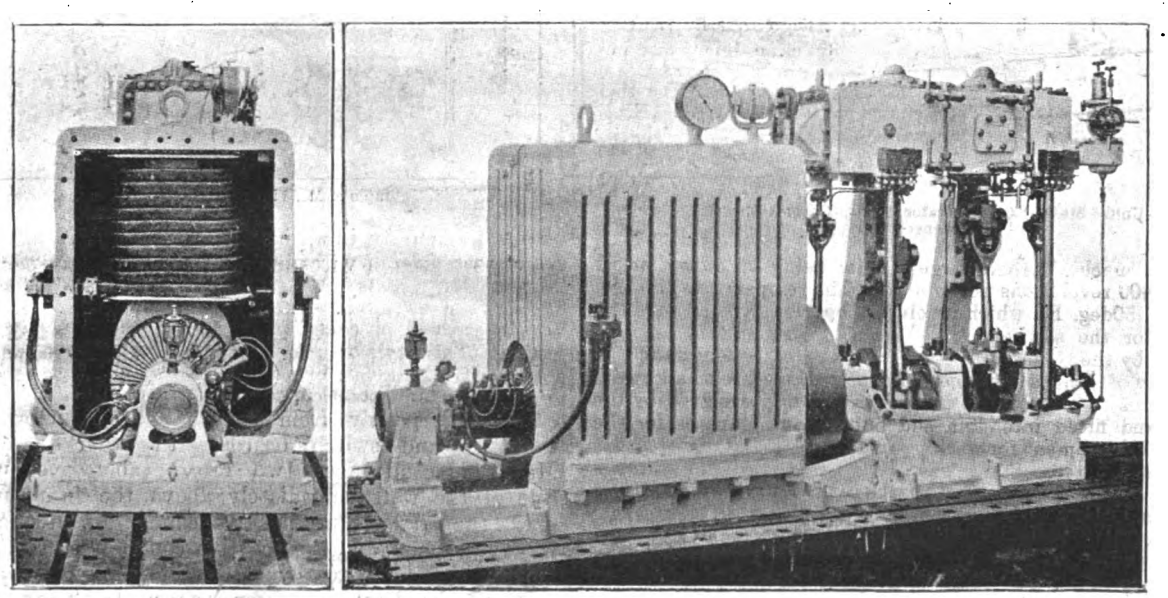


FIG. 4.—Modern Admiralty Multipolar Generator (W. H. Allen, Son, and Co., Bedford).

that giving the best efficiency in the ordinary electric light circuits. With the growing demands for current, this low voltage is becoming increasingly inconvenient—a matter which will be referred to again further on. For all-sized sets, from 200 amperes upwards, the standard speed is 300 to 320 revolutions per minute, though in the smallest sets speeds occasionally run up as high as 500 revolutions per minute. Engines running up to 500 revolutions with forced lubrication are now being introduced for the larger sizes. By the provision of clauses in the specification requiring the engine to work the dynamo with a low steam consumption, and requiring that the temperature of the dynamo after six hours' run at full load shall not exceed 80deg. F. above the surrounding air, the essential conditions for obtaining a well-built machine of high efficiency and moderate weight are secured. The usual British Admiralty steam dynamo is of the ordinary two-pole horseshoe type. These machines almost invariably had smooth cores. "Iron-clad" machines were introduced some five years ago to overcome a difficulty which had been discovered on ships equipped with ordinary dynamos—namely,



FIGS. 2 AND 3.—Ironclad Dynamo (Thames Ironworks).

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that considerable disturbance of the compass readings was observed, depending on the stray magnetic field produced by the dynamos and varying with the number of dynamos that were at work. Until this interference had been actually proved to be due to the dynamos themselves, it had been attributed to induction from the currents in the wires about the ship; but it was found that their action was much less important than the direct influence of the dynamos. With an iron-clad machine the stray magnetic field is reduced to one-half, or less, of what it is with an ordinary open-type machine, the stray field from the magnets (provided the machine is liberally designed as regards the mass of iron) being almost nil, while the leakage of magnetism axially along the armature shaft is greater.

The chief difficulties in designing iron-clad dynamos arise in designing to a minimum weight and in providing adequate ventilation. Figs. 2 and 3 show an iron-clad dynamo of the author's design in which thorough ventilation is secured by the device of coring slots through the bottom, sides, and ends of the magnet castings. The weight of an iron-clad dynamo is greater by 50 to 75 per cent. than that of an ordinary Admiralty open-type machine of the same output, which reason has led to the iron-clad type being superseded by an open four or six pole machine, which, on the whole, provides the best combination of good ventilation, minimum external leakage, and accessibility of parts. Fig. 4 shows a recent 600-ampere Admiralty set, by Messrs. W. H. Allen, Son, and Co. Most modern Admiralty dynamos have slotted cores. The total weight of such a set is about 6½ tons, of which the armature represents about 1½ tons. The United States navy usually employs a

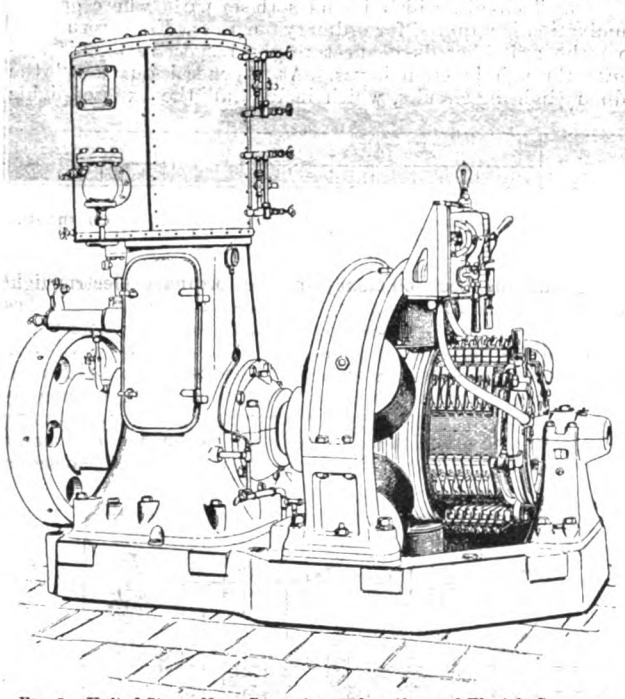

FIG. 5.—United States Navy Generator, 50 kw. (General Electric Company, Schenectady).

four-pole machine, their largest units being of 50 kw. at 80 volts at 400 revolutions per minute. The temperature limit is, however, 50deg. F., which involves a heavier dynamo than the British for the same output. Fig. 5 shows such a set constructed by the General Electric Company, of Schenectady.

By way of contrast to these large machines, a small steam dynamo may be mentioned which was recently designed by the author and fitted into 40ft. and 56ft. steam pinnaces for the Russian Government for working searchlights. In this particular case the required output was 60 amperes × 65 volts at 500 revolutions per minute, though the set has a maximum output of six units on a total weight of 12cwt.

Steam-engines of the open type are usually employed for dynamo driving. They have to be constructed strongly enough to work with the full steam pressure from Belleville boilers (275lb. to 300lb. per square inch), though with cylinder areas large enough to furnish their nominal full output at 150lb. to 200lb. pressure. Among the essential conditions for successful working are ample bearing surfaces, with thorough lubrication to ensure cool working for long periods, and ability to get rid of large volumes of water which come over with the steam when auxiliaries on the same range of steam-pipes are started.

The importance of preserving the dynamos unharmed in war is so great that at least a sufficient number of sets to supply all the fighting parts of the ship must be kept under protection. Unfortunately, this generally means placing the machines in a warm, ill-ventilated space, so that their durability is impaired. Again, if all the dynamos are together, an injury to the compartment, or to the steam and exhaust pipes serving the electric light engines, would place the whole *hors de combat*, and put the ship in darkness. Our Admiralty practice is to put one of a set of three or four dynamos in some daylight position on the upper or main deck to supply all the ordinary lighting current in "peace," and to place the dynamos that are used in action below the water-line. Nations differ as to the advisability of doing this, the control being certainly less convenient when the machines are in separate places. The United States navy place all the dynamos in one compartment. The Japanese divide the dynamos between the fore and aft auxiliary machinery rooms, but keep them all under protection.

Switchboards.

This standard British Admiralty pattern switchboard consists of a slate or slates carrying horizontally upon them a series of omnibus bars, connected severally with the positive and negative terminals of the dynamos, and bridging over these a series of vertical slotted bars leading through fuses to the circuits, and carrying sliding contact plugs which can be pressed down so as to make contact on the top and sides of the omnibus bars, being locked in the "on" position by a spring handle, and maintained in the "off" position by the action of an internal spiral spring, which also gives a quick break. The switchboard has the merit that all the current-carrying parts are on its face, and it is fairly compact; but the method of making electrical contact leaves much to be desired, and the switch parts consist of a number of components which give complexity and add to the cost of maintenance. The present design of board grew

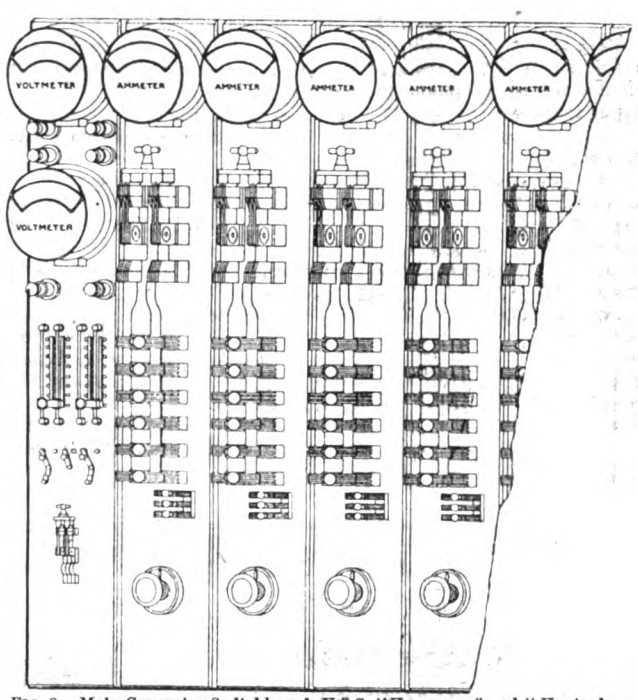

FIG. 8.—Main Generator Switchboard, U.S.S. "Kearsarge" and "Kentucky."

out of that older type known to telegraph engineers as the "Umschalter," in which contact was made between any one of a series of vertical bars and any other of a series of horizontal bars by screwed or coned plugs uniting them at their intersection. This style of board failed in service because of the practice of making and breaking circuit on the plugs, which led to their speedy destruction.

In the English Admiralty board, while any circuit or any number of circuits can be worked from one dynamo, it is not possible to work two or more dynamos in parallel on the same circuit, and in transferring a circuit of lights from one machine to another it is necessary to extinguish them during the process, which is objectionable. Time was when the parallel working of compound-wound dynamos was attended with difficulty, but the conditions are now well understood, and parallel working is, in fact, in successful operation on many ocean liners and in other navies. These switchboards are usually made up to standard drawings, and arranged for three dynamos and six circuits. When, as is commonly the case, the number of circuits exceeds six, one or more additional boards are fitted, and their dynamo bars coupled. Thus the Japanese battleship "Shikishima" carries three 600-ampere dynamos, and has boards with 18 circuits—six circuits supplying incandescent lights, four projectors, and the remaining eight motors.

The battleships of the "Formidable," "Duncan," and more recent classes, and the cruisers of the "Drake" class, will carry four 600-ampere dynamos, usually running at 400 revolutions per minute, and a large number of circuits, some of which will supply current to powerful motors. The design of switch-

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board described above appears to be quite unsuitable for such installations.

The Cardew hot-wire voltmeter and the Siemens torsion spring ammeter are the instruments chiefly to be found on her Majesty's ships, though these are no longer standard, having been replaced by dial instruments of the well-known Evershed pattern. The instruments are usually placed in close proximity to the dynamos, and not upon the switchboard. Circuit breakers are not used in the dynamo circuits of our navy, though double-pole fuses are now generally fitted in the machine leads.

The U.S. navy standard switchboard is planned with its dynamo bars vertical and circuit connections horizontal, and is designed for parallel working. Fig. 8 shows a section of the main generator board fitted in the recent battleships "Kearsarge" and "Kentucky," which each carry seven 50-kw. dynamos. Each dynamo bar is surmounted by its ammeter and main throw-over switch. A panel at one end contains the instruments used in common by all the dynamos. The field

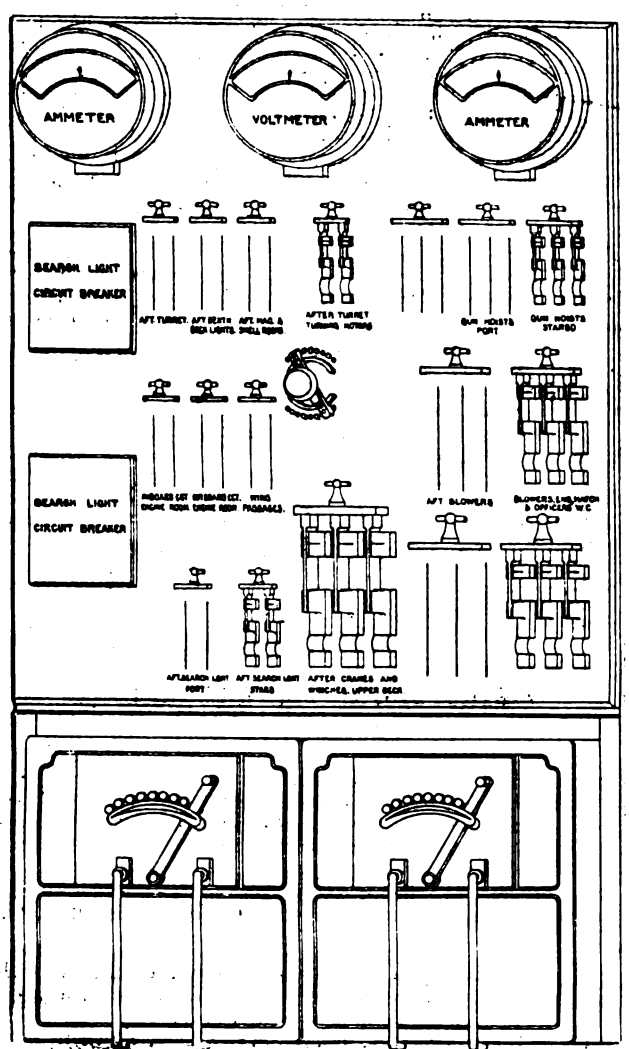

FIG. 9.—Distributing Switchboard, U.S.S. "Kearsarge" and "Kentucky."

terminals of the machines are brought to the switchboard, where they may be connected either for self or separate excitation. Equaliser switches are fitted on a separate panel in another part of the room. From the main board feeders are run to three three-wire main distributing boards (Fig. 9) located respectively forward, aft, and amidships, from which the several power, searchlight, and lighting circuits are run. Each of these boards receives from the main generator board five cables, a pair of "outers" for lighting, a similar pair for power, and a common neutral. Four sub-distribution boards for groups of motors are supplied from the main distribution boards. A circuit breaker and a short-circuiting switch for the series winding are carried by each generator on the terminal board, from which its main cables are led (Fig. 5). The electrical principles involved in this scheme of connections seem, in the main, right, but the multiplication of switchboards is a bad feature, which is said to have been necessitated by restrictions of space in the ship.

Electric Lighting.

The first installation of electric lamps on a warship was put in H.M.S. "Inflexible" in 1881. It consisted of a set of arc lamps run in series from a Brush dynamo with incandescent lamps arranged 18 in series on the high-tension mains. The arc light has disappeared. Modern war vessels are usually too much subdivided and have too little headroom to justify the use of arc lamps, although these are again becoming somewhat common on merchant vessels. The parallel incandescent lamp system became standard practice almost as soon as it was introduced, and the number of lamps employed has been steadily increasing. Thus, in the battleship "Colossus," fitted in 1884, 350 lights were installed; in the "Blenheim," first-class cruiser fitted in 1890, 525 lights were installed; the "Majestic" class of battleships, fitted in 1896, carry between 800 and 900 lamps; the "Albion" and her sister battleships of the "Canopus" class, just completing, carry about 950; the "London" and "Duncan" classes of battleships now building will carry from 1,000 to 1,050 lamps, while the first-class cruisers of the "Drake" and "Monmouth" classes now building will carry approximately 1,000.

It is usual to arrange the electric lamps in six circuits, one circuit being exclusively devoted to engine and boiler rooms, one to magazines, one to the central citadel, one to the crew spaces forward, one to the cabin spaces aft, and one to the stores and machinery rooms below the belt deck. It is desirable to have separate circuits for those portions of the ship which are protected by armour, rather than to mix up the lighting of protected and unprotected portions, though this is by no means generally done. A schedule showing the arrangement of lamps, fittings, and circuits on H.M.S. "Albion" is given in Fig. 10. In the U.S. navy the lamps are arranged on two main circuits, known respectively as the "battle" circuit, which includes the lighting of all parts of the ship occupied in action, and the "lighting" circuit, which includes those parts where general illumination is required for ordinary purposes. Feeders running from the switchboards connect to the respective circuit networks through junction boxes. At "general quarters" the ordinary lighting circuits, which include all the exposed lights

		FITTINGS														CIRCUITS					
DECKS	CIRCUITS	BULKHEAD	PENDGUARDS	BRACKET - PENDT CABIN	BRACKET - PENDT SPECIAL	HAND	TABLE	BUNKER	PEDESTAL	SIGNALS	PILOT	MAGAZINE	YARD ARM	TOTAL FITTINGS	FORWARD	MIDSHIP	AFTER	STORE	ENGINE ROOM	MAGAZINE
ABOVE BRIDGE	AFT					1				-		8					10			
	FOR					1				9		8			18					
BRIDGE	AFT	3	2		2		3			3							13			
	MID									3						3				
	FOR	3	2		2					5	2				14					
UPPER	AFT		8	8	5	2	2	2									27			
	MID		28													28				
	FOR		10	9			1								20					
	ENG			11														11		
MAIN	AFT		18	1	27	19		12									77			
	MID	36	35	6			2									79				
	FOR	15	10	5	5			1							36					
	ENG			12														12		
MIDDLE	AFT		14	9	6	23											52			
	MID	18	22	1					19							60				
	FOR	19	7	11								3			40					
	ENG			11							1							12		
LOWER	FOR	1	2				2	2							7					
	STOR	5	42	25			8	10	1									91		
	ENG	2	9	26				8		14									59	
	STOR	2	32	13			1	13										61		
PLATFORM	ENG	6	27	52				2			2								89	
	MAG											44								44
HOLD	STORE		4				6					6						16		
	ENG		6	2				2											10	
	MAG											38								38
TOTALS		110	278	202	47	44	17	47	16	33	11	12	3	91	16	927	135	170	179	168	193	82

FIG. 10.—Schedule of Electric Lighting, H.M.S. "Albion."

on the upper decks, are disconnected at the switchboards. This arrangement prevents stray light shining outboard.

Lead-covered cables and wires, first introduced into the Japanese cruiser "Naniwa-Kan," built at Elswick, are universally used in our navy, and the insulation is now vulcanised indiarubber in all cases. For single lamps a pair of $^1/_{16}$ wires are employed; stranded wires which group the sets of lamps through fuse boxes up to the circuits are universally composed of multiples of single 20-wire, the standard sizes being $^7/_{20}$, $^{11}/_{20}$, $^{15}/_{20}$, $^{30}/_{20}$, $^{60}/_{20}$, $^{80}/_{20}$, and $^{150}/_{20}$; while for dynamos and heavy motor circuits $^{350}/_{20}$ and $^{550}/_{20}$ are employed. The current density is usually a little below 1,000 amperes per square inch, which ensures in the lengths dealt with a very moderate voltage drop. The present mode of fixing the wires and cables is to attach battens of teak to the bulkheads and to run the wires side by side along the teak under brass cleats or saddles. Thus all the wires are visible. According to Admiralty specifications, steel battens may be used as an alternative to teak, but they would be much heavier, and the author is not aware of any ships so fitted. The introduction of these teak battens into our navy took place but a few years ago, and the step appears to have been quite a retrograde one. The employment of wood allows of fewer holes being drilled in decks and bulkheads

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than would be otherwise necessary, but the aggregate cost of the wiring work is considerably enhanced, useless weight is worked into the ship, and the danger of fire increased. The Japanese have in their latest battleships had the cables and wires attached directly to the decks and bulkheads, dispensing with backings, except where necessary for the heaviest runs or as packing to carry heavy runs of the larger cables over obstructions such as flanges of angle-bars, rows of rivet-heads, and the like. This makes a very substantial and satisfactory job. The practice in the U.S. navy very much resembles land practice. Lead-covered wires were employed at one time, but it is said that the quality of the lead and of the insulation was such as to give trouble, and to cause them to revert to the old system. In their latest ships they have run braided wires in wood mouldings in cabin spaces, and in iron pipe or conduit in machinery spaces, while in the crew spaces, and in some of the fore and aft runs, the wires are supported below the decks on porcelain insulators, and protected by thin iron guard-plates put over them. None of these methods appears to be so safe or so thorough as the British Admiralty method of lead-covered cables closely packed together, and visible and accessible throughout their length.

Watertight Work.

Where the wires go through watertight bulkheads or decks, of course the bulkheads and decks must be made watertight behind them. Until recently, the method of making the cables watertight at the decks consisted in providing a length of iron tube lined with fibre, with a stuffing box and gland at the top end, by means of which an indiarubber packing was screwed down upon the cable, and similar glands were used where the cables passed through bulkheads. One disadvantage of this arrangement was that where a number of cables and wires had to be dealt with, a considerable amount of space was taken up by these pipes in order to provide room for spanners to work in tightening up the nuts. A simple, compact, and effective method is as follows: two pieces of wrought-iron plate are drilled with holes slightly larger than the size of the cables that are to go through the bulkhead; similar blocks of indiarubber about ½in. thick have holes formed in them just the neat size of the cable; the bulkhead is drilled with clearing holes; a slab of rubber and an iron plate are placed on either side of the bulkhead, the cables are drawn through, and then the plates screwed up tight. By this means pressure is put upon the rubber, which tends to make the holes through which the cables pass smaller, so that the cables are gripped, and the holes are left watertight. This arrangement was used by the author throughout the Japanese battleship "Fuji" both for decks and bulkheads.

(To be continued.)

DUBLIN ELECTRIC LIGHTING.

LOCAL GOVERNMENT BOARD ENQUIRY.

(Concluded from page 453.)

At the commencement of the Thursday's proceedings, Mr. HARTY, the city engineer, was examined concerning the foundations of the proposed site at Pigeon House Fort. In answer to questions, he stated that he had laid down conditions with regard to leaving clear space between the works and the wharf for a 40ft. roadway, because it would give a right of way for the military. The entrance into and the exit out of the Fort was only between 8ft. and 10ft. wide. He had now consented to reduce the roadway from 40ft. to 30ft. for the accommodation of the boilers and other works. He only wanted to keep away from the wharf. He did not take borings specially at this site in connection with this scheme, but he had borings taken in connection with the main drainage immediately outside the Pigeon House Fort and then at the pumping station, and they were very deep. Practically at low water there was no water at the wharf. He did not know what tonnage vessels could be accommodated at the wharf. He should have a 6in. main put down there, started from Warrington-place, beside the canal, which was their boundary. The idea was not to charge this main to the electric lighting account, because they wanted it for the main drainage and other works down there. He had not been consulted about this scheme in any way, but he saw no objection to it. He did not consider the foundations available at Pigeon House Fort would be abnormally bad ones.

Mr. H. H. HILLIS, the resident engineer in connection with the main drainage works, gave evidence to show that the depths of the various parts of the harbour of Dublin would be sufficient for the purposes of the scheme.

Mr. HEALY then opened the case for the opposition, and objected to the town obtaining a loan for trade and competition purposes. He claimed that the Corporation had already spent £80,000 on a failure in order to supply some 250 people with electric light. He also strongly objected to the scheme put forward by Mr. Hammond, and submitted that the Corporation had no power to spend money outside its area of supply. Another objection was that the County Council and the Pembroke Urban District Council should have been represented at the enquiry, as it was proposed to break up streets outside the Corporation area. He proceeded to argue against the scheme in detail, and pointed out that the tramway company would be well able to undertake the work. He concluded by the statement that the scheme was unsound financially and unscientific electrically, and the Corporation could at much less expense secure for themselves the light which many of them desired.

Mr. ARTHUR WRIGHT was examined by Mr. Day, and stated that, considering all the circumstances of Dublin, he believed that electricity should be distributed on the continuous-current system. This system was more applicable to the wants of the consumers, and he thought a more reliable and constant service could be obtained by this means. He quoted several cases where alternate current had recently been replaced by continuous.

The enquiry was then adjourned till Friday.

On the enquiry being resumed, Mr. THOMAS TOMLINSON stated that he had carefully examined Mr. Hammond's scheme, and did not consider it a suitable one. He thought that the two-phase system of distribution would have enabled the new works to fit in much more easily with the existing system. The two-phase system of distribution was also adopted in two large electricity stations recently erected in London. He knew the Pigeon House site, and was of the opinion that they would not be able to obtain foundations sufficient to sustain the building proposed to be erected and the moving machinery.

Evidence was then given by Mr. A. E. PORTE on the difficulty the National Telephone Company had in finding foundations for their works along the Liffey. After going down a certain depth black mud was found, and he thought the same thing was likely to occur on the proposed site.

Mr. HORACE PARSHALL, then examined by Mr. Healy, explained a number of objections to the scheme. All the big lighting companies were, in his opinion, in favour of the direct-current system. He pointed out that the tramway company's works at Ringsend were within a reasonable distance of the centre of the city, and no disadvantage had arisen from their presence. He was then questioned as to the offers which the tramway company had made to the Corporation to supply power or to take over the electric lighting order.

The counsel having summed up on behalf of their respective clients, the enquiry was closed without a definite expression of opinion by the inspector.

METROPOLITAN DISTRICT RAILWAY.

As stated in our front notes, the Board of Trade officials inspection of the electrical section of the above railway, from Earl's Court to Kensington High-street, was made on Tuesday last, when the electrically-propelled train was run several times over the line. During its runs the representatives of the Board of Trade made various experiments to satisfy themselves as to the safe working of the system. The report and official sanction to work the electric section is expected early next week, when the company hopes to be able to place the electric train in their regular schedule. It will be remembered that the whole of the plant and equipment in this case is of English manufacture, being supplied by Messrs. Siemens Bros. The engines used to drive the electric generators are of the Bellis type. A novel feature in the line is that both lead and return conductors are insulated, being placed one on each side of the track. These conductors consist of channel irons supported on porcelain insulators. The grades met with on this section, and also the numerous crossing points, will enable a very severe test to be made of this system of supplying electricity to a moving train.

GERMAN TELEPHONE CHARGES.

In view of the secrecy maintained by the Government in regard to the telephone rentals to be charged in London for the State telephone service now being instituted, some interest will be manifested in the new telephone rates introduced by the German Government at the commencement of the present month. These rentals are charged in two ways—a fixed annual rate and a definite sum per annum, combined with a payment for each conversation. The first method is based upon a sliding scale, according to the number of subscribers to the exchange. Thus, for instance, the charge per annum where there are 50 subscribers is £4; over 50 and up to 100, £5; 200, £6; 500, £7; 1,000, £7. 10s.; 5,000, £8; 20,000, £8. 10s.; and exceeding 20,000 subscribers, £9. The second method, where the subscriber is not more than three miles distant from the exchange, provides for the payment in networks comprising

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1,000 subscribers of £3 per annum; over 1,000 and up to 5,000, £3. 15s.; 20,000, £4. 10s.; and exceeding 20,000 subscribers, £6 per annum. In addition to this annual rental a charge of five pfennigs (·6d.) is made for each conversation, with a fixed minimum of £1 per annum. The charge for three minutes' conversation between various localities is 20 pfennigs (2·4d.) for a distance of 15½ miles, 3d. for 30 miles, 6d. for 100, 1s. for 500, 1s. 6d. for 1,000, and 2s. for a greater distance. Where subscribers are situated at a distance exceeding three miles from the central exchange an additional annual charge will be made of 3s. for single lines and 5s. for complete metallic circuits for each 110 yards in excess of that distance, and in cases where the distance exceeds 6½ miles the additional annual charge will be 10s. for a single wire and 15s. for double wires for each excess of 110 yards. On the above basis the fixed charge in a town like Frankfort-on-the-Maine amounts to £8. 10s. per annum on the first system and to £4. 10s. on the second, with the addition in the latter case of the charge for each conversation or connection with the exchange.

We are indebted to the *Financial Times* for the above figures.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

259. What is your opinion of oil *versus* coal as fuel? Describe the method of burning the latter.—A. B.

260. Give a rule for determining the proper distance between driving centres of belt-driven pulleys and the minimum diameter of the same for a given power transmitted.—T. F. T.

ANSWERS.

Question No. 253.—How would you ascertain the number and diameter of tubes to be used in an exhaust-steam feed-water heater for dealing with a given quantity of feed water.

Best Answer to No. 253 (*awarded* 10s.).—The tubes for an exhaust-steam feed-water heater require to be fairly large, as it would do away with all economy occurring through its use if there were to be much back pressure on the piston occasioned by the throttling of the exhaust during its passage through the heater. There is, of course, a limit to the size of the tubes, and, generally speaking, a tube about 2in. diameter is considered the best, mechanical and other details in any special case altering this to a small extent either way. Having fixed the diameter of the tube at 2in., the following method will give a fairly close approximation to the number required. The conductivity of copper after its freshness has worn off with as great an amount of accuracy as it is possible to get is 200 British thermal units (B.T.U.) passing through a square foot per minute per degree difference of temperatures on the two sides of the tube.

Let x_1 = number of square feet of tube surface required;
w = number of lbs. of feed water required per minute;
t_1 = inlet temperature of feed water;
t_2 = inlet temperature of feed water.

Then 200 x_1 is the heat passed into the feed water per minute per degree difference in temperature, and $w\,(t_2 - t_1)$ is the amount of heat required by the feed water per minute. The heat from the exhaust steam which is to be used for heating the feed is nearly all latent heat, as non-condensing engines usually exhaust very near to the atmospheric pressure. At this point the temperature of the steam is 212deg. F.

Now, as some of the steam leaves the feed-water heater uncondensed, it is obvious that the temperature of the steam and water in the tubes may be taken as 212deg. F. without sensible error. It follows, therefore, that the heat other than the latent heat, which is 966 B.T. units per pound of steam, available for use is very small, and may be neglected. To obtain the difference in temperature between the inside and the outside of the tube, the exhaust may be said to be constant at 212deg. and the feed water taken at its average temperature, $\frac{t_2 + t_1}{2}$. Therefore, the difference in temperature of the two sides of the tube $= 212 - \frac{t_2 + t_1}{2}$.

The heat passed into the feed water per minute is

$$200\, x_1 \left(212 - \frac{t_2 + t_1}{2}\right) \text{ B.T. units,}$$

and this amount must be equal to the amount required by the feed water.

$$\therefore\ 200\, x_1 \left(212 - \frac{t_2 + t_1}{2}\right) = w\,(t_2 - t_1),$$

or
$$x = \frac{w\,(t_2 - t_1)}{100\,\{424 - (t_2 + t_1)\}}.$$

The surface of a 2in. tube per foot run is $\frac{\pi\ 2 \times 12}{144}$ = ·52 square foot per foot run; and, therefore, the length of tube required is $\frac{w\,(t_2 - t_1)}{100\,\{424 - (t_2 + t_1)\}} \div ·52$

$$= \frac{w\,(t_2 - t_1)}{52\,\{424 - (t_2 + t_1)\}}.$$

Let x = number of tubes;
l = length of each tube in feet;

then
$$x = \frac{w\,(t_2 - t_1}{52\,l\,\{424 - (t_2 + t_1)\}}.$$

W. B.

Answer to No. 253 (*awarded* 5s.).—As no particulars are given in the question, several conditions must be assumed before it can be answered. For instance, let us assume that it is required to raise 5,000lb. of feed water per hour from a temperature of 56deg. F. to a temperature of 206deg. F., the latter being about as high as water can be raised to in ordinary exhaust steam feed-heaters. If the exhaust steam to be used has a pressure of 3lb. above the atmosphere, or an absolute pressure of 18lb. per square inch, its temperature will be 223deg. F. The number of heat units required per hour will be equal to the product of the pounds of water multiplied by the number of degrees through which they are raised, or 5,000 × (206 − 56) = 750,000 units of heat per hour.

Now, on the authority of Messrs. Babcock and Wilcox's book, "Steam," the number of heat units which will be transmitted per hour through each square foot of horizontal surface equals 330 for each degree of difference in temperature between the two sides, and as in the present case the average difference of temperature between the inside and outside of the tubes will be $\frac{223 - 56}{2}$ = 83·5deg., therefore 83·5 × 330 will give us the number of heat units transmitted through each square foot of tube per hour = 27,555 units, and if we divide 750,000, the total number of heat units required, by 27,555, we obtain 27·21, the number of square feet of tube surface required; but in order to give the water time to part with some of its impurities while passing through the heater, about 25 per cent. should be added, bringing the tube surface up to 35 square feet.

The tubes generally used in feed-water heaters are ¾in. outside diameter, and tubes of this size have an external surface of ·196 square foot per foot in length, so that if we make the tubes 5ft. long we shall require 35 ÷ (5 × ·196) = 35·71 tubes, or, say, 36 tubes.—R. D. S.

Answer to No. 253 (*awarded* 5s.).—The solution of this question naturally divides itself into two parts: (*a*) the quantity of heat to be transmitted to the water; (*b*) the tube surface necessary to transmit that heat.

In order to calculate (*a*) for any special case we should require to know the quantity of water to be heated and its original temperature, also the temperature it is required to

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leave the heater. Then, if we know the heat transmitted per square foot of tube surface, (b) can be calculated. Thus to take the general case :

Let Q = the quantity of feed water in pounds per hour to be heated ;

Let t_i and t_f = the initial and final temperatures of the water ;

Let c = the number of thermal units of heat transmitted per square foot of tube surface per hour ;

Then $Q \times (t_f - t_i)$ will be the thermal unit of heat required to be taken up by the water per hour. Consequently,

$$Q \times \frac{(t_f - t_i)}{c} = \text{total square feet of tube surface required.}$$

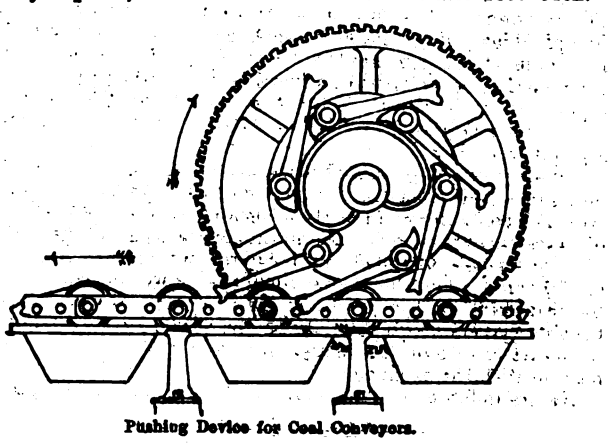
The efficiency of the tube surface for transmitting heat depends upon the temperature, and therefore the pressure of the steam admitted to the heater, the average temperature of the water, the material of which the tubes are made, and the thickness of the tubes. The greater the difference between the temperature of the steam on one side of the tubes and the water on the other side, and the thinner the tubes, the higher will be the efficiency of the tube surface. By adopting a tube as small as practicable the maximum amount of tube surface for a given space is obtained. Further, the smaller the diameter of the tubes, the thinner they can be made.

In practice the tubes are invariably made of brass, and the diameter varies from about ½in. to 1in. in accordance with the size of the heater. The length of the tubes depends upon the size and general character of the heater. If the feed water contains mineral matter, it should be more slowly passed through the heater than would be required to raise its temperature to enable any suspended mineral matter to be deposited in the heater. In such a case the tube surface will require to be larger than necessary to simply transfer the heat. It will be seen, therefore, that the value of c is dependent upon each particular case. Under average conditions one square foot of tube surface will transmit about 8,000 to 12,000 thermal units per hour, and this may be taken as the average value of c for normal conditions, and when there is no mineral matter present in the water.

To calculate the tube surface for an actual case the thermal units of heat to be given to the water should be obtained from the general formula above and divided by the value assigned to c to obtain the tube area. The diameter and length of the tubes having been decided upon, the number can readily be calculated. A simple, though unscientific, rule is to allow about one square foot of tube surface for every 30lb of feed water passed through the heater per hour.—E Y. T.

Question No. 254.—State the advantages of coal conveyors, and give figures as regards economy of the same.

Best Answer to No. 254 (*awarded* 10s.).—Coal conveyors decrease the cost of coal handling, save labour, and prevent breakage. The C. W. Hunt Company, of New York, has designed an elevator and conveyor which is very largely employed. The scoops used to lift the coal open out 7ft. and carry from 1 to 1½ tons. A hoisting engine is employed, and when the shovel reaches the top of the booms over the hopper, it is automatically tipped. It has been found that the average expense for lifting by this means does not exceed ¾d. per ton. The wear and tear of machinery is slight and the repairs to the shovel are stated not to exceed $\frac{1}{10}$d. per ton of coal hoisted. This shovel makes about one trip per minute, so that its capacity of unloading varies between 60 and 80 tons per hour. The conveyor consists of a series of brackets suspended in such a way that they are upright in all positions of the carrying chain. This chain is composed of heavy wrought-iron links, the pins connecting the links being provided with small flanged wheels, which run on rails. As the buckets swing freely on pivots, some special method of loading them is required. Two methods of doing this are adopted by the Hunt Company, one known as the "measuring," the other as the spout filler. The first delivers to each bucket a given quantity, the latter is a continuous feed, each bucket being filled as it passes underneath it. The conveyor is driven by a set of pawls, which push the endless chain along. The bucket chain is run at a very low speed. The ordinary capacity of the buckets is two cubic feet each.



Pushing Device for Coal Conveyors.

The average speed is about 15 buckets per minute, or about 40 tons of coal per hour. The speed can be increased to 25 buckets per minute, or about 90 tons of coal per hour. This conveyor can also be used for carrying ashes and clinkers from the stokehold.—A. B.

PHYSICAL SOCIETY.

At the meeting of the Physical Society held last Thursday week, Prof. W. E. Ayrton, F.R.S., vice-president, in the chair, a paper on "**Some Experiments Illustrating Syntony**" was read by **Mr. P. E. Shaw**. The experiments described in this paper have been devised for the purpose of showing in a lecture-room the principles of magnetic space telegraphy, the distance between the sending and receiving circuits being about 15 yards. A current flowing in a main circuit was interrupted by a tuning-fork of 100 vibrations per second, and a fraction of the current was passed through the sending coil. The sending coil was placed in series with a coil of adjustable self-induction, and the two coils were shunted with a condenser of variable capacity. By suitable adjustments an oscillation of frequency 400 could be maintained in the sending circuit. The receiving coil was in series with a variable self-induction and a variable capacity, and was tuned to respond to the waves given out by the primary. The current induced in the secondary coil was passed round a light drum fastened to a wire tuned to 400 vibrations per second. The drum was placed in a strong magnetic field, and the electrical oscillations caused mechanical vibrations of the drum. On to the drum was attached one carbon of a microphone, and the induced oscillations were thereby considerably magnified in the microphone circuit. This circuit was also arranged in the same way as the former, and by means of another microphone the vibrations were transferred to another circuit, where their intensity was sufficient to actuate the diaphragm of an ordinary telephone receiver to such an extent as to render the sound perfectly audible.

Mr. Watson described some experiments which he had shown to illustrate syntony, both by obtaining galvanometer deflections and sparks in the secondary circuit.

Dr. Lehfeldt asked how the circuit was tuned when it contained both a variable capacity and a variable self-induction ?

Mr. Shaw said that the values of the capacity and self-induction were connected with the vibration frequency by a formula given by Dr. Lodge. Starting with a known capacity, the necessary self-induction was calculated, and small alterations produced by means of an iron core.

Mr. Shaw then read a paper on "**An Electrical Micrometer.**" In this paper the motion of the centre of a telephone diaphragm was measured by means of a system of levers and a spherometer screw. The screw, which had a pitch of 0·5mm., and a head divided into 500 parts, pressed against the long arm of an aluminium lever. The short arm of this lever pressed against the long arm of another, and so on through three levers. In this way any motion of the spherometer screw was transmitted to a fine platino-iridium point close to a small platino-iridium disc fastened to the centre of the telephone diaphragm. Since the head of the spherometer could be accurately read to 0·1 of a division by means of a telescope, and since the system of levers minified any motion a hundredfold, it followed that an accurately observable twist of the spherometer head corresponded to a movement of a millionth of a millimetre, or 1 $\mu\mu$ of the fine point. To test the action of the levers, the point was removed and a convex lens was substituted. That lens formed one of a system by means of which Newton's rings were produced and observed. By means of an optical experiment the author had found that 0·1 of a division on the graduated head equalled 1·033 $\mu\mu$ at the platino-iridium point. The point and the diaphragm then formed part of a circuit containing an ordinary telephone, and the levers were so adjusted that the point just touched the diaphragm. A sharp click was then heard in the telephone. A small current was then sent through the electro-magnets of the original telephone, and the displacement of the diaphragm was measured by turning the spherometer screw until the point just touched it and a second click was heard.

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By carrying out a series of experiments of this description a curve had been drawn showing the relation between current strength and diaphragm displacement. It was then interesting by exterpolation from the curve to find the movement which corresponded to the least audible sound. The author had done that and found that he could not hear sounds if the amplitude was less than 0·37 $\mu\mu$. A motion of 50 $\mu\mu$ gave comfortable sounds, 1,000 $\mu\mu$ uncomfortable sounds, and 5,000 $\mu\mu$ sounds unbearably loud. Throughout the experiments it was necessary to get rid of extraneous vibration by means of indiarubber balls and door-spring suspensions and by working at night.

Prof. Everett expressed his interest in the delicacy of the system of measurement, and asked if the micrometer had been used to determine the form of the plate when vibrating.

Mr. Phillips asked if experiments on the smallest sound audible had been made on different people, as it would be physiologically interesting to know if this minimum value were constant.

Mr. Campbell asked if the sound was expected when heard.

Mr. Shaw said he had not conducted experiments on the form of the plate when vibrating, although he had investigated its law of damping. He said the small sounds were expected and the limit varied.

The **Chairman** said he found it easy to rid galvanometers and electrometers from extraneous disturbance by placing them on a block of stone resting on a thickness of 3ft. or 4ft. of slag wool contained in a hollow brick pillar.

The society then adjourned until April 27, when the meeting will be held at eight o'clock in the solar physics laboratory of the Royal College of Science.

HUDDERSFIELD ELECTRIC LIGHTING ACCOUNTS.

From the accounts of the Huddersfield central station for the year ended Dec. 31, 1899, it appears that the total expenditure on capital account up to date amounts to £106,684. Below will be found an abstract of the revenue account, general balance-sheet, and statement of electricity generated, supplied, etc.

Revenue Account.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel, including carting	£1,813	13	4			
Oil, waste, water, and engine-room stores	202	17	3			
Wages at generating station	1,121	8	5			
Repairs of buildings	72	4	2			
Repairs of boilers and engines	188	9	4			
Repairs of condensing plant, etc.	132	3	9			
Repairs of alternators and dynamos	23	17	5			
				3,554	13	8
Distribution of Electricity.						
Repairs of transformers, meters, switches, etc.	166	12	3			
Repairs and renewals of mains	335	9	9			
				502	2	0
Public lamps				191	3	5
Rent, rates, and taxes				829	0	5
Management				1,135	8	8
Legal expenses				389	9	8
				6,601	17	10
Balance carried to net revenue account				9,040	17	9
				£15,642	15	7
Cr.				£	s.	d.
Sale of current per meter				13,214	17	5
Supply to public arc and incandescent lamps				793	17	9
Rental of meters and other apparatus				827	1	11
Sale and repairs of lamps				106	18	6
Legal expenses				700	0	0
				£15,642	15	7

Balance-Sheet.

Liabilities.	£	s.	d.
Mortgages	105,928	18	1
Floating liabilities	3 311	13	4
Depreciation and contingencies account	5,684	6	4
Excess of assets over liabilities	15,151	1	11
	£130 075	19	8
Assets.	£	s.	d.
Buildings	17,664	10	3
Machinery and boilers	38,624	9	10
Mains, including cost of laying	46,869	9	4
Transformers, motors, etc.	11,007	18	1
Meters and fees for certifying	5,942	0	0
Electrical instruments, etc.	443	14	6
Costs of obtaining provisional order, 1890	516	12	8
	121,068	14	8
Mains and services	1,080	0	0
Stores in hand	524	12	3
Floating assets	7,402	12	9
	£130,075	19	8

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			1,319,221
Quantity sold: Public lamps	79,787		
Quantity sold: By contract	171,670		951 033
Quantity sold: Private consumers by meter	699 576		
Quantity used on works			73 560
Total quantity accounted for			1,024,593
Quantity not accounted for			294,628
Total maximum supply demanded in B.T. units			1,012

Number of public lamps, 33 arc, 52 incandescent.

BRIGHTON ELECTRIC LIGHTING ACCOUNTS.

The Brighton electric lighting accounts for the year ended Dec. 31, 1899, have just been published. The total expenditure to this date amounts to £290,930. We give herewith an abstract of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

Revenue Account.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£8,331	3	10			
Oil, waste, water, and stores	1,212	14	3			
Wages at generating station	4,460	1	3			
Repairs and maintenance: buildings, £588. 10s. 10d.; engines, boilers, dynamos, etc., £2,677. 1s. 7d.	3,265	12	5			
				17,269	11	9
Distribution of Electricity.						
Wages and other remuneration	857	13	1			
Repairs, maintenance, and renewals of mains	408	0	8			
Repairs, maintenance, and renewals of transformers, etc.	718	2	3			
Outlay for works executed	443	18	10			
				2,427	14	10
Public Lamps.						
Street-lighting installations	157	4	1			
Attending public lamps and repairs	4,350	1	6			
				4,507	5	7
Rates and taxes				1,091	0	4
Management Expenses.						
Salaries	2,618	17	0			
Stationery and printing	380	0	8			
Registrar of stock, and stamp duty	179	18	1			
General establishment charges	391	2	9			
				3,569	18	6
Special Charges.						
Insurance	137	8	6			
Law expenses	12	6	9			
				149	15	3
Total expenditure				29,015	6	3
Amount carried to net revenue account				16 700	0	0
Balance to be carried to next account				144	10	2
				£45,859	16	5
Cr.				£	s.	d.
Balance from last account, £147. 16s. 5d.; less bad debts written off, £96. 13s. 8d.				51	2	9
Sale of current per meter: 976,339 units at 7d., £28,476. 11s. 1d.; 2,769 units at 1½d., £17. 6s. 2d.; 1,624,931 units at 1d., £6,770. 10s. 11d.; additional (minimum) charges under special contracts, £56. 14s. 10d.				35,321	3	0
Public lighting: 61,152 units at 7d., £1,783 12s; 541,432 units at 1d., £2,255. 19s. 4d.; attending, etc., £4,350. 1s. 6d.; installation works, £157. 4s. 1d.				8,546	16	11
Rental of meters, works executed, rents receivable, and interest on cost of main				1,940	13	9
				£45,859	16	5

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital—amount received, £273,155. 0s. 2d.; less premiums, etc., on stock, £9,611. 6s. 9d.; and amount appropriated for extinction of debt and interest thereon, £33,855. 18s. 4d.	229,687	15	1
Premiums on stock, £13,118. 3s. 1d; less discounts and costs, £3 506 16s. 4d.	9,611	6	9
Sundry creditors	15,263	2	11
Customers' deposits	1,394	19	7
Interest accrued due	920	16	0
Proportion of appropriation in respect of sinking funds accrued due	5 687	16	8
Revenue account—balance at credit thereof	144	10	2
Net revenue account—balance at credit thereof	1,454	18	2
Treasurer	9,889	12	10
Reserve fund	4,881	1	4
Surplus account	29 359	0	7
	£308,295	0	1

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Cr. Assets.	£	s.	d.
Capital account—amount expended for works	286,433	2	11
Stores on hand: coal, £838. 0s. 1d.; oil, waste, etc., £395	1 233	0	1
Sundry debtors for current supplied	12,944	8	8
Other debtors.....	436	7	4
Engineer's advance	50	0	0
Reserve fund investment.....	7,198	1	1
	£308,295	0	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units.....		3,815,743
Quantity sold { Public lamps 602 584		
Quantity sold { Private consumers by meter ... 2,604,039 }		3,206,623
Quantity used on works		160,650
Total quantity accounted for.....		3,367,273
Quantity not accounted for		448,470

Number of public lamps, 257 arc, 1,027 incandescent.

LEGAL INTELLIGENCE.

GOLDBERG AND SONS v. LIVERPOOL CORPORATION.

In the case of J. Goldberg and Sons, Limited, *v.* the Corporation of Liverpool, the defendants appealed from a decision of the Vice-Chancellor of the County Palatine of Lancaster granting an injunction restraining them from continuing in front of the plaintiffs' shop a pole used in connection with the overhead system of electric tramways. By special leave the appeal was heard on April 3 before the Master of the Rolls, the President of the Probate Division, and Lord Justice Rigby.

Mr. Neville, Q.C., Mr. M'Morran, Q.C., and Mr. Maberley appeared for the appellants; and Mr. Mattinson, Q C., and Mr. Rotch for the plaintiffs in this action.

The question raised by the appeal was whether the defendants had the right to place the pole, together with a fuse-box, in a position which the plaintiffs alleged was inconvenient to their business. In Paradise-street, where the plaintiffs' premises are situated, the committee adopted span wires. A letter was sent to the owners requesting permission to place rosettes on their houses, the Corporation paying a rent of 5s. a year. It was found necessary to erect the pole in question, and the plaintiffs complained on Feb. 28, 1898, that it had been so placed as to cause the greatest possible inconvenience. The plaintiffs had refused to have a rosette placed on their premises, and the pole was the only alternative.

For the respondents it was contended that it had been established that the defendants had created a nuisance, and that from that nuisance the plaintiffs had suffered special and particular damage.

The hearing was resumed on the 4th inst., when **Mr. Mattinson, Q.C.**, on the part of the plaintiffs, submitted that it was for the Corporation to show that it was necessary for the establishment of an efficient tramway system that the pole and box should be in the particular position in which they had been placed, and that the evidence established clearly that at least three other areas were available, by which interference with the access to Messrs. Goldberg's premises would have been avoided. If the things were removed 6ft. further up College-lane, or at about 10ft. in the direction of Paradise-street, all cause of complaint would have been removed. Supports had to be provided at every 120ft., but coming from Lord-street the next support to the one in question was distant only about 95ft.

Mr. Neville contended that the Corporation had a right to place these poles where they were necessary and expedient, and they themselves were the sole judges of what was necessary or expedient. They had power to commit a nuisance, as the very thing they were authorised to do was in itself a nuisance.

Their **Lordships** allowed the appeal, holding that it was clear that the Corporation had statutory authority to do what they had done, and the plaintiffs had not shown *mala fides* which would entitle the Court to interfere with the Corporation's discretion.

LONDON COUNTY COUNCIL v. LONDON ELECTRIC SUPPLY CORPORATION

The London Electric Supply Corporation, Limited, were summoned at the Southwark Police Court, before Mr. Paul Taylor, on Tuesday by the London County Council for not constantly maintaining a proper supply of electric light and of sufficient power in Borough High-street, at the Weights and Measures Office, Union-road, and at the Public Library, Borough-road, on various dates. They were further summoned for making default in supplying electric light to Frederick Redman, at 148, Borough High-street; to the London County Council, at the Weights and Measures Office, Union-road; and to the Library Commissioners, at the Public Library, Borough-road. Mr. Andrews appeared on behalf of the Council, and Mr. Deakin represented the defendants. Mr. Deakin said that as a very important point was to be discussed, he asked for an adjournment, which was granted.

Bradford.—A recommendation to borrow £56,000 for electric light extensions will come before the Council next Tuesday.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN DISTRICT RAILWAY.

An extraordinary general meeting of this Company was held at the Westminster Palace Hotel, Victoria-street, S.W., on Friday last, for the purpose of considering certain Bills promoted in the ensuing session of Parliament.

Major Isaacs occupied the chair, and stated that the directors had had under consideration the question of changing the motive power of the line. The proprietors had given the directors sanction, in conjunction with the Metropolitan Railway, to try an experimental line of about 1½ mile in length from Earl's Court Station to High-street, Kensington, and to expend upon such experiments £20,000, each company to provide £10,000. They had so far succeeded in their object that at the last half-yearly meeting the chairman was able to give the proprietors an excellent report from the engineers engaged. He had then to supplement that information by saying that in the course of a few days the first trial trip by the directors would be made from Earl's Court Station to Kensington High-street and back again, so that the Board might have evidence that that part of the line was in working order, and it would be submitted officially to the Board of Trade on the following day. In order to work the railway by electricity they must first generate the power, for which it was necessary to acquire land upon which to build a generating station, and the Bill asked for power to be given to the Company to enable them to acquire that land. The land selected for the purpose was at Lots-road, Chelsea, and had great facilities for getting in coal cheaply, and water for condensing purposes could also be easily obtained. It adjoined land which had been selected by the Brompton and Piccadilly-circus Railway for the construction of their generating station. The Company also sought for further powers to work the railway by electric power, and to confer upon the District Railway reciprocal clauses to those which the Metropolitan Railway Company possessed, so that they could enter into partnership with them in regard to this particular subject upon equal terms.

Sir C. Dalrymple, M.P., seconded the motion to approve of the Bill, which was carried.

FOLKESTONE ELECTRICITY SUPPLY.

The fourth ordinary general meeting of the Folkestone Electricity Supply Company, Limited, was held at the Company's works, near Shorncliffe Station, on Saturday. Alderman George Spurgeon, J.P., chairman, presided.

The report presented showed that up to December, 1899, the equivalent of 17,834 8 c.p. lamps had been supplied as against 10,089 in 1898, or an increase of 77 per cent. The profit on the revenue account, after charging £220. 18s. 9d. for preliminary expenses, is £2,084. 0s. 11d. This, with a balance of £405. 2s. 3d. from last year, and after paying bank charges on a temporary overdraft, showed a net balance of £2,442. 8s. 8d. The directors recommended payment of a dividend at the rate of 4 per cent. per annum, which would absorb about £1,900, placing £400 to a reserve fund, and carrying forward the balance to next year's accounts.

The **Chairman** said the capital expended during the year 1899 had been £21,400, increasing the total outlay of the Company to over £64,000. The capital of the Company was only £54,000, and the directors had decided to issue £25,000 of debentures of 4½ per cent., which he hoped the shareholders would take up. They were unable to cope with the increasing demand unless they made provision for additional new machinery and for the extension of the buildings. They had applications now for another 500 odd lights to be put in next month, and he believed he would be within the mark in saying they would put in 500 new lights a month for every month in the year. During the past year the number of units sold had been £209,931, giving a revenue of £4,156. 8s. 6d., or an average cost to the consumer of about 4¾d. per unit. He believed that in time even this would be reduced. He understood they had given satisfaction to their customers, and he believed that within a year or two they would have a very large accession of business. This was the first year of working, and they were paying an honest 4 per cent. One item in the report was £2,709. 16s. 6d. for installation work for consumers, on which a profit of only £20. 1s. 6d. had been brought into the year's accounts. Some shareholders might think this a very little profit on such an outlay, but they had put in installations at practically cost price, and the £20 odd shown in the accounts was just a small margin of profit made. By this means they had gained many consumers, on the supply of light to whom they made a profit. The directors desired to offer an expression of appreciation to Mr. Hesketh, their engineer, and the members of the staff, for the assiduous manner in which they had worked for the Company.

The report and dividend was carried, and the retiring directors (Messrs. S. Penfold and C. J. Pursey) were re-elected. Mr. White was re-elected auditor.

NATIONAL ELECTRIC WIRING.

The ordinary general meeting of this Company was held on Tuesday at Faraday House, Charing Cross-road.

Mr. R. S. Bain, who presided, stated that though the proposed dividend of 3 per cent. was not a large one, it was promising well for

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the future, as it had been earned in the second year of the Company's existence. The business had steadily increased during the year. They had completed 1,970 installations, equivalent to 51,774 8-c.p. lamps, and they had in hand at the end of the year 395 installations, with an aggregate of 13,012 lamps, and since the books were closed they had received further orders for 478 installations, equivalent to 13,021 lamps, being more than double the number in hand last year.

The report (published in our last issue) was adopted, and the dividend approved.

ANGLO-ARGENTINE TRAMWAYS.

The accounts for the past year show a balance of £49,930, compared with £40,769 in 1898. It is proposed to pay a dividend of 2s. per share, to add £6,250 to reserve, and to carry forward £17,679, under the terms of the agreement with the Argentine Electric Traction Company. With the interim dividend of 2s. paid in October, this will make 4s. per share for the year 1899. The receipts show an increase of £35,778, and the expenses an increase of £20,002.

BROCKIE-PELL ARC LAMP.

Directors: Right Hon. Lord Suffield, K.C.B. (chairman); Sir F. D. Dixon-Hartland, Bart., M.P. (vice-chairman); Hon. R. Brougham; H. W. Maynard, Esq.; W. Shrimpton, Esq. (managing director).

Third annual report of the directors, to be presented at the ordinary general meeting of the Company at the Company's new premises, 60, Worship-street, Finsbury, E.C., on 9th inst. at 3 p.m.:

In submitting the accompanying profit and loss account and balance-sheet for the 12 months ending Dec. 31, 1899, the directors have pleasure in calling attention to its being much more satisfactory than that of the previous 12 months, showing the continued progress in the Company's business, and a further improvement in its profits and management. The profit and loss account for the year, before charging depreciation, shows a credit balance of £1,237. 13s. 7d., as against a debit balance of £1,496. 15s. 5d. for the preceding 12 months, which the directors have applied as under: to depreciation of 5 per cent. for two years (no amount having been written off such account last year) on plant and machinery, £403. 9s. 10d.; on furniture and fixtures, £92. 11s. 3d.; on tools, £166. 17s. 5d.; on patterns, £135. 11s. 9d., making a total of £798. 10s. 3d. thus written off, and leaving a balance of £439. 3s. 4d., which the directors propose to carry forward. The serious and continued increase in the price of metals has affected the Company's profits. The sales of the Company's lamps continue to show an increase over those of the preceding year. The Company have, during the past year, supplied their patent lamps to the Corporations of South Shields, Ayr, Greenock, and Stirling, also to her Majesty's Government, and the London and North-Western Railway, and are now supplying them to the city of Gloucester and the Vestries of Lambeth and Poplar. The directors are increasingly convinced with the great advantage that has accrued to the Company from the appointment of Mr. Shrimpton as managing director, and consider it is largely due to his ability and devotion to its service, upon a very inadequate remuneration, that the Company is in such a different position to that it formerly occupied. The plant and machinery have been maintained in thorough efficiency, and additions have been made during the past year. The serious inadequacy of the Company's present works referred to in their last report has led the directors, after most careful consideration, to secure, on advantageous terms, the larger and more suitable premises at 60, Worship-street, Finsbury, E.C. Such new premises, with the increased facilities they offer, will enable the directors not only to meet the present increasing demand for the Company's patent lamps, and to keep the necessary stock, but also to cope with a still larger business they are confidently looking for in the near future. Under the articles of association the Hon. R. Brougham is the retiring director, but, being eligible, offers himself for re-election. The auditors, Messrs. Mellors, Basden, and Co., also offer themselves for re-election.

Dr.	Profit and Loss Account.	£	s.	d.
Rent, rates, and taxes, electric light, coal, etc.		806	6	8
Salaries		2,081	11	5
Agency and travelling expenses		409	10	10
Advertising		472	11	3
Printing, stationery, postage, and telegrams		252	19	9
Trade, office, and other expenses (including carriage)		344	12	2
Patent fees, etc.		189	7	6
Discounts and reserve for doubtful debts		300	3	11
Directors' fees		359	7	6
Legal expenses		250	9	3
Repairs to plant and tools		146	6	5
Depreciation of plant, tools, fixtures, and patterns		798	10	3
Interest on debenture		13	4	4
Balance carried to balance-sheet		439	3	4
		£6,864	4	7
Cr.		£	s.	d.
Manufacturing—gross profit		6,803	19	7
Transfer fees		10	5	0
Royalties		50	0	0
		£6,864	4	7

LIVERPOOL TRAMWAYS.

The accounts of the Liverpool Corporation Tramways Committee for the year ended Dec. 31 last have been issued. The revenue from the horse trams was about £290,000. The working expenses of all sorts were £242,392, leaving an apparent profit of £47,708. Interest and sinking fund and capital, besides the great depreciation involved in the gradual change of traction, have to be provided out of this sum. The electric tramcar revenue was £77,663, and the expenditure £36,973, showing a profit of £40,690, or more than 50 per cent. of the receipts. There is to be considered that the charge made to the tramways for electric power is less than to ordinary consumers. The gross expenditure amounted to £302,159, the income being £365,859, leaving a balance of £63,700. The capital account shows that the purchase of the undertaking of the late Liverpool United Tramways and Omnibus Company, Limited, cost £596,548. The total expenditure on the lines up to the end of 1898 was £257,821, on tramroads for electrical haulage the expenditure was £172,301, nearly all in 1899. The gross expenditure on capital account has been £1,161,279, of which £244,756 was spent in 1899.

NEWMARKET ELECTRIC LIGHT.

Directors: Messrs. H. Verrall (chairman): B. Channell; H. J. Garrod; F. E. Gripper; T. Jennings, sen.; G. J. Jennings; G. O. Mead; W. T. Pressland. Secretary: Mr. A. Harold Euston, Newmarket. Engineer: Mr. Frank A. Simpson.

Report of the directors (with abstract of accounts) for the year ended Dec. 31, 1899: The total expenditure on capital account to that date amounts to £22,561.

The works were completed and opened on March 9, 1899, and current has been supplied continuously since that date. The sale of current for the first few months was naturally small, but the directors are more than satisfied with the way in which the lighting has been taken up in Newmarket, as already the equivalent of over 5,000 8-c.p. lamps has been connected. The accounts show a balance, after paying all expenses (including interest on debentures), amounting to £47. 8s. 9d., which they propose should be carried forward to next year. Applications for light still continue to be received, and it is anticipated that another 1,000 lamps will be connected in a few weeks. The directors are well satisfied with the progress of the Company, and consider a good start has been made with every prospect of earning a substantial profit in a very short time. They have already had to order additional machinery and plant, which is in course of erection, and which will enable them to double the output of the generating station. There are three vacancies in the directorship—Messrs. Benjamin Channell, George Owen Mead, and William Thomas Pressland—retiring by rotation, and all of whom are eligible for re-election.

Revenue Account.

Dr.	Generation of Electricity.	£	s.	d.
Coal or other fuel		159	11	9
Oil, waste, water, and stores		38	18	0
Wages and gratuities		135	5	3
Repairs and maintenance: buildings, £4. 5s. 9d.; other machinery, instruments, and tools, £3. 3s. 6d.; accumulators and accessories, £4. 6s. 9d.		11	16	0
	Rents, Rates, and Taxes.			
Rents payable		7	10	0
Rates and taxes		4	0	2
	Management Expenses.			
Salaries		140	0	0
Stationery and printing		14	3	3
General establishment charges		9	17	5
Insurances, superannuation, etc.		9	10	0
Total expenditure		530	11	10
Balance carried to net revenue		99	16	5
		£630	8	3
Cr.		£	s.	d.
Sale of current per meter		591	19	7
Sale under contracts		8	0	0
		599	19	7
Rental of meters and other apparatus on consumers' premises		27	18	8
Rents receivable		2	10	9
		£630	8	3

General Balance-Sheet.

Dr.	Liabilities.	£	s.	d.
Capital account—amount received		18,830	0	0
Sundry tradesmen and others		4,788	6	1
Balance at credit of net revenue account		47	8	9
		£23,665	14	10
Cr.	Assets.	£	s.	d.
Capital account—amount expended for works		22,561	8	1
Stores on hand: coal, £21. 6s.; oils, waste, etc., £12. 14s. 8d.; general, £5. 17s. 11d.		39	18	7
Preliminary expenses		195	17	4
Sundry debtors for current supplied		427	10	4
Other debtors		264	19	10
Cash at bankers		176	0	8
		£23,665	14	10

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WILLANS AND ROBINSON.

Directors: Mark Robinson, Esq., M.I.C.E. chairman; Sir Gilbert A. Clayton-East, Bart., deputy chairman; Captain H. Riall Sankey, R.E. (ret.), M.I.C.E.; Lieutenant-General Sir Richard H. Sankey, K.C.B., R.E.; Thomas O. Lazenby, Esq., J.P.

Twelfth half yearly report of the directors, to be submitted at the ordinary general meeting of the Company, to be held at the City Terminus Hotel, Cannon-street, London, at 2.45 p.m. on Wednesday, April 11, 1900:

After writing off as depreciation from plant, patents, etc., the sum of £5,658. 15s. 10d. and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year, including £4,944. 2s. 6d. brought forward, is £32,140. 13s. 6d. Out of this the directors propose that dividends be paid at the rate of 6 per cent. per annum upon the preference shares and 10 per cent. per annum upon the ordinary shares, together amounting to £13,324. 4s. 5d., and that a bonus of 2 per cent. be paid upon the ordinary shares for the year 1899, amounting to £3,193. 6s. 10d. The amount payable to the original directors, in accordance with the articles of association, is £4,911. 1s. 2d., leaving a balance of £10,712. 1s. 1d. From this the directors propose to carry £2,000 to the debenture redemption fund (now invested in the names of the trustees for the debenture holders), and £3,500 to the reserve fund, leaving a balance of £5,212. 1s. 1d. to be carried forward. The directors propose shortly to invite applications from the shareholders for 10,000 preference and 10,000 ordinary shares remaining to be issued under the authority of the extraordinary resolution passed upon March 29, 1899. Mr. Mark Robinson and Lieut.-General Sir Richard H. Sankey, K.C.B., R.E., retire from the Board in accordance with the provisions of the articles of association, but are eligible, and offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also retire, but are eligible for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Rent, rates, and taxes	614	19	7
Interest on debenture stock	2,125	0	0
Salaries, including directors' remuneration	6,544	19	6
Contingent salaries to employés	1,536	6	6
Fire insurance	178	11	4
Legal and professional charges	45	8	2
Advertising	632	10	3
Books, stationery, and printing	664	15	1
Postages and telegrams	201	11	3
Travelling, hotel, and general charges	328	11	1
Auditors' fee and expenses	91	19	10
Company's subscription to sick club, doctor's club, and benevolent fund	259	19	8
Allowances to reservists' families and subscriptions to works' war relief fund	63	8	0
Depreciation of property, plant and machinery, and patents	5,658	15	10
Balance carried down	27,196	11	0
	£46,143	7	1
Contingent salaries to directors, as per articles of association	£4,911	1	2
Balance, available for dividend or reserve	22,285	9	10
	£27,196	11	0

Cr.	£	s.	d.
Gross profit for the half-year	44,668	6	3
Royalties	400	0	0
Interest on investments, etc.	1,056	6	4
Transfer on registration fees	18	14	6
	£46,143	7	1
By balance profit (half-year) brought down	£27,196	11	0
	£27,196	11	0

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Birkenhead.—The Corporation invite tenders for various plant. Tenders by April 23.

Plymouth.—The Corporation invite tenders for overhead line construction, etc. Tenders by May 2.

Belfast.—The Electric Committee invite tenders for the supply of electric motors for a period of 12 months. Tenders by April 19.

Whitechapel, E.—The District Board of Works invite tenders for the construction of an electricity supply station at Osborn-street, Whitechapel, E. Tenders by 3 p.m. on 24th inst.

Glasgow.—The Corporation invite tenders for supplying them with 136 cast-iron columns, with brackets, and 17 split bases and brackets for street electric arc lighting. Tenders by April 10.

Sunderland.—The Corporation invite tenders for the supply of two additional switchboard panels, with instruments, etc., complete. Tenders by April 27. Details in our advertisement columns.

Colwyn Bay.—The Urban District Council invite tenders for the erection of buildings, etc., for electric lighting station to be established at Ivy-street, Colwyn Bay. Tenders by 12 noon on April 10.

Dundee.—The Town Council invite tenders for the supply and erection at the electric station, Dundee, of a traction switchboard and equipments. Tenders by April 25. Details in our advertisement columns.

Salford.—The Corporation invite tenders for the supply and delivery and erection of ash conveyor and two electrically-driven travelling cranes. Tenders by April 9. Details in our advertisement columns.

Wilna (Russia).—The Municipal Authorities invite tenders for the concession for the erection of a station and the supply of current in the town. Tenders by April 13. Particulars may be obtained from Mr. Rudolph Mosse, Cologne.

Glasgow.—The Corporation invite tenders for the supply of telephone cables (including drawing into conduits and jointing of same) and telephone instruments (wall and table). Tenders by April 18. Details in our advertisement columns.

Manchester.—The Directors of the Lancashire and Yorkshire Railway invite tenders for the supply of the company's ordinary requirements of stores during the 12 months ending April 30, 1901. Tenders by April 9. Full particulars appear in our advertisement columns.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and erection of the following: boilers and accessories—viz, six Lancashire and four water-tube boilers and two economisers; polyphase generators—viz., two 1,000-kw. and two 500-kw. low-speed generators. Tenders by April 26. Details in our advertisement columns.

Maidstone.—The Urban District Council invite tenders for the erection and construction of the necessary buildings and chimney shaft, together with roads, fences, boundary walls, etc., for the electricity station and destructor house in the Fairmeadow, Maidstone. Tenders to be sent to Mr. Herbert Monckton, town clerk, 72, King-street, Maidstone, by April 9.

Wimbledon.—The Urban District Council invite tenders for the supply of 5,000 16-c.p. and 1,000 32-c.p. incandescent electric lamps, packed and delivered free at Wimbledon in such quantities as may be required during year ending March 31, 1901. Tenders, endorsed "Incandescent Lamps," to be delivered to Mr. R. H. Butterworth, clerk, Council Offices, Wimbledon, not later than April 9.

Mariupol.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Taganrog stating that tenders are invited by the Municipality of Mariupol not later than May 16 (29) for the construction and exploitation of an electric tramway and the installation of electric light in that town. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Barking.—The Urban District Council invite tenders as follows: (Contract No. 1) for the supply, construction, and erection of about 365 tons of cast iron and 235 tons of steel in an opening bridge over Barking Creek, 45ft. in clear opening, and to carry a double line of railway, together with two shore spans of 45ft. each, and the embanked approaches, and with all the electrical and other machinery and appliances incidental thereto and required for opening and closing the bridge by electrical power supplied from the generating station of the Council; (No. 2.) the construction of 73 chains of 3ft. 6in. gauge single-line railway (83lb. tramway rails) and 38 chains of double-line railway, with granite sett paving on concrete, electrical rail bonding, etc. Tenders before 12 noon on May 7.

RESULTS OF TENDERS.

Leeds.—The tender of Dixon and Son has been accepted for an installation of electric light in the town hall crypt.

Lincoln.—The tender of Mr. J. M. Harrison, at £3,900, has been accepted for the construction of a generator and other works.

Stockport.—The tender of Heap and Worthington, Manchester, has been accepted for electric wiring and fittings at the infirmary.

Blackpool.—The Corporation have accepted the tender of the Midland Railway Carriage and Wagon Company, Limited, Abbey Works, Shrewsbury, for the construction and delivery of 15 tramway cars.

West Ham.—The Town Council have accepted the tender of J. H. Senior and Son for the High-street traction and lighting columns, at £19. 10s. each.

Inverness.—The Town Council have accepted the tender of the Brush Electrical Engineering Company, Limited, for electricity works, amounting to £21,000.

Cheltenham.—The Town Council have obtained the following tenders for a 500-kw. steam alternator: Brush Company, £4,970; Ferranti, £5,135; Siemens, £4,780; Parsons, £3,820 (recommended for acceptance).

Torquay.—The Destructor Committee have recommended that the offer of the British Insulated Wire Company to supply the cable required for extension of the electric lighting in the roads adjoining the destructor be accepted.

Walthamstow.—The Urban District Council have accepted the tender of F. Suter and Co., 66, Berners-street, London, W., at £4,049. 10s., for the supply and erection of electric and Dowson gas plant at the isolation hospital, Chingford.

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Poplar.—Tenders for free wiring have been received from Pearson and Co., of Benson-road, Forest Hill, and the National Electric Wiring Company, of 8 and 10, Charing Cross-road. The latter has been accepted. The agreed charge is ¾d. per unit for hire of fittings, and an easy purchase system payments by instalments are to be spread over a period of from one to five years, the price to be given to consumers when the fittings are put in.

Plymouth.—The following tenders have been accepted by the Corporation: W. J. Corse and Co., Plymouth, for wiring municipal offices, £198. 15s. Twelve months' supply of oils at per schedule rates: C. Hawken, Plymouth, engine oils; J Laing, Son, and Co., Manchester, cylinder oils. Also for 12 months' supply at per schedule rates: General Electric Company, Limited, alternating-current meters; British Electric Transformer Company, alternating-current transformers at sub-station; Brush Electrical Engineering Company, Limited, ditto street box; De Grelle, Houdret, and Co., arc lamp carbons.

Whitechapel.—The District Board of Works have accepted the tender of Messrs. Babcock and Wilcox, Limited, to supply two boilers, each capable of evaporating 11,000 lb. of water per hour at 180lb. steam pressure per square inch, for the sum of £2 300; also for supply of one feed pump, capable of discharging 10,000 gallons per hour at the above-mentioned pressure for the sum of £450, and certain spare parts for pump at the price of £55; and also to remove the pump heater and two boilers now in use at the electrical works of the Board to the new power-house, when erected, for the sum of £292, making a total cost of £3,097. No other tenders had been received for the work.

BUSINESS NOTES.

TRACTION.

Tipton.—The Council have petitioned in opposition to the South Staffordshire Tramway Bill.

Burnley Corporation Tramways Bill.—This Bill has been ordered to be reported for third reading.

Hull Tramways.—The Board of Trade official inspection of the Holderness-road section is fixed for April 19.

Liverpool.—The construction of the electric tramway for Stanley-road is being pushed forward with all possible speed.

Cleckheaton.—The District Council have withdrawn their opposition to the British Electric Traction Company's scheme.

Carlisle.—The Town Council on Tuesday decided to accept the tramway company's offer in modification of the construction scheme.

Wakefield.—The Light Railways Commissioners' enquiry into the Wakefield and district tramway scheme will be held at the town hall on April 10.

Manchester.—The City Council Tramways Committee are sending a deputation to Berlin and Hamburg to investigate the tramway service in those cities.

Middlesbrough.—A permanent regular service has been started on the Parliament-road section of the tramlines, a loop line connecting the Newport-road lines.

Wigan.—Almost the whole of the contracts necessary for the completion of the power-house and of the tramways from Martland Mill Bridge to Market-place have been let.

Witney.—The Light Railway Commissioners have held an enquiry into the proposed line from Witney to Andoversford, and have expressed themselves in favour of the scheme.

Lowestoft.—The Town Council have sealed the draft agreement with the Drake and Gorham Electric Power and Traction Company, who are promoting electric tramways for Lowestoft.

Paisley.—The conference which was to have taken place on March 30 between the Council and Mr. Murphy, the promoter of the Glasgow District Tramways Bill, has been deferred till April 5.

South Hams Light Railway.—The Dartmouth Town Council have agreed to approve of this scheme, and the Mayor will support it at the enquiry which will shortly be held by the Light Railway Commissioners.

Westhoughton.—The representatives of the District Council will give evidence before the Select Committee of the House of Commons in support of the South Lancashire Tramways Bill and the Lancashire Electric Power Bill.

Manchester and Liverpool Electric Express Bill.—This Bill has been referred to a committee consisting of Sir J. Kennaway, Mr. J. H. Roberts, Mr. Arthur Elliot, and Mr. Chas. Douglas, which will sit on Tuesday, May 8, at 12 o'clock.

Stockton.—The case at present proceeding in the police court against the tramway company appears to be a kind of friendly suit, in order to settle a dispute with the Assessment Committee as to the assessment under which the rates were levied.

Hastings.—The Tramways Bill, which proposes the construction of 11 miles of tramways to be worked by electricity on the overhead or trolley system at an estimated cost of £300,000 to £400,000, has passed a committee of the House of Commons.

Leith.—A letter from the Edinburgh Street Tramways Company, proposing to remove the Seafield terminus to a little to the west of the cemetery, and to reduce the fare from that point to Pilrig from 1½d. to 1d., is before a committee of the Town Council.

Barrow.—The Town Council have referred to the surveyor a letter from the British Electric Traction Company applying for the adoption of electric traction on the tramways in the borough, of which the company have now had possession for three months.

Worcester.—Messrs. Kincaid, Waller, and Manville are to be paid 100 guineas for their report on tramways. It is announced that an agreement has been arrived at between the joint committees of the Council and the representatives of the Worcester Tramway Company.

Warley.—The Council have passed a resolution with the idea of strengthening the hands of the Halifax Corporation urging them to persevere with the tramway clauses referring to outside districts in the Bill, notwithstanding the action of the House of Commons relative to the Huddersfield Bill.

Southborough.—At the last meeting of the Urban District Council the proposed light railways or tramways were under consideration, and it was decided to refer the matter, including a letter from the Tunbridge Wells Corporation, to a committee with instructions to obtain further particulars.

Central Electric Railway.—It is now announced that the Central Electric Railway will not be opened until June. Although the tunnels are finished, and a train has been the whole length of the route, about seven miles, the lifts and approaches to the different stations are still to be completed.

Halifax.—The Chamber of Commerce has passed a resolution urging the Corporation to persevere with the clauses in their parliamentary Bill relating to tramway extensions outside the borough. A petition is to be forwarded from the Chamber to the House of Commons asking them to retain the clauses.

Cardiff.—At a meeting of the Electric Tramways Committee of the Corporation on Monday it was decided that there should be a separate generating station for the tramways. An amendment proposing that the Council should be recommended to adopt a combined station for lighting and traction purposes was defeated.

Southport.—Work in connection with new electric tramways is proceeding rapidly, and already something like 260 poles have been permanently fixed over the two sections that have been undertaken first. Mr. Tait, the electrical engineer, expects that he will be able to have cars running over these two sections by July.

King's Norton.—The King's Norton and Northfield Urban District Council on Wednesday decided not to offer any opposition to overhead traction upon the Bristol-road, and appointed a committee, consisting of the members representing Northfield parish, with power to negotiate with the City Council and the tramway company.

Elland.—The opinion is expressed generally that Halifax should be encouraged to construct a line to Elland, and that, in the case of the clause referring to outside districts not being approved of by Parliament, Elland should undertake the construction of the section themselves and work the same under an agreement with the Halifax Corporation.

Cheltenham.—A Board of Trade enquiry has been held with regard to the terms of the order for the Cheltenham and Cleeve Hill electric tramway. The order will probably be issued in the course of a week, and the work of construction put in hand directly it has been obtained. Mr. Nevins, jun., has taken a house in Cheltenham to superintend the work.

Wellingborough and District Tramways.—When this Bill came before the Select Committee last week the Midland Railway Company's opposition to the scheme was withdrawn, and the preamble of the Bill was proved, with the provisions that the North-Western Company should give reasonable facilities for traffic at Higham Ferrers and Wellingborough.

Sunderland.—The sale of the tramways to the Corporation has now been completed. The Corporation should have taken possession on Jan. 1, but a slight hitch occurred which prevented this being done. The delay will, however, make no difference to the Corporation, who are to receive the income of the company from Jan. 1, just as though they had taken over the concern from that date.

Winton.—At the last meeting of the Urban District Council a letter was read from the Bournemouth, Christchurch, and Winton Electric Traction Company stating that the company were unable to obtain the assent of Bournemouth to the construction of lines in the borough, and so were unable to comply with the parliamentary Standing Orders in respect to the lines from Bournemouth to Winton.

Portsmouth.—At Tuesday's meeting of the Tramways Committee, a letter was read from the solicitors to the company stating that the directors could not see their way to accept the proposal of the Corporation to submit the points in dispute to the arbitrator. The committee resolved to make application for a writ of mandamus for the possession of the tramways, according to their Act of Parliament.

Wandsworth.—The General Purposes Committee having been informed that the enquiry with respect to the London County (Clapham, Wandsworth, and Kingston-road) light railways draft order will in all probability shortly take place, the Vestry have decided that the committee be authorised to take such steps as they may deem necessary for sustaining the objections of the Board to the scheme.

Lancaster Tramways Co.—At an extraordinary general meeting of the shareholders of the Lancaster and District Tramways Company, Limited, on Saturday, the following resolution was passed: "That this meeting of shareholders of the Lancaster and District Tramways Company declines to accept the offer of the Lancaster Corporation of Feb. 27 or any other offer less than 20s. per share both ordinary and preference."

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Loughborough Light Railways Scheme.—The enquiry by the Light Railway Commissioners into the application by a syndicate for an order authorising the construction of light railways in Loughborough and the district has been concluded. The Chairman said that, subject to certain limitations already indicated, the Commissioners would be prepared to recommend that an order should be issued sanctioning its construction.

Birkenhead.—The Birkenhead Corporation paid £26,000 for the acquisition of the lease they renewed a few years ago to the Wirral Tramway Company. In accordance with the powers of purchase the Town Council have given the company notice that they will take over the lines on May 8, and during the reconstruction for the electrical trams they will carry out the work in such manner as they think fit, and in their own time.

Huddersfield Tramways.—The tramway employés to the number of 140 seek an all-round advance in wages of 2s. a week. The suggested advance would mean an increased annual expenditure in wages considerably in excess of the surplus balance from the tramways revenue. It is further urged that the men receive a more remunerative rate of pay, and work under more favourable conditions, than obtains at Leeds, Bradford, Sheffield, Halifax, and many other places.

Hendon.—At a meeting of the Rural District Council last week the surveyor reported that the Herts County Council scheme for a light railway line running from Watford into Stanmore, *vid* Stanmore Hill, had been dismissed. The enquiry into the Middlesex County Council scheme had been adjourned until the end of April, and the county surveyor, in conversation with the surveyor, had agreed to the insertion of clauses providing for the lighting of the road along which the line is to pass.

Harrow.—The Middlesex Council have informed the Town Council that they were willing to increase the width of the roads in the district over which the proposed light railway would pass to a minimum of 48ft. where practicable. In the Wealdstone district there were several points at which it would be impossible to do so. The County Council would be willing to make up the roads to the width mentioned as soon as the Council compelled the owners to put back their frontages.

St. Helens.—The St. Helens Parliamentary Committee at their last meeting came to the decision to recommend the Town Council to withdraw from the conference of municipal corporations of Lancashire. The step is taken on the understanding that the clauses for the protection of boroughs would be inserted in the Lancashire Electric Power Bill. Those clauses make the Council's consent a condition in respect of the route of "through cables," and the supply within the boroughs.

Dundee.—It is confidently expected that at latest in July horse and steam haulage will be superseded by electricity on the Perth and Lochee road sections. The additions to the power station and the erection of the car station in Lochee-road are well advanced. Already one of the large dynamos and engines have been placed in position, while a second dynamo is ready for testing, and a third—the largest—is well forward, and the new cars are expected to be delivered in time. The laying of the rails on the High-street will be commenced immediately.

Uxbridge.—The Council have placed on their minutes the following letter, which speaks for itself: "London United Tramways. Dear Sir,—Light Railway Extensions, 1899.—I beg to acknowledge receipt of your letter of the 5th inst., and in reply beg to say for the information of your Council that the order referred to was confirmed by the Board of Trade, May 9, 1899. The lines are to be constructed two years from that date, and I have no reason to doubt that we shall be able to carry out the work within the period named.—J. CLIFTON ROBINSON, Managing Director."

Bolton.—At the meeting of the Town Council on Wednesday the chairman of the Tramways Committee said the three months' experience of the electric tramways had been exceedingly serviceable to the committee and the town at large. The troubles in connection with the curves were considerably fewer in number, and he was anticipating that in another three months the system would be all that could be desired. Since last month's meeting six additional cars had been received, and the traffic upon the system had proportionately increased. In March 939,905 passengers had been carried, as against 728,024 in February, with a corresponding increase in the receipts.

Birmingham.—The loop-line in the Old-square has been completed. The King's Norton and Northfield Urban District Council propose not to oppose overhead traction upon that portion of Bristol-road coming within the jurisdiction of the Council, provided that the tramway company extended the system to Oak Tree-lane, Selly Oak. The appointment of a special sub committee to negotiate with the Birmingham City Council and the tramway company in the matter is suggested. The Council on Tuesday rescinded a resolution, passed some two years ago, instructing the Public Works Committee not to reopen negotiations with the City of Birmingham Tramways Company.

Loughborough.—The promoters of the scheme of light railways for the Loughborough district, says the *Leicester Daily Post*, must be congratulated on the concessions they obtained from the Royal Commissioners at their sitting on Monday. They have not, indeed, secured all they desired, and have seen their Hathern line shorn of its original length. But they have, at least, obtained their order for the construction of their lines, subject to certain limitations, which had evidently been the subject of painstaking and impartial consideration. Now that the first Anstey scheme has been succeeded by a second for Loughborough, it is to be hoped that these may be welcomed as only two of many which are destined to be constructed and worked within the next few years.

Littleborough.—The District Council have sealed an agreement with the Rochdale Corporation in reference to the tramways, which provides that at the expiration of the company's lease the Council purchase the existing lines in the Littleborough district and reconstruct the same on the standard gauge of 4ft. 8½in. Afterwards they would lease the lines to the Corporation for a term of 21 years. The Council would also extend the lines from the terminus near the church at Littleborough to a point near the Summit Inn at Summit, and this line would be leased to the Corporation for 21 years. The Corporation would equip the lines for electrical overhead traction and supply the power for running the cars. The rent would be equivalent to a sum of money sufficient to cover the capital outlay and interest in 30 years, and the Corporation would pay the cost of maintaining the permanent way during the period covered by the lease.

Aberdeen.—At a meeting of the Great North of Scotland Railway Company at Aberdeen on April 2 the chairman, Dr. Wm. Ferguson, stated that the working plans for the light railway from Fraserburgh to St. Combs—about 4½ miles in length—were in course of preparation, and the directors expected to be in a position to commence the construction of the line in the autumn. There were 3,010 signatures in the petition presented to the Council from the electors and residents of Torry Ward in favour of the double line of tramways to Torry. In consequence of a letter from Captain Hector Macneal, adjutant of the 1st V.B. Gordon Highlanders, asking if special tramway facilities would be granted to members of the corps going to and from the shooting-range at Seaton Farm, it was agreed to offer to run special cars at certain specified hours in the evening for the sum of 5d. each double journey, and to issue special tickets available for volunteers between any point on the tramway routes and Seaton Farm at 3d. each for the double journey.

Newcastle.—At a meeting of the New Tramways Committee of the Corporation on April 2 it was reported that all sections of the work were well advanced, and it was arranged that the first rail of the new system should be formally laid in the course of a few days by the chairman of the committee (Mr. Cail). The committee decided on a handsome design for the poles in the streets which will carry the trolley wires. On the top of each of these poles in the main streets will be an electric lamp. In the narrower streets, where side poles will have to be resorted to, it was decided that the electric lamps should be hung from the end of the pole. At Wednesday's meeting of the City Council it was explained that two months ago the Council accepted a tender for the construction of the car trucks; but, before the letter accepting the tender was dispatched, the British Thomson-Houston Company withdrew its tender for the supply of the Baltimore trucks, but said they could supply Brill trucks from America at a cost of £1,196 extra. The Council agreed to the alteration.

Sheffield.—Owing to the delay in completing new machinery at the Kelham Island power station, it was found impossible to run the electric tramcars on the Hunter's Bar section on Tuesday, as was previously intended. It will probably be another fortnight before the section can be opened. The Board of Trade inspection of the track and equipment has not been made yet, but the inspectors were expected this week. Two of the new boilers at the power-house are ready for working; it is the large new engine of 500 h.p., coupled with an 800-kw. generator, which is not complete. At the meeting of the Tramways Committee on Tuesday it was decided to commence running electric cars on the Ecclesall-road section at Easter. There will be six double-deck cars, giving a 10 minutes' service. Several additional single-deck cars having just been delivered, it was arranged to put two additional cars on the Nether Edge section, two on the Walkley section, two on the Attercliffe section, and one car on the Park section. The takings for the last 13 weeks averaged over £1,800 per week.

Batley.—An enquiry is to be held at the town hall, Leeds, next Monday into the application of the British Electric Traction Company for an order to make extensions to their Dewsbury and Spen Valley electric tramways scheme. The company have already obtained power to construct tramways in Dewsbury, and amicable arrangements have been made with Ravensthorpe, Thornhill, Heckmondwike, and Cleckheaton District Councils to construct lines along the main roads in each of these places. The Batley Town Council are opposing the application, as their scheme includes a tramway along the same road. So far as the Dewsbury-Cleckheaton line is concerned, it is stated that the Electric Traction Company intend to take current for the Cleckheaton end from the Urban Council, just as they have engaged to take it from the Dewsbury Town Council for the Dewsbury end. Extensions to Millbridge and Hightown Heights, and thence to Gomersal and Birkenshaw, and a line to Drighlington and Morley, are under consideration. It is stated in the local Press that on Tuesday the Board of Trade issued an order sanctioning the Corporation's application for leave to construct tramways throughout the borough.

LIGHTING AND GENERAL.

Colchester.—The extension of a main at £75 is proposed.

Frome.—The District Council are taking steps to ascertain the cost of electric lighting.

Colne.—The electrical engineer has been asked to prepare estimates for an electric generating station.

Llantwit.—The School Board have decided to support the South Wales Electrical Power Distribution Bill.

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Enfield.—The Board of Trade have refused a provisional order to a company for lighting Enfield by electricity.

Lancaster.—A main is to be laid to the new hotel at the corner of George-street and Thurnham-street at a cost of £28.

Chadburn's (Ship) Telegraph Co.—Warrants for the 6 per cent. preference dividend, due 1st inst., have been posted.

Removal.—The offices of the Brockie-Pell Arc Lamp, Limited, will be situated at 60, Worship street, E.C., after 9th inst.

Hoddesdon.—The Council have decided to take no action with regard to the North Metropolitan Electric Power Distribution Company's Bill.

Metropolitan Electric Supply Co.—Letters of allotment in respect to the issue of £125,000 3½ per cent. mortgage debenture stock have been posted.

Newark.—The Board of Trade have granted a provisional order to the Corporation to supply electricity within the borough and to expend for that purpose £20,000.

South Shields.—The position taken up by the Corporation as regards the power supply companies' Bills now before Parliament is being extensively criticised in the local Press.

British Westinghouse Electric Co.—The directors have declared an interim dividend calculated to Jan. 31 on the preference shares in respect of £3 per share paid thereon at that date.

Patents, etc., Act.—The Electrical Inkless Printing Syndicate, Limited, Brixton, has applied for leave to amend the specification of letters patent No. 27,243 of 1897. Full notice appears in another column.

Walsall.—The Chamber of Commerce are taking steps to obtain extended and cheaper telephone facilities. They also advocate that the various city departments should be connected with the exchange.

Aberdeen.—The property known as Dee Village is to be acquired by the Electric Lighting Committee department for the erection of a new electric station, at the price of £8,000, with entry at Whitsunday next.

Islington.—A recommendation from the Electric Lighting Committee will come before the Vestry to-day to the effect that the salary of the electrical engineer, Mr. Gay, be increased by £100 per annum.

Mangotsfield.—A parish meeting having decided upon the principle of lighting, the question has been referred back to the Parish Council to make further enquiries as to the methods of lighting, and report again in two months.

Deal.—At their next meeting the Town Council will consider a recommendation to the effect that they should not oppose the Walmer District Council in obtaining the powers they required, provided the interests of Deal are safeguarded.

Lowestoft.—At the last meeting of the Town Council electric light and telephone matters were discussed. It was reported that considerable progress is being made with the former, and that subscribers were coming forward in good numbers.

Oriental Telephone and Electric Co.—The directors recommend, subject to final audit of the accounts, a further dividend of 8d. per share, free of income tax, making together with the interim dividend paid in October last 5 per cent. for the year ended Dec. 31, 1899.

Parliament.—During the past week the Lincoln Corporation Tramways Bill was read a third time and passed in the House of Lords, and the Reading Corporation Tramways Bill was considered in the House of Commons. The Devonshire Corporation's Bill is now before Mr. Schwann's committee.

Wembley.—The Urban District Council have passed a resolution to oppose the North Metropolitan Electric Power Supply Company's Bill so far as the same relates to the area of the Wembley urban district. A rider has been added, that before any steps are taken in the matter a public meeting shall be called.

St. George's, Southwark.—Ratepayers in Montague-street and other places desire to obtain electric power and light. In consideration of this fact, and also that the Brush Company will supply the energy from their own generating station at Peckham, and not through another company, the Vestry will not oppose the company laying mains.

Tunbridge Wells.—The Corporation have just received sanction to their loan of £24 682 for electric light extension purposes. The application to the Postmaster-General for a special license for the municipal construction and control of the telephone system at Tunbridge Wells has elicited a reply stating that the authorities were prepared to grant a local telephone license if the conditions required by the Post Office were agreed to.

Bromley.—Some discussion took place at the Bromley Council meeting on Tuesday respecting the smoke nuisance at the electric lighting company's works in West-street, and the matter was referred to the Sanitary Committee to report upon. The Electric Lighting Committee are conferring with the British Insulated Wire Company with a view to obtaining a loan for free wiring and doing the work themselves. The surveyor is to be appointed as electrical inspector *pro tem.*, subject to the approval of the Board of Trade.

Filters.—We have received from Messrs. Mather and Platt, of Manchester, a copy of the pamphlet which they are about to issue respecting the Reeves patent filters. The pamphlet is illustrated by well-executed photographic views of various installations of the Reeves filters, and at the end contains a list of the sizes in which the filters are made and the capacity of each. One block which we notice particularly is an illustration of Messrs. Cook and Son's Nile steamer "Rameses," which is fitted with a filter with a minimum capacity of 6,500 gallons per 24 hours.

Leith.—There appears some dissatisfaction about the fact that the electric light cables are only laid down for sufficient capacity to supply the compulsory area or the present wants, and that any extension means a new cable from the station. The extension now proposed to Trinity is estimated at £10,687. 4s. 3d. The engineer has been instructed to report as to the probable income from the proposed extension. The Council have approved of the extension of the light to Quality-street at a cost of £313. 13s. 4d., and of the laying of a new feeder to Bernard-street at a cost of £1,389.

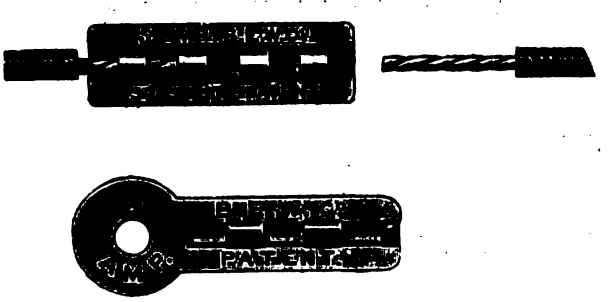
Appointments Vacant.—The Corporation of Cardiff are prepared to receive applications for the position of electrical mains superintendent.—There is required, for abroad, a telephone superintendent and a telephone line foreman.—About six months' work is open to two or three good cable jointers.—The Visitors of the Hereford Lunatic Asylum want a clerk of works to supervise the electric lighting installation. — The Cambridge Electric Supply Company require the services of a mains superintendent.—There is wanted at the electric light station, Wimbledon, a good all-round mechanic as fitter, etc. Full particulars of above appointments appear in our advertisement columns.

Newcastle.—At the meeting on Wednesday the Watch Committee's recommendation, referred to in our last issue, to apply for £10,000 for street-lighting, was agreed to. It was stated that to light the whole of the tramway routes with electricity they would require 373 lamps, at £18 per lamp, amounting in all to £6 714. The cost of gas was £2,541, the extra cost for electricity being £4,173. To light the centre of the city they would need 180 lamps, but they would put out 380 gas lamps and 18 of the electric lamps, which together cost £756, and would get 180,000 c.p. instead of 47,000 c.p., as at present, at an extra cost of £1,726. The total cost was £7,750, but they desired to provide for extensions.

Stock Exchange.—The Stock Exchange Committee have ordered W. T. Henley's Telegraph Works Company's further issue of 18,000 4½ per cent. preference shares of £5 each, fully paid, Nos. 12,001 to 30,000, to be quoted in the official list. Applications have been made to appoint a special settling day in and to grant a quotation to the Bournemouth and Poole Electricity Supply Company's £70 000 4½ per cent. debenture stock; and to allow the Dublin United Tramways Company's (1896) 51 450 ordinary shares of £10 each fully paid (Nos. 1 to 51,450). 8,550 ordinary shares of £10 each fully paid (Nos. 51,451 to 60 000), 59.987 6 per cent. preference shares of £10 each fully paid, and £300,000 3½ per cent. mortgage debentures, to be quoted in the official list.

Leeds.—The Electric Lighting Committee reported to the Town Council on Wednesday that in view of the largely increased demand for the supply of electricity in the city, the committee had to ask the Council to authorise them to extend the boiler-house building, and provide additional engines, boilers, dynamos, mains, etc., to enable them to meet such demands at the estimated cost of £20,000, and for that purpose to make application to the Local Government Board for the borrowing of that sum. The report was adopted. The Tramways Committee were on Wednesday authorised to contract for the supply of three steam dynamos at a cost not exceeding £36,000. It was explained that so many tenders had been received that the committee had not yet had time to consider them all. The resolution would enable them to push on and arrange for the further electric installation.

Connectors.—The patent cable connector and terminal being manufactured by the British Electric Works Company, and christened the "Stellite" type, has a number of advantages which should make it of great service in electrical work. In the illustration herewith we show a straight through connector for jointing



two cables together, and also a terminal connector which is exceedingly handy for connecting a cable on to a fuse block The connectors are made of high-conductivity sheet copper, and so stamped and pressed that the alternate segments along the middle of the connector embrace opposite sides of the wire. The end view of the connector is thus like the end view of a wing nut, the hole in the centre receiving the conductors. When the wire has been inserted through this hole a hammer is used to close up the same, and this gives an exceedingly good contact. The wire can then be soldered, if wished, and this would naturally be done in jointing up a wire into continuous lengths. When, however, the terminal connector is used, the contact obtained without soldering is much superior to that which is given by the ordinary socket and set screws on switchboards. These connectors would seem to meet every requirement, except in those cases where joints have to be made in a drawing-in system.

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Halifax.—The Electricity Committee of the Corporation have decided that from the 1st inst. the charge for electric current for lighting purposes shall be 4d. per unit, instead of 5d., with the present rate of discount; also that the price of current for tramway purposes be 1½d. per unit, instead of 2d.

Long Eaton.—The Urban District Council have decided to proceed at once with the work of telephonic and electric communication between Long Eaton and the reservoir at Castle Donington, the necessity for such communication having been demonstrated at the recent fire at Willatt's factory.

New Showrooms.—The Electrical Company, Limited, 122 and 124, Charing Cross-road, W.C., have, owing to large increase in their business, found it necessary to take larger premises in Brighton, and have now opened extensive showrooms at 134, North-street to serve their clients on the South Coast.

Beckenham.—A conference is to be held between the Urban District Council's officers, the British Insulated Wire Company, and the Council's contractors, with regard to free wiring, and a report will be prepared on the lines of the Council obtaining a loan for the wiring and undertaking the work by contractors in the usual way.

Hereford.—The asylum report submitted to the Town Council shows that £4,462 has been expended in electric lighting. It is also reported that since the introduction of the electric light into the town there has been an increase in the consumption of gas due to the penny-in-the-slot system every week except one, compared with the corresponding weeks of last year.

Walker.—At the last meeting of the District Council a special committee reported that they had met the directors of the Newcastle-on-Tyne Electric Supply Company, and had settled with them the details of terms on which the Council would support their Bill as proposed to be amended. The clerk was instructed to ask the Local Government Board to expedite the matter of a loan.

Cleethorpes-with-Thrunscoe Electric Lighting Order.—The Board of Trade Bill for the confirmation of this provisional order came before Mr. Campion, Examiner of Private Bills, on Tuesday, in connection with Standing Orders. Proofs showing that the regulations of Parliament had been complied with were investigated and passed, and the Bill was allowed to proceed to the next stage in the Lower House.

Electric Power Bills.—The Committee of Selection has held a conference with the parties concerned in the several Electric Power Bills now before Parliament, the second reading of which gave rise to a prolonged debate in the House some two or three weeks ago. It was resolved to take the Durham, the Tyneside, and the Lancashire Bills in the order given at sittings commencing on Thursday, May 3.

Buxton.—The Urban District Council have written to Prof. Kennedy stating that attention had been repeatedly drawn to the slow progress made with the various trades in connection with the electric lighting works, and promises having been made, the time had now arrived when the Council would enforce the agreement, and gave him notice to that effect. The penalty commenced on March 1 on all trades not completed.

York.—The Electric Lighting Committee in their report, which was adopted on Monday, stated that in view of the largely increased demand for the supply of electricity in the city they had to ask the Council to authorise them to extend the boiler-house and provide additional engines, boilers, dynamos, mains, etc., at the estimated cost of £20,000, and for that purpose to make application to the Local Government Board for power to borrow that sum.

Circular Junction Boxes.—We have before us a pamphlet from Messrs. Hayward Tyler and Co. describing their improved junction boxes for the electric conduit system. These boxes are made of more convenient depth in plaster work than others we know of, and a special point is made of the fact that the covers fit on to the boxes with a faced joint so as to prevent moisture getting in. The firm also specialise split bends and split T's with electric conduit work, which will be found exceedingly handy in practice.

Rugby.—The General Purposes Committee reported to the Urban District Council last week that they had further considered the providing of an electric light installation for Rugby, and recommended that the Council exercise their leasing powers under the Rugby provisional order, and that Messrs. Edmundson, who formerly applied, be approached to ascertain whether they were disposed to take a lease. After discussion it was decided that the committee's report should be considered by the Council in committee.

Paisley.—The Electric Lighting Corporation accounts for the year show an income of £1,037. 13s. 7d. for the sale of current per meter, and £270. 0s. 6d. from public lighting—a total of £1,307. 14s. 1d. The expenditure amounted to £1,475. 3s. 7½d., an excess over income of £167. 9s. 6½d. The net revenue account shows an expenditure of £1,039. 11s. 4d., and £681 devoted to sinking fund. The committee have authorised the Provost to sign a petition by the Town Council for additional borrowing powers under the electric lighting order to the extent of £20,000.

London Gazette.—A first and final dividend of 4½d. in the £ has been declared *re* E. B. Pym, 29, Bramham-gardens, South Kensington, payable any day (except Saturday) between 11 and 2 at the offices of the Official Receiver, Bankruptcy-buildings, Carey-street, W.C. Application has been made for debtor's discharge by J. A. Hirst, Burnley. The hearing will take place on May 17 at 10 a.m. at the Court House, Burnley. The public examination of F. Beville de Foe Paynter, Catford, Kent, will be held on April 6, at 12 noon, at Bankruptcy-buildings, Carey-street, W.C. A receiving order has been made out *re* E. Bates, Manchester, March 29, on debtor's petition.

Bryan Donkin and Clench, Limited.—This Company has been registered with a capital of £120,000 in £10 shares, the object being to adopt an agreement made between Bryan Donkin and Co., the Donkin Land Company, Limited, Messrs. Clench and Co., Limited, and Mr. S. L. Mumford, as trustee for and on behalf of this Company, for the acquisition of the business now carried on under the styles or firms of, respectively, Donkin and Co., Limited, the Donkin Land Company, Limited, and Clench and Co., to develop and extend the same, and, generally, to carry on in all or any of their respective branches the businesses of manufacturers of and dealers in every description of electrical machinery, apparatus, etc.

Kensington.—The Works Committee reported to the last meeting of the Vestry that with reference to the recommendation of the committee, adopted by the Vestry on Jan. 17 last, that an iron main should be laid throughout the portion of Cromwell-road about to be paved with wood, so that the same would be available for electric mains in the event of the Vestry deciding at any future time to light the thoroughfare with electricity, the committee now found that as some difficulty would be likely to arise it was inexpedient that this order should be carried out, and they therefore recommended that the surveyor be instructed to take no further action in the matter. The recommendation was agreed to. The Vestry also sanctioned an application of the Notting Hill Electric Lighting Company relative to a proposed extension of their mains in Kensington Park-road.

Bradford.—On Tuesday at the Sunbridge-road destructor works, Mr. William Land, the chairman of the Cleansing Committee, and J. B. Moorhouse, the deputy-chairman, started respectively a new dynamo and horizontal engine which have been erected in connection with the installation of the electric light at these works. The horizontal engine, shafting, etc., for driving the mortar-mills has been erected by Messrs. Newton and Bean, engineers, Dudley-hill, Bradford; the high speed single-acting engine in connection with the electric lighting installation has been put down by Messrs. Thwaites Bros, Thornton-road; the dynamo, designed to give an output of 85 amperes at 115 volts, has been constructed by Messrs. Roeling and Appleby, Trafalgar-street; and the wiring, arc lamps, etc., have been erected by Messrs. Rhodes and Webster, Lumb-lane.

Electric Motors.—We have received from Messrs. Marryat and Place a list of Lundell motors, with which the firm are doing a large business. Its engineers have taken up very largely the equipment of printing machines with direct-coupled motors, and in the list before us illustrations are given of some typical installations carried out by the firm. These show what little space an electric motor takes up when properly arranged, and also the convenient way in which the stopping and starting gear can be placed. In one case we notice that a chain gear, which seems to be of the Hans Renold type, is used as the connecting link between the motor and the driving axle of the printing machine. A large number of the illustrations have been taken at the works of Messrs. Alabaster, Passmore, and Sons, where Messrs. Marryat and Place have installed a very complete equipment.

Newington.—At the last meeting of the Vestry a letter was received from the London County Council, in reply to the Vestry's request that they would promote legislation to enable local authorities to borrow money for the purpose of wiring consumers' premises, stating that the matter would receive their consideration when the parliamentary schemes for next session were prepared. The following resolution was passed on behalf of the delegates appointed to attend the Islington conference on this subject: "That in the opinion of this Vestry the London County Council, as the sanctioning authority for the raising of loans, are justified in requiring such information from the local authorities in their applications for electric lighting loans as would prevent the inclusion in such applications of works covered by former loans, or of charges of the nature of revenue; and that a copy of this report be forwarded to the Council."

Grays.—We learn from the *Essex County Chronicle* that at the meeting of the Urban District Council last week a letter was read from the Local Government Board asking for the Council's remarks on a petition they had received praying them not to grant the order for electric light asked for by the Council. The petitioners pointed out that the rates at present were 8s. 2d. in the pound, exclusive of Queen's taxes and water rates, and urged that the electric light was not needed. The Clerk said he had drafted a reply pointing out that the ratepayers abstained from raising their objections when the Local Government Board attended for the purpose of receiving such objections. Nothing was easier than to promote a petition against any contemplated improvement, and to induce ratepayers to sign that petition. The Council protested against the tactics adopted by the opponents to the scheme. The letter drafted by the clerk was agreed to.

Gravesend.—A committee of the Town Council is making enquiries with regard to electric lighting. Alderman Cooper has been appointed chairman to the Electric Lighting Committee. The electric lighting will be considered in connection with a dust destructor. The town clerk has been instructed to enquire with regard to expert assistance, and to suitable municipal works which might be viewed by members of the committee. In reply to the letter from the Drake and Gorham Electric Power and Traction Company, Limited, the committee have replied that, in view of the fact that the Corporation have taken no steps other than the appointment of this committee in connection with carrying out

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the electric lighting order for Gravesend, it is impossible at present to give the company an assurance that the Corporation will supply the company with current for electric traction. The agreement of March 9, 1898, made between the Corporation, of the one part, and Crompton and Co., Limited, of the other part, has come to an end.

Cheltenham.—With regard to the Corporation's application to supply electric light to private consumers along the tramway route beyond the borough boundary, a letter was read at the last meeting of the Town Council from the Board of Trade stating that they were not prepared to dispense with the consent of the Cheltenham Rural District Council as to the extension of the electric lighting area, and were unable to proceed with the application in so far as it related to the district of that Council; that inasmuch as the Cheltenham rural district separates the existing area of the Corporation from the Winchcomb rural district, the Board were unable to include any portion of the last-named district in the proposed area of supply; and that the Board had decided to proceed with the application in respect of the urban district of Charlton Kings only. It is expected that similar action will be taken with regard to the part of the line within the Prestbury district. The number of customers connected is at present 380, with an equivalent of about 23,300 8-c.p. lamps.

Eccles.—The Town Council have adopted a report from their Public Lighting and Electrical Supply Committee stating that the question of the lighting of Garden-street was left in the hands of the chairman and vice-chairman. The town clerk was instructed to inform the consulting electrical engineer that unless the contract for the condensing plant is completed within a fortnight the committee will exercise their powers under the contract to have the work completed and charge any difference in cost to the contractors. The Town Clerk reported that on the 27th ult. the Mayor and he while in London called upon the Local Government Board with regard to the overspent capital on the electric light undertaking, and were informed that if the Council intends to apply within two or three months for borrowing powers for extensions it was not necessary to apply at the present time for the overspent capital. The committee deferred the consideration of the matter.

Eastbourne.—From the last Electric Light Committee's report we note that the low-tension main proposed to be laid as far as Avenue-mansions is to be continued the whole length of the road. Messrs. H. H. Bowland and W. Jessop, electricians, have agreed to their appointments being subject to one month's notice on either side. A letter from the Local Government Board with reference to the suggested application for sanction to borrow money for the purposes of electric light extensions, and stating that it is usual for local authorities applying for sanctions for service connections, extensions of mains, and purchase of meters to furnish the Board with an estimate of the amount required for such works during the ensuing three years, was deferred for the present pending the receipt of Mr. Hawtayne's report. The Town Clerk reported that while the Corporation was under a statutory obligation to have a map of the electric system they were not obliged to supply copies at 5s. each. The provisional order fixes a charge of 1s. for an inspection and 5s. for any party himself making a copy of the map.

Torquay.—The Electric Lighting Committee's estimate of income and expenditure for the half-year to Sept. 30 next, adopted on Tuesday, showed that the works are anticipated to cost £1,640 during the half-year. To this has to be added £1,219. 10s., balance due to the treasurer on March 31, and £583 for interest and redemption on loans, making the half-year's liabilities £3,442. 11s. As against this it is anticipated that there will be an income of £2,250 for public and private lighting, leaving an estimated deficit of £1,192. 11s. The estimated income is made up of £1,250 for quarter ending Lady Day, 1900, and £500 for each of the Midsummer and Michaelmas quarters. The charge for public arc lamps has been increased from £20 to £22. 10s. per annum; but the charge for the arc lamp opposite Upton Church is to be £20. In future the incandescent electric lamps are to be switched off at 1 a.m. The Council have agreed to grant the electrical engineer £20 for his services in connection with the installation of electric light at the destructor. Sanction to a further loan of £9,640 is to be applied for.

Babcock and Wilcox, Limited.—The share transfer books will be closed until 16th prox. The report of the directors, to be submitted to the meeting on 10th inst., states that the profit during the year, after deducting the amount written off purchase of business account, amounts to £106,585. 7s. 2d. To this has to be added the balance brought forward from last account, £9,333. 11s 10d., making a balance of £115,918. 19s. After deducting the interim dividends for the half-year to June 30, 1899 (paid Sept. 15, 1899), at the rate of 6 per cent. per annum on the preference shares, and 20s. per share on the ordinary shares, amounting to £25,000, a balance of £90,918. 19s. is left, from which the directors recommend that the following dividends be paid for the half-year ending Dec. 31, 1899—viz.: dividend at the rate of 6 per cent. per annum on the preference shares (from which income tax to be deducted), £3,000; dividend of 20s. per share on the ordinary shares (free of income tax), £22,000; placing to the reserve fund £50,000; and leaving a balance to be carried forward of £15,918. 19s. The directors retiring at this general meeting are Mr. Arthur Telford Simpson and Mr. Frederick G. Bourne. The auditors, Messrs. Cooper Bros. and Co., also retire, but they are eligible and offer themselves for re-election.

New Issue.—The Potteries Electric Traction Company, Limited, are making an issue of £125,000 4½ per cent. debenture stock at the price of £103 per cent. According to the prospectus, the debenture stock will be constituted and secured by a trust deed, made between the Potteries Electric Traction Company, Limited, of the one part, and the Electric and General Investment Company, Limited, as trustees for the debenture stockholders, of the other part, and by a series of debentures, each for the sum of £5,000, issued to the trustees in proportion to the amount of debenture stock outstanding. The series of £5,000 debentures will operate as a first charge by way of floating security upon the whole undertaking and property of the company, both present and future. The powers under which the construction of the several tramways and light railways referred to has been carried out are as under: (*a*) In respect of the tramways of the North Staffordshire Tramways Company, Limited, authority has been granted under the following provisional orders confirmed by Acts of Parliament: the North Staffordshire Tramways Order, 1880; the North Staffordshire Tramways Extension Order, 1881; the North Staffordshire Tramways Order, 1882; the North Staffordshire Tramways Order, 1883; the North Staffordshire Tramways (Release of Deposit) Order, 1886. (*b*) The extension tramways extending over a distance of about 12¼ miles, authorised by the Potteries extension tramways provisional order, confirmed by Act of Parliament, 1896. (*c*) The light railways, extending over a distance of about 12 miles, sanctioned by light railway order granted by the Commissioners and confirmed by the Board of Trade in December, 1897, under the Light Railways Act, 1896.

Electric Instruments.—Mr. James White, of Glasgow, has just issued a new catalogue of the numerous Lord Kelvin instruments which he manufactures, as well as instruments of other types specialised by his firm. The catalogue includes a number of new types. The convenience of the purchaser of these instruments is carefully studied, as is seen by the fact that dimensioned sketches of the instruments are given showing their position on the switchboard, their size, etc. Another feature of interest is the full-sized scales of instruments, recording and otherwise, from which the purchaser can see whether the same will give the accuracy of reading he requires at any particular point. Lord Kelvin's types of electrical instruments are now so well known that a recapitulation of their names would be wearisome. The great majority, however, are now being manufactured for stock, so that there need be little delay in obtaining them. One feature in this particular catalogue which strikes us as being of great value is a central-station voltmeter with an exceedingly open scale. For instance, one of these instruments with an 8in. dial is constructed so that the movement of the needle across the dial corresponds to a difference in voltage of from 95 to 105 only. When the switchboard attendant has to keep his voltage constant within a few per cent., such an instrument is of great value, as it enables him to see from a distance small changes in the voltage of supply. The ordinary voltmeters and ammeters are now being manufactured on the edgewise principle, so as to economise space on the switchboard. Another new set of instruments which we notice in this catalogue are the Voysey and Wilson electrostatic ampere-meter. This is a combination of an electrostatic ampere-meter for alternating currents. The current to be measured is passed through the heavy wire winding of a specially constructed transformer. The voltage on the fine-wire winding then gives an indication of the current, and by varying the number of turns great accuracy can be obtained with widely varying currents. Arrangements are also made so that the current in a sub-station can be read at the end of pilot wires in the central station. Another new instrument we do not remember to have seen before is a rail tester for ascertaining the conductivity of joints on a tramway. In this case the resistance is measured directly by means of the drop in pressure between two points when a given current is passed through the joint.

London County Council.—At the meeting of the Council on Tuesday, upon the recommendation of the Finance Committee, it was agreed to lend the Shoreditch Guardians £1,575 for electric lighting at the workhouse. The Highways Committee reported that their attention had been drawn to a letter which had recently been addressed to each member of the Council by the general manager of the National Telephone Company. Having regard to the fact that litigation was now pending between the Council and the company, they were advised that they could not comment upon the points raised in it. They wished, however, to make one point quite clear, and that was that there was a fallacy underlying the whole letter—namely, that it was alleged that the company was conducting its business under a license obtained from the Postmaster-General. They had understood throughout their negotiations that the company had actually obtained a license, but they knew now that this was not the fact, as proceedings had actually been instituted by the Postmaster-General to restrain the company from breaking up the streets without his license. It followed, therefore, that the Council was not yet really in a position in which it could legally grant any consent at all, nor indeed could it be advised to grant any provisional consent until the pending litigation with the Postmaster-General had been decided. The Council could not, therefore, be considered to have stood in the way of the company doing its work and improving its service. The remaining points referred to would be dealt with in the pending litigation between the Council and the company, and they refrained from making any further comment. The consideration was postponed. It was further recommended: (1) that the Council approve the plan submitted under the provisions of the Baker-street and Waterloo Railway Act, 1893, by the company's engineer showing the booking-office accommodation at and the York-road entrance to the company's proposed Waterloo station, but that such approval be not taken to refer to the sanitary arrangements at the station, with regard to which the requirements of the local

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sanitary authority concerned and the by-laws made by the Council must be complied with; (2) that the Council approve the plan submitted by the engineer of the City and South London Railway Company under the provisions of the company's Act of 1893, of the station proposed to be erected at the corner of Torrens-street and City-road, Islington, such sanction being, however, subject to all sanitary arrangements in connection with the station buildings being carried out to the satisfaction of the local authority concerned, and in accordance with the requirements of the Council's by-laws; (3) that the sanction of the Council be given to the works referred to in a notice from the Vestry of Hampstead, under the Hampstead Electric Lighting Order, 1893, so far as relates to the laying of the mains in Finchley-road and Edgware-road, such sanction being subject, however, to the following conditions: that full details of the work in those roads be supplied to the Council's chief engineer, and any modification thereof which the Council may desire be made, and that the work be in all respects be carried out to his satisfaction.

Poplar.—At the meeting of the District Board on Tuesday the electrical engineer submitted a report, in which he said: "With reference to the question of the extension of the electricity supply mains to the side streets of the district with the object of improving the public lighting, your engineer has no doubt that a judicious extension of the mains already in hand would result in the more satisfactory lighting of the streets concerned, light for light, at no increased cost to the Board; over and above which the electricity department could not fail to reap the benefit accruing from the fact of the electricity supply being placed within the reach of a vastly increased number of possible customers. The very inadequate nature of the street-lighting is so pronounced as to render comment upon the point unnecessary, the defects being due to three causes—viz, an insufficient number of lamps, the nominal candle-power of each lamp is insufficient, and many of the lamps do not efficiently give and distribute their nominal candle-power, partly on account of the general dirty and neglected condition of the lanterns, and partly for other reasons. Should an improved light be decided upon, the fact must be emphasised that the increased cost is due to that cause, and that cause alone, and is in no way attributable to the substitution of electricity for gas. Your engineer would suggest that, under any scheme for improving the street-lighting, only the last two defects be remedied at first, and that the spacing of the lamps be remedied after the electricity department has had time to establish itself, when it will be quite feasible to reduce the price of electricity below the present cost of gas, by which time the existing gas lamp-posts in the main streets to be lighted with arc lamps will have been removed and be available for re-erection in the side streets. Your engineer has selected a number of streets in Poplar, Bow, and Bromley suitable for conversion under the improved lighting scheme, and these streets have been selected with the twofold object of improving the public lighting and of extending the electricity mains to streets likely to yield a revenue from private consumers. The length of the streets is 13½ miles, and the number of gas flames in them is 500. The 12-c.p. lamps are of the same nominal candle-power as the present gas lighting, and yield a small profit to the Board compared with the present cost of gas lighting. The engineer submitted designs he had prepared for the conversion of the gas lamp-posts. Design A is intended for use if the street-lighting is simply changed over from gas to electricity without increasing the nominal light, and design B is intended for use if either 16 c.p. or 20 c.p. be substituted for the present 12 c.p. per post. Your engineer strongly recommends that the two lamps per post design be adopted, with either two 8-c.p. or two 10 c.p. lamps, as owing to the increased candle-power it becomes practicable to use two lamps on each post, each of half the candle-power required, in place of one lamp of the full candle-power, the result being a greatly improved efficiency in the distribution of the light, thus making the improvement in the lighting greater than that consequent upon the additional candle-power only. It must also be borne in mind that if the 12-c.p. design be adopted, and it is desired to increase the light after the cost of electricity is reduced, the increased candle-power could only be given by one lamp of increased power, so that the lighting with one lamp per post would never be as efficient as if the 'two lamps per post' design be adopted. It is not practicable to divide 12 c p. between two lamps. The network main included in this report would be laid upon one side of each street only, and with the exception of that proposed between the junction of St. Leonard's-road and Dewberry-street and the junction of Old Ford-road (running *vid* Dewberry-street, Brunswick-road, High-street, Bow, and Old Ford-road) would be of a smaller size than that in hand for the principal streets of the district. This smaller network is amply large for the public lighting and any private lighting likely to be required for some considerable time. If, however, the network at some future time became fully loaded, or if a heavy call for power arose at any point, it would be strengthened by laying another cable on the opposite side of the street. These future extensions would be done gradually and from time to time as necessitated by the natural extension of the department, and after the actual applications for a supply of current had been received. Should this report meet with approval, the Board would probably place the order for the mains, as an extension of the existing contract, with the British Insulated Wire Company, Limited, who are supplying the present mains at schedule rates, and as one of the sizes of network proposed under this report is not in use among the mains already in hand, your engineer has obtained a price from the contractors for this main, and has based the cost of mains for this extension upon their quotation." The report was adopted.

PROVISIONAL PATENTS, 1900.

MARCH 26.

5609. An improvement in electrical (static) transformers and in the arrangement of sub-stations containing them. Thomas Tomlinson, 18, Eustace-street, Dublin.

5649. Improvements in and relating to telegraphic apparatus. Sidney George Brown, 45, Southampton-buildings, Chancery-lane, London.

5650. Improved method and apparatus for determining the size and position of bodies by means of Rontgen rays. William Phillips Thompson, 6, Lord-street, Liverpool. (The Voltohm Electrical Company, Germany.)

5656. Improved means for utilising the flow of currents. Edouard Ernest Lesigne, 18, Buckingham-street, Strand, London.

MARCH 27.

5693. Improvements in and relating to telephonic systems. Morris Clinton Mengis and Frederik Sinding Christensen, 70, Market-street, Manchester. (Complete specification.)

5698. Improvements in the method of and means for protecting electrical connections. John Langton, 70, Market-street, Manchester. (Complete specification.)

5707. Improvements in means for carrying or supporting electric leads or conductors. Sigmund Wolf, 57, Chancery-lane, London.

5710. Improved indicator for storage batteries. Philip Johnstone Spenser Tiddeman, 70, Deansgate, Manchester.

5727. Improvements in the electric heating of liquids and apparatus therefor. Joseph Arthur Godfroy Trudeau, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

5751. Improvements in or in connection with storage batteries. Elmer Ambrose Sperry, 6, Lord-street, Liverpool. (Complete specification.)

5755. Improvements in the manufacture of electrical insulating material. Carl Jung, Adolf Brecher, and Adolf Kittel, Clun House, Surrey-street, Strand, London. (Complete specification.)

5764. Means for retaining the field-magnet coils of electric motors and dynamos in position. Charles August Lindstrom, 115, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 16, 1899, being date of application in United States.) (Complete specification.)

5767. Improved construction of carrier for globes or glasses of electric gas or oil lamps. Eadley Stanley, 166, Fleet-street, London.

MARCH 28.

5773. Improvements in automatic and safety subsidiary devices for controlling electrically-propelled vehicles and the like. Anthony George New, The Voltage, Woking, Surrey.

5786. Improvements in electric cables. George Hinde Nisbett, 15, Water-street, Liverpool.

5806. Improvements in the regulation of dynamo-electric machines. The British Thomson-Houston Company, Limited, 83, Cannon street, London. (Charles P. Steinmitz, United States.) (Complete specification.)

5833. Improvements in and relating to starting, regulating, and reversing switches for electric motors. George Augustus Mower, 11, Southampton-buildings, Chancery-lane, London.

5841. Improvements in electricity meters. Medwin Caspar Clutterbuck, Norfolk House, Norfolk-street, Strand, London.

MARCH 29.

5848. Improvements in conduits for electric tramways. Michael Holroyd Smith, 47, Victoria-street, Westminster, London. (Complete specification.)

5860. Improvements in electrical apparatus for hoisting or other intermittent work. William Harding Scott, Gothic Works, Norwich.

5900. A method of securing intermittent motion in electric switches and other devices. Cecil Burman Callow and Henry Justus Eck, 5, Priory-road, Chiswick, London.

5925. An electric lift controller. Joseph Gershom Childs, 145, Farringdon-road, London.

MARCH 30.

5928. Improvements in telephone divided multiple board systems. William Aitken, 2, Oxford court, Cannon-street, London.

5944. Improvements in train-lighting by electricity. Benjamin John Day, Sports Club, St. James-square, London.

5961. Improvements in and relating to the rendering watertight the attachment of fittings used in electric wiring to branch cables. William McAulay, George Alexander Clark, and John Alexander McLaren, 34, Ann-street, Glasgow.

5980. An improved plug and socket fitting for electrical circuits. Henry Bevis and Frederick William Morris Chapman, 73, St. Stephen's-road, Upton Park, London,

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MARCH 31.

6823. **Improvements in electric bells.** The British Electric Works Company, Limited, and Bertie Brander, 24, Temple-row, Birmingham. (Complete specification.)

6828. **Improvements in brush holders for dynamo-electric machines.** Edgar Woods Mix, 26, Bush-lane, London. (Complete specification.)

6854. **Improvements in telegraph poles.** Howard Cochrane Jobson, 24, Southampton-buildings, Chancery-lane, London.

6869. **Improvements relating to the generation of direct electrical currents and to apparatus therefor.** Robert Lundell, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published April 21, 1900.

1899.

6812. **Magnetic power transmitting devices.** Bacon.

6833. **Step-by-step printing telegraph instruments.** Casella.

6993. **Switching contrivances for two electric incandescent lamps connected up together.** Schloesser and Moeres.

7577. **Method and apparatus for operating contacts for electric traction.** Ballance and Jefferson.

10608. **Manufacture of conduits for electrical conductors and other purposes and apparatus therefor.** Morrison.

10860. **Electric railways and tramways worked on a mixed power system.** Andreas.

11189. **Dynamo electric machines.** Wise. (Actien-Gesellschaft Electricitätswerk, vorm. O. L. Kummer und Co.)

11227. **Ventilation of electromotors, dynamos, and the like.** Hall and Robertson.

11456. **Contact boxes for electric tramways and the like.** Mills. (Bonnet, Paufique, and Linière.)

11513. **Self-acting mule with electrical driving gear.** Bretschneider and Lauth.

11657. **Apparatus for forming plates of secondary batteries.** Leitner.

12114. **Electrically-driven fans.** Scott.

12956. **Electric furnaces.** Compagnie Electro Métallurgique des Procédés Gin et Leleux. (Date applied for under International Convention, Jan. 27, 1899.)

13088. **Electric tramways or railways on a road-contact system.** Mills. (Bonnet, Paufique, and Linière.)

21355. **Apparatus for measuring multiphase electric currents.** Aron and Aron Electricity Meter, Limited.

23663. **Armature for alternating-current motors.** Burke.

25164. **Electric igniting devices for lighting gas and like lamps.** Schmidt.

25451. **Electric switches.** British Thomson-Houston Company, Limited. (Oxley.)

25681. **Electrodynamometers.** Feeny. (Allgemeine Elektricitäts-Gesellschaft.

1900.

633. **Alternating-current meter for small non-inductive loads.** Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

1366. **Arrangement of switching appliances for use with telephones.** Newton. (Rabbidge.)

3105. **Systems of electrical distribution and safety apparatus therefor.** Reed, Reed, and Farrar.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Mar. 30	3,977	4,012	− 35	51,234	48,806
Blackpool-Fleetwood	,, 30	200	433	− 233	2,072	2,520
Bradford City Trams	,, 30*f*	242	—	—	28,301*c*	—
Bristol Tramways Co.	,, 30	2,552	2,745	− 193	—	—
City & South London	Apl. 1	1,360	889	+ 471	15,939	14,239
Dover Tramways	Mar. 31	145	199	− 54	1,868	1,895
Dublin U.T., elec. cars	,, 30	2,886	969	+1,917	—	—
Dublin S.D. Electric	,, 30	653	661	− 8	—	—
Halifax Corporation	Apl. 1	588	564	+ 24	30,304*a*	11,274*b*
Hull Corporat'n E.S.	Mar. 31	718	—	—	—	25 912*c*
Liverpool Corporat'n	Feb. 24*d*	6,882	5,723	+1,159	52,098	46,118
Liverpool Overhead	Apl. 1	1,277	1,405	− 128	18,137	17,025
Sheffield Corporation	,, 1	1,890	—	—	—	—
South Staffordshire	Mar. 30	617	572	+ 44	7 826	7,664

a Since April 1, 1899. *b* Since June 29, 1898. *c* Total receipts. *d* Partly electrical. *e* Since July 5, 1899. *f* Five days.

NOTE.—Apparent decreases due to Good Friday falling in corresponding week last year.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Tuesday.
Commercial and Industrial.—		
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	11/16-13/16xd
British Insulated Wire, Ord., 1-40,000	5	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	6 6½
—— 5 per cent. Mortgage Debentures	100	96-103
British Electric Works, Ordinary, 50,001-95,000	1	½-1
—— 6 per cent. Cum. Pref., 1-50,000	1	½-1
—— 4½ per cent. First Mortgage Debentures	100	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	4½-5½
Brush Electrical Engineering, Ordinary	2	1½-2
—— Non. Cum., 6 per cent. Pref.	2	2½-2¾
—— 4½ per cent. Debenture Stock	100	108-113
—— 4½ per cent. 2nd Debenture Stock	100	103-105
Callender's Cable, Debentures	100	113-118
—— Ordinary	5	14½-15½
—— 5 per cent. Pref.	5	5½-6
Crompton and Co.	2	3½ 4
—— 5 per cent. Debentures	—	99-101
Edison and Swan United, Ordinary	2	2-2½
—— 5 per cent. Debentures	5	2½-4½
—— 4 per cent. Deb. Stock, Red.	100	93-96
Electric Construction	2	2½-2¾
—— 7 per cent. Cumulative Pref.	2	2½-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100	104-107
Giffre Electro-Chemical and Power, Ordinary	1	½-1
W. T. Henley's Telegraph Works, Ordinary	5	13½-14½
—— 4½ per cent. Preference	5	5½-5¾
—— 4½ per cent. Debentures	100	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	100-103 xd
Telegraph Construction and Maintenance	12	36-40
—— 5 per cent. Bonds	100	102-105
Telegraph Manufacturing, Ordinary	5	9½-10½
—— 5 per cent. Cum. Pref.	5	5½-5¾ xd
Willans and Robinson, Ordinary, 1-30,000	5	12-13
—— 6 per cent. Cum. Pref., 30,001-60,000	5	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	104-106
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	¾-⅞
Bournemouth and Poole, Ordinary	10	11½-12½ xd
—— 4½ per cent. Cum. Pref.	10	10-11
Brompton and Kensington, Ordinary	5	7-8 xd
—— 7 per cent. Preference	5	8½-9½ xd
Charing Cross and Strand	5	9½-10½
—— 30,001-50,000	5	9½-10½
—— 4½ per cent. Cum. Pref.	5	5¼-6
Chelsea Electricity Supply	5	7-8
—— 4½ per cent. Debentures	100	110-112
City of London, Ordinary	10	9½-10½
—— 6 per cent. Cumulative Pref.	10	12½-13½
—— 5 per cent. Debenture Stock	100	122-127
County of London and Brush Provincial, Ordinary	10	9½-10¼ xd
—— 6 per cent. Cum. Pref.	10	12½-13½ xd
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	100-103
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	4½-5½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	10-10½
London Electric, Ordinary	2	1½-2½
—— 6 per cent. Pref.	5	4½-5 xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	14-15
—— 62,501-85,000	10	14-15
—— 4½ per cent. First Mortgage Debenture Stock	100	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	96-98
Notting Hill Electric Lighting	10	15½-16½
Oriental, 1879	1	1½-1¾
—— £5 Shares	5	7-7½
—— £4½ Shares, New	4½	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	6½-7
River Plate Electric Light and Traction, Deb.	100	75-85
Royal Electrical Company of Montreal	1½	150-170
—— 4½ per cent. First Shares Mortgage Debentures	100	103-104 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	2½-2¾
—— 4 per cent. Debenture Stock	100	85-95
South London, Ordinary	2	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 40,081-52,080	5	14½-15½
—— 7 per cent. Pref.	5	8½-9½
Westminster, Ordinary	5	14½-15½
Electric Railways.—		
Central London, Ordinary	10	10-10½
—— Pref. Half-Shares	5	4½-5½
—— ,, ,, deferred	5	5-5½
City and South London, Consolidated Ordinary	100	67-70
—— Ordinary	10	6-7
—— 4 per cent. Debenture Stock	100	125-130
—— 5 per cent. Pref. Stock '91	100	140-145
—— ,, ,, ,, '96	100	132-137
Liverpool Overhead, 5 per cent. Pref.	—	13½-13¾
Waterloo and City, Ordinary	100	101-104
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10	17-18
Brisbane Tramway	100	104-106
British Electric Traction, Ordinary, 1-30,000	10	17-18
—— 60,001-75,000	10	16½-17½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	12½-13½
—— 5 per cent. Perpetual Debenture Stock	100	124-127 xd
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4-4½
—— 5 per cent. Deb. Stock, Red.	100	105-108
Isle of Man Electric Power, 1-95,000	1	11/16-¾
—— 6 per cent. Preference, 100,001-170,000	1	¾-13/16
Kidderminster and District Lighting and Traction, Pref.	10	10-10½
New General Traction, Ordinary	5	3½-4½
—— 6 per cent. Cum. Pref.	5	5-5½
North Staffordshire Trams	6	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	18-19
—— Preference	10	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	10-11
Telephones.—		
Consolidated Telephone Construction and Maintenance	½	½-½
National Telephone, Ordinary	5	5-5½
—— 6 per cent. Cum. First Pref.	10	14-15
—— 6 per cent. Cum. Second Pref.	10	14-15
—— 5 per cent. Non. Cum. Third Pref.	5	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	97-100
Oriental Telephone and Electric Company	1	½-1

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NOTES.

Municipal Electrical Association.—The annual convention of the above association is this year to be held in Huddersfield, commencing on June 20. The meeting will last four days, and we understand that an interesting programme is being arranged.

The Tramways and Light Railways Association.—An inaugural dinner in connection with the above society has been arranged for Wednesday, April 25. The dinner will be held in the Victoria Hall of the Hotel Cecil at 8 p.m., and a large number of gentlemen interested in tramways and light railways are expected to be present.

London Chamber of Commerce.—On Monday, April 23, the president and council of the London Chamber of Commerce have arranged a complimentary dinner to the delegates of the Australasian Colonies in England. The dinner will be held at the Trocadero Restaurant, at 7 p.m. A goodly number of delegates have already accepted.

Municipal Wiring.—The Parliamentary Committee of the London County Council has, in reply to an application from the Vestry of Fulham, decided to defer the consideration of municipal wiring until the next parliamentary session. The Fulham Vestry has asked the Council to promote legislation to enable the metropolitan local authorities to borrow money to be used for wiring consumers' premises for electric lighting.

Incandescent Lamps as Heaters.—The incandescent lamp is not usually considered as a source of heat, but as such it has exceptional advantages in a chemical laboratory. For instance, where a highly inflammable liquid is to be heated, and in so doing gives off volatile products which are explosive, it is most important that the source of heat should not explode the mixture. In such a case an electric lamp immersed in the liquid is about the safest means of heating that can be adopted.

Electricity is Life.—An expert makes the calculation that when electric light has entirely displaced gas, oil lamps, and candles in the United Kingdom, 40,000 less people will die each year than at present. It is a pity that the gentleman in question has not capitalised the value of these 40,000 lives, and compared the same with the capital cost of providing the electric light universally. We need hardly say that the decreased death-rate is calculated on the assumption of the unhealthiness of the rival illuminants to electric light.

Telephones in London.—The law case between the Attorney-General and the National Telephone Company to restrain the latter from breaking up the streets in the London County Council's area without the license of the Postmaster-General, was referred to in the Court of Queen's Bench last week. It was agreed to adjourn the hearing of the case for three months, owing to a similar action being down for hearing about that time between the London County Council and the National Telephone Company. In the meantime the company undertake not to lay any more wires underground.

Wireless Telegraphy and the London County Council.—We notice that, in consequence of a disagreement with the Post Office authorities respecting the fixing of a telephone and fire-alarm on some premises the Council have taken at Streatham, it has been decided to try wireless telegraphy, and negotiations have been entered into with the Wireless Telegraph and Signal Company, Limited, who have agreed to instal and maintain the necessary electric instruments for a period of two years in consideration of an annual payment of £50, the instruments to remain the property of the company, and the pole required to be erected by the Council.

Refuse Destructors.—The refuse destructors at Darwen were fully described in an article we gave on the station in our last volume. These destructors, which are of the Meldrum type, have now been in regular work for some considerable time, and are giving great satisfaction. There are now some 5,000 lamps connected to the mains, and the refuse destructors have enabled sufficient steam to be obtained regularly to supply this number of lamps without burning any coal whatever. It will be interesting to know the exact point at which the refuse at Darwen will be insufficient to meet the demand for electric lighting.

The New York Underground.—On March 24 the ceremonies connected with the breaking of ground for the New York Rapid Transit Tunnel were gone through. The Mayor of New York was presented with a silver spade with which to turn the first shovelful of earth from the excavation. In doing so, he used his silk hat as the receptacle for this first spit of earth, which he intends to distribute as souvenirs of the occasion. The contractor for this enormous work states that he will shortly have some 20,000 workmen employed on the tunnelling operations. It will be remembered that within the tunnel the motive power will be electricity.

Telephones at Hull.—The Hull Corporation and the National Telephone Company are in disagreement over the underground wires which the company has already laid in that town. Thus the Corporation has served a notice on the company requiring the removal of all pipes and underground works, which would mean the disorganisation of the telephone system. This the company refuses to do, holding that the notice is not valid. The point at issue would seem to resemble somewhat the dispute between the County of London and Brush Provincial Electric Lighting Company and the Battersea Vestry. When wires and pipes are once laid underground, it is not an easy thing for a corporation to compel their removal.

Paris Congresses.—We mentioned last week a congress to be held in Paris to discuss steam engines and boilers. We notice this week that there will take place at Paris, somewhat later in the year, an international congress on tramways. The congress will be held from Sept. 10 to Sept. 13, under the auspices of the Permanent International Union of Tramways. The congress will include in its programme the questions of the heating of carriages, brakes, electrical traction, etc., and will also go into the question of tariffs. The Permanent International Union, which is mainly responsible for the congress, was founded in 1886 for the development, improvement, and cheapening of the methods of transport and communication in cities.

Telephone Complaints.—As suggested at the monthly dinner of the London Chamber of Commerce, at which the subject of telephonic communication was discussed, it has now been arranged that any complaints as to the working of telephones in the United Kingdom should be forwarded to the secretary of the Chamber. A special committee, called the Postal Telegraph and Telephone Committee, are to take such steps as may be deemed advisable to prevent the faults complained of continuing. We think that the organisation is an exceedingly valuable one, as the complaints, if properly tabulated, will give an indication of what parts of the country are most in need of improved means of communication. As far as the trunk-line telephone service is concerned, it is well known that more trunk wires are needed, and the London Chamber of Commerce should soon be able to

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bring pressure to bear on the Government in order that these lines may be constructed in the proper order.

Electrical Tramway Lectures.—We notice that a number of lectures on electric tramways are now being delivered in different parts of the country. Thus Mr. A. L. C. Fell, the electrical engineer to the Sheffield Corporation tramways, lectured before the Society of Engineers and Metallurgists at Sheffield on Monday last. In his lecture he dealt with the various systems of electric traction, and then described in detail the equipment of the Sheffield trams. The lecture was much appreciated. Mr. F. Bruton also lectured last week at Swindon on the same subject. In this lecture, again, the various systems were explained in detail, together with their advantages and disadvantages. Mr. Bruton also commented on the great reduction in cost from working tramways electrically.

London Electric Lighting.—The Vestries of St. George-in-the-East, Limehouse, and Mile End Old Town came before the Board of Trade on Friday last in order to get their electric lighting provisional orders confirmed. The County of London and Brush Provincial Electric Lighting Company opposed the order, as the company already had an order for supplying electricity in the vestries' districts. The supply, however, had not yet started. The three vestries argued that in November next they would join with Whitechapel, which had an electric supply order, and would form the new borough of Stepney, and that a private company should not be allowed to compete. Sir Courtenay Boyle reserved his decision on the preamble, and stated that if the orders were granted they should all conform to the provisions of Whitechapel, so that the new municipality of Stepney should have identical provisions over the whole borough. The decision on the preamble is to be communicated to the persons interested as soon as possible.

Branch Railways.—With the large number of light railways being constructed or contemplated in Great Britain, the question as to whether these should be worked by electricity or steam is of the utmost importance. The cost of equipment is naturally somewhat higher with electric working, but, on the other hand, exceptional facilities can be obtained by electric driving on a line on which the traffic is comparatively small. The engine may often weigh considerably more than the train it draws when loaded, and in consequence the cost of working is increased much beyond what it should be. On the other hand, with electric driving a single motorcar can be used when the traffic is light, and more can easily be added to provide accommodation during those parts of the day in which more passengers or goods have to be carried. We notice in this respect that certain lines in the United States are already making their new branches so that they shall be equipped electrically on the trolley system. The ordinary gauges will be used so as to enable a steam-engine to run over the tracks if need be.

Electrical Charging Stations.—With the use of accumulators on electrically-driven vehicles the need for charging stations in different parts of a large town is at once felt. For instance, in the development of electric launches on the Thames the system was not successful until charging stations had been established at various points along the river at which the electric launches could be charged for private owners. The London Electrical Cab Company, which was not financially successful, had only one charging station, and in consequence its cabs had to go back to this point, often at the expense of the accumulators, as they were discharged down to a destructively low voltage. We are pleased to note, therefore, that in New York private enterprise has resulted in the establishment of several charging stations for automobiles, in which the supply is taken from the public mains. In these stations the electrical vehicles can be overhauled and charged at reasonable rates, and it is stated that a considerable business is being already done by the stations.

Tesla Telegraphy.—As the outcome of Mr. Nikola Tesla's experiments on wireless telegraphy at high altitudes a patent has recently been issued to him in America, which is briefly summarised in the *Electrical World* as follows: "The patent relates to the production at one point of an electrical pressure of such character and magnitude as to cause thereby a current to traverse elevated strata of the air between the point of generation and a distant point at which the energy is to be received and utilised. As illustrated, the apparatus consists of a generator supplying current to the primary of a transformer; the secondary consists of many turns, and is connected at one side to the earth and at the other side to a terminal of large surface, maintained by such means as a balloon at a high elevation. The receiver duplicates this apparatus, except that instead of a generator being in one circuit of the transformer, receiving devices such as lamps and motors take its place. The transformer consists of a coil of very large diameter wound in spiral form, either with or without a magnetic core. The inventor claims that this furnishes a practical method or system of transmission of energy through natural media without the use of wires."

Royal Institution.—We have received the following list of the lecture arrangements at the Royal Institution after Easter: Dr. Hugh Robert Mill, three lectures on "Studies in British Geography"; Dr. Alexander Hill, two lectures on "Brain Tissue considered as the Apparatus of Thought"; Mr. R. Warwick Bond, two lectures on "(1) Ruskin, Man and Prophet, (2) Ruskin, the Servant of Art"; Prof. Dewar, four lectures on "A Century of Chemistry in the Royal Institution"; the Rev. Canon Ainger, three lectures on "Chaucer"; Prof. Stanley Lane-Poole, two lectures on "Egypt in the Middle Ages"; Dr. Alfred Hillier, two lectures on "South Africa, Past and Future"; Sir Frederick Bridge, three lectures on "The Growth of Chamber Music from Allegri's Symphonia (1580-1652) to Haydn's First Quartet" (with musical illustrations). The Friday evening meetings will be resumed on April 27, when a discourse will be given by the Right Hon. Lord Kelvin on "Nineteenth Century Clouds over the Dynamical Theory of Heat and Light." Succeeding discourses will probably be given by Prof. T. E. Thorpe, Mr. Sidney Lee, Prof. J. A. Ewing, Mr. Francis Fox, Sir Henry Roscoe, and other gentlemen.

Phosphorescence and Radium Rays.—The following abstract of a paper contributed by Mr. Henri Becquerel to the *Comptes Rendus* appears in the *Journal* of the Chemical Society. The abstract reads as follows: "The author finds that, in general, substances which phosphoresce when exposed to the action of ultra-violet rays, or of the X-rays, also become luminous under the influence of the radiation emitted by radio-active barium chloride; the order of the relative intensities of the luminous effects is, however, not the same in the two cases. The phosphorescence excited by radium in certain minerals shows great persistence; fluorite, for example, remains luminous 24 hours after the influence of the radium has ceased. When phosphorescent substances, which have been heated, and thus rendered incapable of phosphorescence, are subjected to the action of an electric spark or to the prolonged action of the violet and ultra-violet rays, they are found to possess the property of exhibiting phosphorescence on heating. Fluorite, in these circumstances, emits a greenish-blue light, and the author finds that this mineral, after heating and exposing

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it to the radium radiation, gives out when heated a greenish-blue light which spectroscopic analysis shows to be identical with that produced by the electric spark.

Low-Voltage Dynamo Brushes.—In an article which appears in the *Elektrotechnische Zeitschrift*, Dr. G. Langbein considers the suitability of the Boudreaux laminated dynamo brush for low-voltage machines employed for electroplating, etc. According to his observations it seems conclusively proved that laminated brushes of anti-friction metal, while they may serve well for dynamos yielding a potential difference of four volts and above, are not to be recommended for machines of lower voltage, since the resistance of the brushes themselves, coupled with that of the skin which forms upon the surface of the commutator, is too great when large currents at the low voltage have to be dealt with. It is advisable, therefore, in the case of dynamos employed for copper and electroplating giving a potential difference of two volts, to revert to the use of gauze brushes of copper or brass, despite the greater wear entailed; or should there be special reasons for giving laminated brushes the preference, the same should not be composed of anti-friction metal, but of pure thin sheets of copper or brass. It is also advantageous to cleanse the metal sheets to be employed for the brushes in a solution of cyanide of potassium, tinning them before folding the metal in order to prevent a subsequent oxidisation of the surface.

Silver Voltameters.—With the extended use of silver voltameters for the calibration of electrical instruments, it is highly important to know the exact effects of atmospheric conditions on the results obtained in order that correct results may be calculated under all circumstances. Mr. J. H. Merrill has experimented very largely in this direction, and gives the results of his experiments in the March number of the *Physical Review*. A brief review of his experiments would occupy more space than we have at our disposal, so that we can only give the bare facts he has established. An increase of pressure up to as much as 103 atmospheres does not alter the deposit obtained. Three experiments showed in each case a very slight increase, but this was only in the fifth or sixth significant figure. The temperature of the solution when varied from 0deg. C. to 90deg. C., did not affect the deposit within the limits of experimental error, and the size of the anodes used was also practically without effect. The author found, however, that working with old and used solutions did make a slight difference in the deposit. He concludes that the increase in deposit from used solutions must be due to some reduction of the valency of the silver in the electrolyte. Further experiments are promised by the author in this direction.

Magnetisation and Elasticity.—It has been known for some time that the magnetisation of an iron or steel rod has considerable effect on its elasticity. Mr. James Stevens publishes in the *Physical Review* the results of some experiments he has made to get the relation between magnetisation and torsional elasticity. In the experiments he used rods of iron and steel 183cm. long and 0·48cm. in diameter. These were magnetised by means of magnetising forces going up to over 400 units in the absolute scale. The rods were fixed at one end and subjected to a torsional strain at the other. The current was then switched on to the magnetising coil, and the difference in deflection of the twisted end was read. The author's conclusions are as follows: (1) Magnetisation of an iron or steel rod increases its torsional elasticity. This would be expected from the results of the experiments mentioned in the first part of his paper, dealing with the effects of torsion upon elasticity. (2) The effect is greater in iron than in steel rods of the same dimensions. (3) The increase in the elasticity varies with the length of the rod. If the results of this experiment are compared with those of the experiments on elasticity of flexion, we note a distinct agreement. In the first place, the modulus of elasticity is increased in each case when the rod is magnetised; the increments are fairly proportional to the magnetising forces; and they are inversely proportional to the magnitudes of original stresses.

An Electroscope in Vacuum.—A brief digest of an article relating to electroscopes appears in the *Elektrotechnische Zeitschrift*, the author describing a vacuum electroscope which he had had constructed for experimental purposes. The apparatus has the form of a pear about 12cm. in length, its top consisting of a hollow aluminium ball which rests upon an aluminium wire welded into the glass. This wire projects into the interior of the electroscope, where it takes the form of a flat ribbon, to which the broad pendulum leaves are attached, these latter being of aluminium foil about 1cm. long and 1½mm. broad. In the lower portion of the glass bulb are two platinum wires welded into the sides of the bulb, the distance between them amounting to about 0·4mm. Experiments with the instrument proved the vacuum to be a perfect insulator, and that intensive electrostatic effects might be obtained in the same. The ordinary electroscope experiments succeeded when applied to the apparatus, though the heavy charges on the glass walls which occurred during these experiments had a disturbing influence. When the apparatus was observed in a dark room, no trace of luminosity was apparent in it during the occurrence of strong electrostatic effects. Discharges of electricity into a vacuum are therefore dark, from which it may be concluded that the phenomena of light are dependent upon the presence of ponderable material.

Gas Testing.—The London County Council Bill, which is to legalise the use of a portable photometer for gas testing, is very strongly opposed by the gas companies of London. The grounds of this opposition are not far to seek, as it has been conclusively proved that, whereas the illuminating properties of gas may be up to the standard in a large supply main, it may have deteriorated very much before being delivered to the consumer. The object, then, of the portable photometer is to ensure that the gas consumer should get the quality of gas prescribed by the Act of Parliament, and that the gas companies should be compelled to deliver this gas under penalties. The evidence brought before the committee before they adjourned for Easter forms interesting reading, and shows that considerable variations in quality can be observed within comparatively short periods at the same testing point on the consumer's premises. The opponents of the Bill bring this forward as evidence against the reliability of portable photometers, but we cannot conceive of anyone believing this plea. No doubt there are precautions which must be taken in order to ensure that the portable photometer should give correct results under peculiar local conditions, but there is nothing in this but what could be guarded against by a clause in the proposed Bill. We trust, therefore, that this Bill, which will place electric lighting and gas supply on an equal footing as regards the supervision of the character of the supply, will be duly passed.

The Hastings Tramways.—After many years of strenuous opposition, electric tramways are to be tried in Hastings. The history of the various schemes put forward for the construction of tramways in the district shows that the Corporation and private promoters have been equally unfortunate in their previous attempts to

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get powers to construct tramways. Only last year the House of Lords threw out a scheme promoted by the Corporation, while the House of Commons was responsible for the rejection of a company's scheme. This year the preamble of Mr. Murphy's Bill has been proved. The full text of the evidence given before the committee has been republished by the *Hastings and St. Leonards Observer*, and forms interesting and instructive reading. The conclusion of the committee is a most reasonable one, and we are sure that the tramways which are now to be constructed will prove to be of great value to the town. The hills which surround Hastings and St. Leonards have been in the past a great drawback to the extension of the suburbs, because of the inconvenient means of access. With the lines now proposed, a very large area of high ground will be opened up, to the advantage not only of the owners, but also to the inhabitants of the older portions of the towns. The grades on these lines are such as can be conveniently overcome by electric traction, but they are exceedingly trying to horse traffic, and the service of omnibuses which has been running for years up these hills has been nothing more than an authorised system of cruelty to animals.

Unipolar Induction.—At a meeting of the French Physical Society, held at the beginning of last month, Mr. Craveau read a communication on the "Elementary Law of Electromagnetic Phenomena" and "Unipolar Induction." On this latter subject the author stated the following opinions: First, that all the experiments carried out on closed circuits could be explained equally well on the hypothesis of the movement of lines of force or of their immobility. This fact has been noted before, and the general reason given is that the E.M.F. of induction is calculated from the expression for the electromagnetic energy, which naturally depends on the magnetic force and the intensity of the current in a circuit. Secondly, the experimenter Edlund, who is a strong adversary of the hypothesis that the lines of force are moved by the magnet, has reproached the above theory as admitting that the production of the induced current is without any expense of energy. The author showed in a previous lecture that Edlund only arrived at this conclusion after having considered as negligible the work necessary to maintain the movement. Thirdly, if it is admitted that the lines of force follow the movement of the magnet to any extent, it is not possible to state any problem relative to the case with a revolving magnet which it is impossible to actually realise. Maxwell's theory seems to indicate, in the author's opinion, that the rotation of a magnet, even if its action is confined to a circle of revolution, will set up double disturbance. The magnetic field will not be exactly the same after the movement, and it will then produce, amongst other things, an electrostatic field.

Atmospheric Electricity. — Dr. Andrew Wilson publishes, in the columns of the *South Wales Daily News*, some interesting information from the work of Dr. Schliep, of Baden-Baden, on atmospheric electricity and its influence on animal and vegetable life. Prof. Perry has called attention to the work of this scientist, but we do not remember to have seen before his views so fully expressed as they are by Dr. Wilson. Dr. Schliep is of opinion that when the atmosphere is positively charged with electricity considerable beneficial results are experienced by human beings and animals, while a negative charge is injurious to health. He states that in the cholera epidemic it was noticed that the atmosphere was negatively charged. The exact opposite is recorded with respect to plant life. Dr. Schliep remarks that our bodily processes and functions are favoured in their performance by positive electricity, which stimulates the bodily mechanism. The negative electricity, on the other hand, acts as sedative in character. Dr. Schliep describes it as "tiring." But while positive electricity stimulates, it may cause sleeplessness, or may even irritate the nervous system in some cases and produce neuralgia, this probably being the result of over-stimulation. The effect of negative electricity on plants is, according to the scientist, astonishing, and he states that heavy thunderstorm weather makes plants sprout and grow amazingly, and experimentation proves that this growth is due to the effects of negative electricity. When plants are subjected to the influence of this latter phase of the energy, they flourish at the negative pole and exhibit a falling off at the positive pole. The researches of this gentleman are very interesting, and when published by him in full will no doubt be widely read.

Solid Hydrogen.—At the Royal Institution on Friday last Prof. Dewar delivered a lecture on "Solid Hydrogen," in which a number of most interesting experiments were shown. He pointed out in the commencement that it was expected that solid hydrogen would have been metallic in character, but that Prof. Odling had predicted that this would not be the case. Experimental evidence had now been obtained to support Prof. Odling's conclusion. Prof. Dewar proceeded to explain, by means of a long series of experiments, the physical properties of liquid hydrogen, and showed how essential it was to have a reasonable quantity of it for experimental purposes. The difference in behaviour of liquid nitrogen and liquid oxygen was then explained experimentally, the lecturer showing that while nitrogen became viscous and ultimately solid when evaporated under diminished pressure, the same process did not solidify liquid oxygen. He next showed how hydrogen could be liquefied in a closed tube, and explained the importance of this in ascertaining the density and other physical properties of the liquid. He then proceeded to convert a portion of the liquid hydrogen into a solid by slowly reducing the pressure in the vessel. The hydrogen was suddenly seen to assume a white and solid form, the temperature obtained by the process being 256deg. below zero Centigrade. Alluding to the advantages of liquid hydrogen for scientific research, Prof. Dewar commented on the fall in the electrical conductivity of metals at very low temperatures. From experiments with liquid air it was expected that at the zero of absolute temperature pure metals would have no electrical resistance at all. Prof. Dewar had found, however, experimentally that while the resistance curves were straight and pointed to the absolute zero at the temperature of solid air, a sudden change in the curve occurred, so that there seemed to be a finite specific resistance below which one could not go. The lecture was much appreciated by the audience.

Royal Meteorological Society. — The Royal Meteorological Society celebrated its jubilee on April 3, and, in consequence, a commemoration meeting was held in the afternoon at the Institution of Civil Engineers, Dr. C. Theodore Williams in the chair. There was a large attendance, including delegates from a number of other scientific societies. In view of the jubilee the late Mr. G. J. Symons, F.R.S., was elected president at the annual meeting in January, but owing to illness he was obliged to resign the office. Mr. Symons had, however, prepared an address giving a brief history of the society, which Dr. Williams read, and added some remarks of his own in appreciation of Mr. Symons and on the work of the society. Mr. Symons stated that the first English meteorological society was founded in 1823, but it died. A second society was formed in 1836, which was also short-lived. The present society was founded on April 3, 1850, by Mr. James Glaisher,

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F.R.S., and was called the British Meteorological Society, but in 1866, when a Royal charter was obtained, the name was changed to the Meteorological Society. In 1882, her Majesty the Queen accorded the society permission to adopt the prefix "Royal." Dr. Williams, in concluding his address, stated that Mr. Symons had bequeathed to the society £200, as well as the bulk of his large and valuable library. Brief congratulatory addresses were delivered on behalf of the Royal and many other scientific societies. In the evening a conversazione was held at the Royal Institute of Painters in Water Colours, in Piccadilly, the guests being received by the president and Mrs. Theodore Williams. An exhibition of meteorological instruments, etc., was arranged in the banqueting-room, and lantern demonstrations were also given. The Royal Artillery string band played during the evening. On Wednesday a large party of the Fellows were shown over the Royal Observatory, Greenwich, by the Astronomer Royal, after which they paid a visit to the Painted Hall and Naval Museum. On Wednesday evening a dinner was held at the Westminster Palace Hotel, which was well attended, the president being in the chair.

Slow-Speed Engine Design.—We have referred to Mr. A. Marshall Downie's paper read before the Glasgow and West of Scotland Technical College Society on the "Design of Slow-Speed Engines." We have now had the opportunity of reading the full text of the paper, and can recommend it to all interested in engine design. While Mr. Downie does not put forward any striking innovations in the design of steam-engines, he has collected some most useful information on the subject, and has put the same forward in a way which enables the whole subject to be reviewed in a profitable manner. He particularly considers the case of the slow-speed engine to be used for either electric lighting or for driving a traction generator subjected to widely varying loads. He gives a list of the sources of loss in steam-engines, special stress being laid by the author on wire-drawing, on initial condensation, and on radiation losses. He also treats, in passing, of incomplete expansion before release, incomplete compression before admission, and of the leakage of steam past the piston. After all, the largest source of loss in a steam-engine is very apt to be that of initial condensation. Mr. Downie reviews past experiments made with a view to ascertaining the proportion of heat lost in this way, which, he states, varies from 25 to 80 per cent. The question of dividing the expansion up amongst several cylinders is explained, and the author considers at length the advantages derived from superheating the steam before its admission into the cylinder. When considering the arrangements of the parts of steam-engines, the advantage of a two-cylinder arrangement with the flywheel and electrical generator between the two cranks is shown to be a good arrangement, and the author sarcastically refers to the primitive method of guarding against eccentricity of the armature and field ring by making the crankshaft and its bearings of enormously great diameter. With such an arrangement working with a compound engine Mr. Downie considers that a steam pressure of from 150 to 160 is as high as is economical. He also adds that it is advisable to give a greater range of pressure to the low-pressure cylinder, as the proportion of volume to wall surface is greater in that cylinder, or, in other words, the initial condensation is less. The part of the paper dealing with the materials used in the construction of first-class engines can be read with profit by the American engine makers who export to this country. On the question of governing, the author advocates the most careful detail in design, and refers to actual results obtained with both the crankshaft and the pendulum types. He points out that, in order to use the Corliss type of valve gear, it is practically impossible to have a governor of the crankshaft type. We do not see any reference in the paper as to the vexed question of the permissible variation in speed during one revolution, which is an essential consideration when the steam-engines have to be used to drive in parallel with the rotary converters on the system.

Constant and Fluctuating Magnetisation.—Messrs. E. Gumlich and Erich Schmidt contribute an article to the *Elektrotechnische Zeitschrift*, which considers at some length the difference between constant and fluctuating magnetisation. The ballistic method of examination of magnetic materials is based on the measurement of instantaneous current flow which occurs in a secondary coil surrounding the rod to be tested when the current flowing through the magnetising coil is varied by a known amount. The result of the measurement may be rendered more accurate, say the authors, by the investigation of an ellipsoid with the magnetometer. The magnitude of the change in magnetic field embraced by the exploring coil depending, of course, upon the construction of the yoke piece and of the rod to be tested, as well as upon the degree of magnetisation attained. But even when conducting measurements with the magnetometer use is frequently made, for convenience' sake, of such resistances which enable only a jerky variation of the current strength to be made. The results obtained are therefore free from error only if the magnetic condition of the material corresponds with the condition obtained with a steady change of the field strength, instead of being dependent upon the magnitude of the variation employed. This is, however, by no means certain, since it is not safe to assume that a jerky variation of the magnetising current has not an effect on the molecular condition of the rod. At the same time it has been proved by numerous experiments that, at any rate, with soft material, a mechanical strain during the process of magnetisation results in an increase of permeability and also a decrease of the hysteresis loss and of residual magnetism. In order to avoid error in the measurements which might result from these phenomena, the authors have devised a method of procedure in conducting their experiments which they describe in detail. A rotary ellipsoid constructed of repeatedly annealed Swedish cast steel and another of unhardened Remscheider steel, both of the dimension $2a = 33\text{cm.}$, $2b = 0{\cdot}8\text{cm.}$, are magnetised in a coil, and the deflections of the magnetometer mirror observed through magnifying glasses. The observations are always made after the electric street cars have ceased to run for the night, the resultant error with a maximum deflection of about 450 divisions of the scale scarcely exceeding a tenth of a division. The authors give numerous interesting comparisons in tabular form, the method of measurement being fully explained. These comparative measurements are very instructive, and the deductions therefrom are summed up as follows. The magnetic condition, as regards soft material, is influenced in the same way by a jerky variation of the field intensity as by hammerblows administered externally. Whilst the maximum induction with high field intensities is not appreciably changed, the residual magnetism, coercive force, and the consumption of energy, on the other hand, decrease in proportion to the size of magnitude of the sudden variations. The deviations from the corresponding values obtained with constant magnetisation cannot be neglected when exact measurements for soft material are concerned, whilst with hard material they do not appreciably exceed the magnitude of the error of observation.

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DONCASTER ELECTRICITY SUPPLY WORKS.

(Concluded from page 476.)

We may now proceed with the description of the boiler-house equipment. This consists at present, as previously mentioned, of three boilers only. They are of the Lancashire double-flued type, by Messrs. Tetlow Bros., of Oldham. Each has a length of 28ft. and an internal diameter of 7ft., the flues being of 2ft. 9in. internal diameter. The working pressure of these boilers is 200lb. per square inch. Hopkinson's patent fittings are provided throughout. Feed water is obtained from what are known as the old river mains, which are distinct from the ordinary service mains, and supply the town with water for street sprinkling and flushing purposes. It is river water pumped from the Don, without filtration or other treatment. Before entering the boilers the water passes through a feed-water heater of 150 n.h.p., shown in Fig. 4, whence it is pumped to the boilers by the motor-driven pumps, shown in the same illustration. This heater is capable of supplying 1,500 gallons of water per hour to the boilers at a temperature of 200deg. F. It is situated, together with the feed pumps and service tanks, in the condensing-room, marked on the plan of the station buildings (Fig. 2). The two feed pumps are electrically driven by separate motors. Each is capable of delivering 3,000 gallons of water per hour, either direct into the boilers or through the feed-water heater mentioned above.

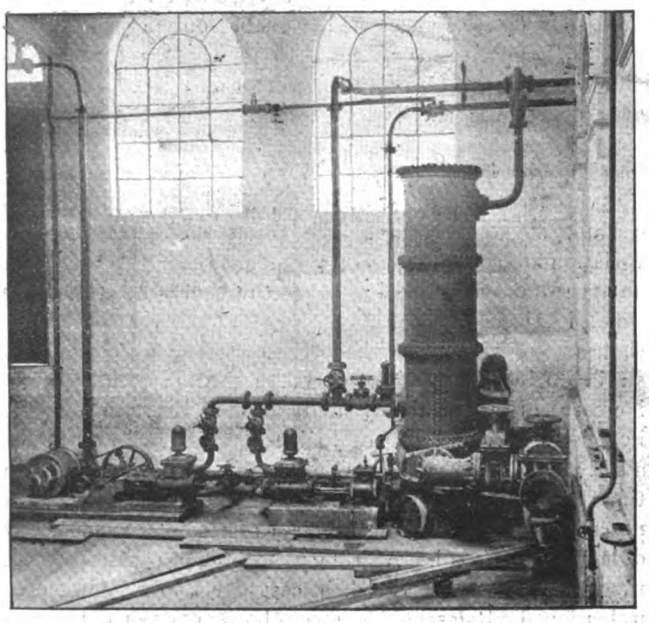

FIG. 4.—Feed Water Heater and Feed Pumps, Doncaster.

The accompanying illustration shows the arrangement of the steam-pipes, which are all fixed with a fall towards the boilers. No condensers are yet installed, Mr. Shoolbred deeming them of doubtful advantage for a small plant, though provision has been made for working the engines in conjunction with condensers when the anticipated extensions justify the expenditure involved. Meanwhile the feed-water heater will be employed as described. Besides supplying steam to the engines, the boilers will supply live steam in winter to an extensive system of heating pipes fitted throughout the buildings; also for heating the public baths situated across the road. A view of the boiler, showing the mechanical stokers, by Vicars, and conveyor platform in course of erection, is given in Fig. 5.

With regard to the engine-room equipment, this comprises five sets of steam dynamos. The engines are of two outputs, three of them being capable of indicating 90 h.p. each when running at a speed of 450 revolutions per minute with a pressure in the steam-chest of 180lb., while the other two indicate 240 h.p. each when running at a speed of 380 revolutions per minute with the same pressure in the steam-chest. All five engines are of the triple-expansion, inverted, vertical condensing type by Messrs. Willans and Robinson, Limited. To each of the smaller engines is coupled direct a shunt-wound dynamo of 56 kw. capacity (224 amperes at 250 volts terminal pressure) under the above conditions of working. The dynamos coupled in the same manner to the larger engines are also shunt-wound, and give an output of 150 kw. (300 amperes at 500 volts terminal potential) each. Both sizes of dynamo are of Messrs. Mather and Platt's well-known multipolar type. The smaller machines are capable of giving 310 volts for the ordinary charging of the accumulators, but for the first charge of the same they are capable, at an increased speed of the engines, of giving a pressure of 331 volts, with a corresponding diminution in the ampere output, being at the same time wound so as to allow of the pressure being reduced to 230 volts, with a corresponding reduction both in speed and output. The larger machines are capable of giving 550 volts if necessary. Fig. 6 gives a view of the plant already in position; this occupies a very small portion only of the total engine-room area. An overhead traveller, capable of lifting six tons, runs the length of the engine-room.

The switchboard, which occupies the position in the engine-room shown in Fig. 7, was supplied by Messrs. James White, of Glasgow. It is arranged to work on the low-tension three-wire system, with 460 volts between the outer conductors, and to deal with current from the three

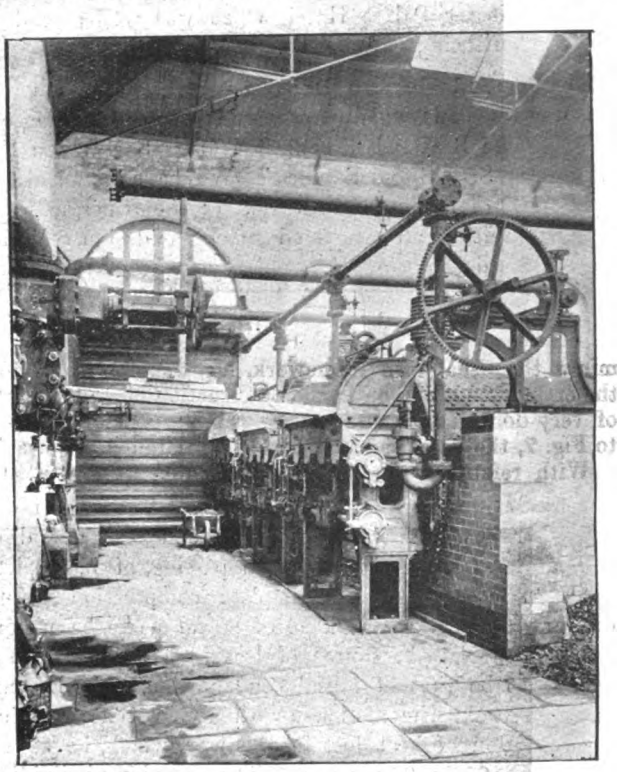

FIG. 5.—Boiler-House, Doncaster.

56-kw. dynamos and two 150-kw. dynamos described above. The board is divided into three sections—positive side, negative side, and middle-wire panel. Each side is arranged for six feeders, and regulators are provided for two batteries, one on each side of the middle wire. In circuit with each dynamo is one of Ferguson and White's minimum automatic cut-outs, an ampere-gauge, and a fuse. These fuses are mounted on porcelain carriers, and can be used as switches in case of emergency. On the left hand negative panel are provided, the dynamo field-regulating switches of the circular type with light handwheels, and above these are the dynamo voltmeters. On the top half of the panels are the necessary dynamo and feeder bars, connecting to the service bars on the back of the board by means of screwed copper plugs. Each feeder is provided with a duplex fuse and switch, and in circuit with it is one of Lord Kelvin's edgewise ampere-gauges of the plunger type. On the middle-wire panel are fitted feeder voltmeters of the Kelvin multicellular electrostatic type, two bar voltmeters, voltmeter switches, as well as a middle-wire ammeter, and a Kelvin earth-current recorder provided with an automatic short-circuiting switch. The panels of the board are of enamelled slate carried in a polished teakwood frame, a spare positive and spare negative panel being provided for future extension. The fact of the

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several panels comprising the board being perfectly distinct from each other of course minimises the danger of a short-circuit, besides which it should be noted that the board is

capacity of 750 ampere-hours, and is capable of discharging at the rate of 150 amperes for five hours consecutively, or for one hour at a maximum discharge rate of 400 amperes

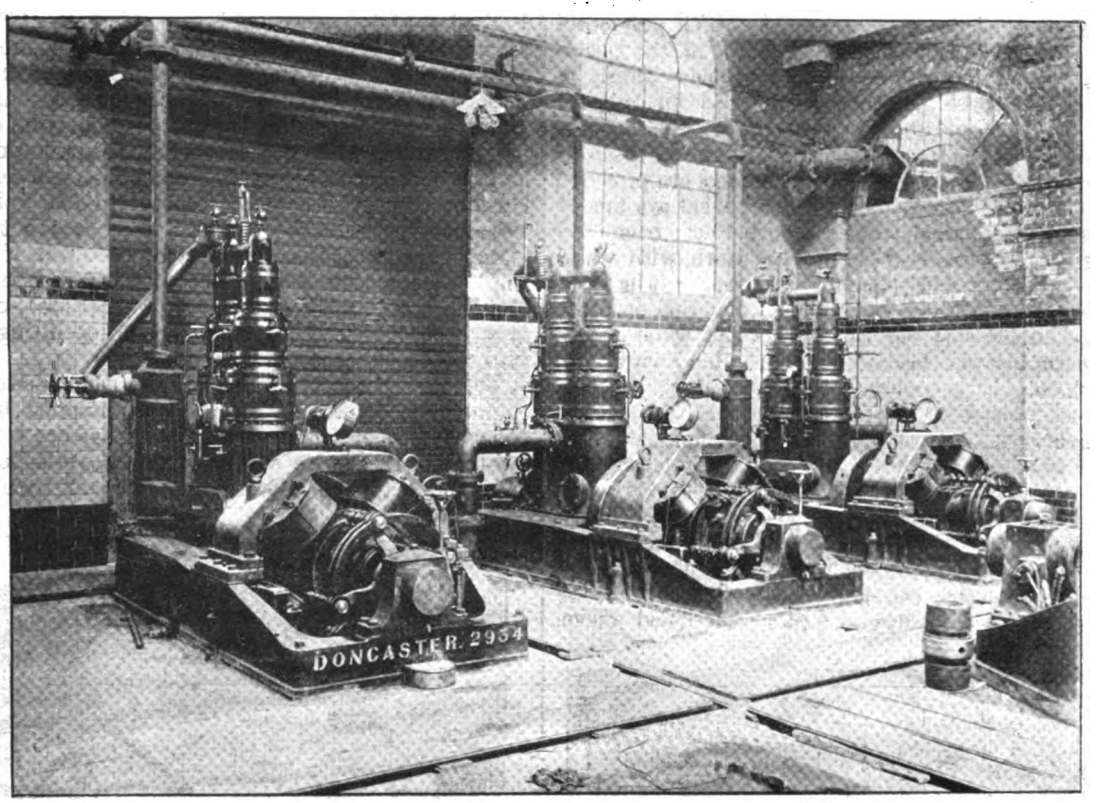

FIG. 6.—Engine-Room, showing Three Smaller Steam Sets, Doncaster.

minus the usual iron framework, Mr. Shoolbred deeming the employment of iron in the construction of switchboards of very doubtful advantage. As will be seen on reference to Fig. 7, the board is of very neat appearance.

With reference to the storage battery (Fig. 8), this

at 250 volts. All connections are of copper rod, as shown, except to the switchboard, near which the copper rod conductor of the regulating-cell connection gives place to stranded copper cable of equal sectional area to the copper rod replaced.

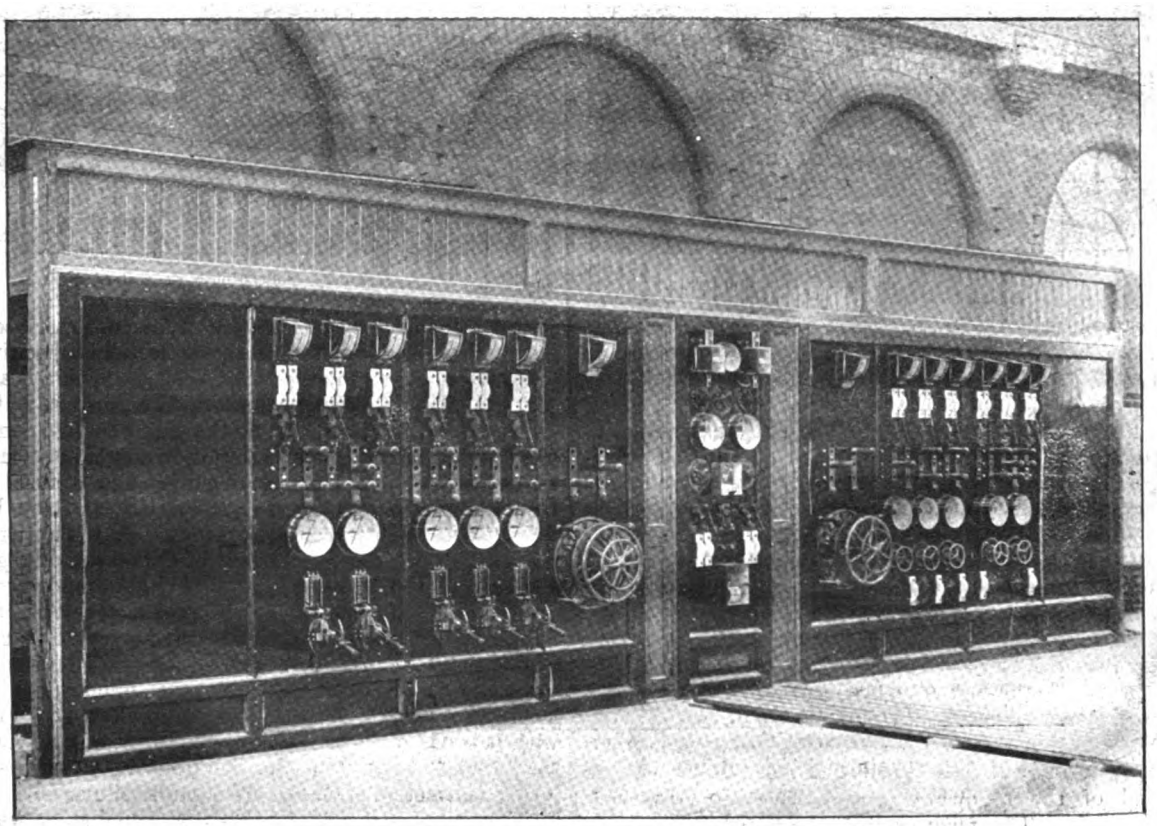

FIG. 7.—Elevation of Switchboard, Doncaster.

was supplied by the Electrical Power Storage Company, Limited, and consists of 136 of their K^{ws} 34-plate cells enclosed in wood lead-lined boxes. The battery has a

From the main switchboard are laid three three-wire feeders to the three feeding points, marked in Fig. 1, situated at a distance from the generating station of 1,250 yards, 650

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yards, and 850 yards respectively. These feeders, together with their pilot wires, are single lead-sheathed fibre cables. They are laid in wooden troughs, and are disposed in two tiers, the three cables comprising one feeder being placed in the bottom of the trough, while the three corresponding pilots form the top layer. The cables are separated from each other by means of bridges, and the whole trough is run in solid with bitumen. The respective sizes of the feeders are as follows: ·7, ·4, ·7; ·6, ·3, ·6; ·6, ·3, ·6, while the pilot wires are $^{7}/_{.038}$ in each case. The distributors are lead-sheathed steel-armoured cables of the single-conductor type, and of the following sections—viz., ·2, ·15, and ·2 square inch. The feeding and network boxes are of the single-pole type, and so placed that any street in the town can be entirely isolated if necessary. Where any cables cross the roadway, brick culverts have been constructed, provision being made at the same time for pulling in further cables without disturbing the road. The whole of the main work was executed by the Callender Cable and Construction Company, Limited. Fig. 9 gives an idea how the main-laying was conducted in Doncaster under the supervision of the firm's engineer, Mr. W. C. Knight. Our last illustration (Fig. 10) shows the exterior appearance of the generating station buildings.

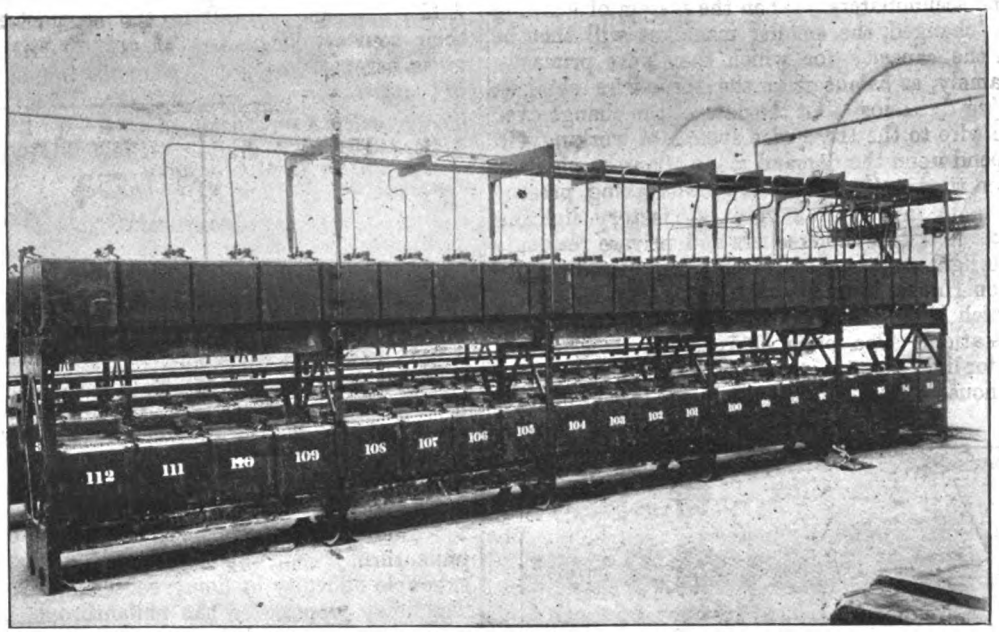

FIG 8.—Battery-Room, Doncaster.

Although the mains, together with the station switchboard, have been arranged throughout for the three-wire system of distribution, it is, nevertheless, proposed to run the station temporarily on the two-wire system. To enable this, the outer conductors of each feeder are joined up in parallel at the station switchboard. The object of the arrangement is, of course, to ensure economical working of the station during the early days of its existence, for with a two-wire system of distribution the smaller dynamos, generating at a terminal pressure

FIG. 9.—View of Main-Laying as conducted at Doncaster.

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corresponding to 230 volts at the consumers' lamps, supplemented by the battery of accumulators previously described, are likely to suffice for the requirements of Doncaster, apart from the proposed traction work, for some little time to come. The smaller sets, as we have seen, are also quite capable of furnishing the requisite charging E.M.F. for the accumulators. When the system of working is ultimately changed, the smaller machines will then be employed in the capacity for which they were primarily intended—namely, as balancers on the three-wire network and as charging dynamos. But the date of the change over from the two-wire to the three-wire system of working will naturally depend upon the demand made upon the plant.

With regard to the prospects of the undertaking, present indications are in favour of a very satisfactory lighting load being obtained, the shopkeepers and private residents taking up the light well, not to mention a proposed supply to the Mansion House, Municipal Offices, and other public buildings, which should make a welcome addition to the load on the station. The price charged per unit to consumers is 5d. for light and 3d. for power. No meter rents are charged and house connections are also made free of charge.

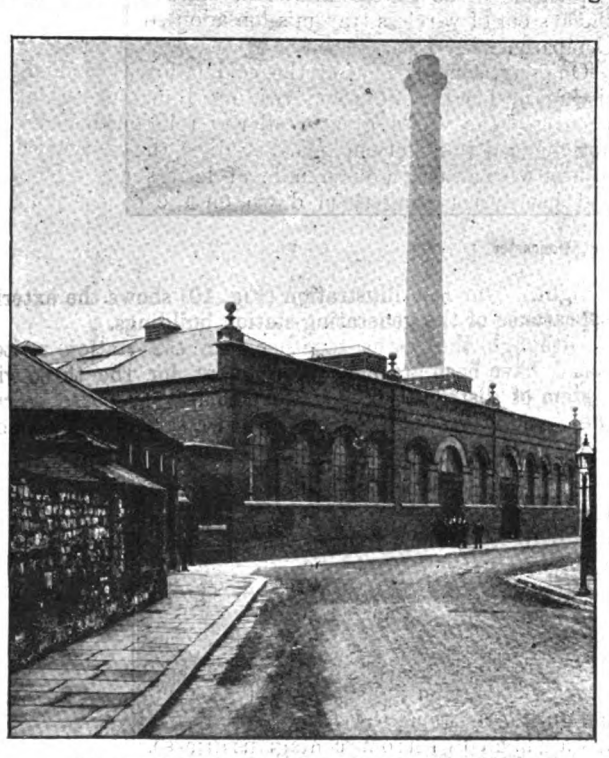

FIG. 10.—Exterior View of Station Buildings, Doncaster.

There is no street-lighting at present, though we understand that later on, when the proposed tramway scheme assumes a more definite shape, it is intended to suspend arc lamps from the trolley masts erected in the principal thoroughfares of the town. Mention has already been made of this tramway scheme, powers to carry out which were obtained by the Corporation under the Light Railways Act of 1897, it being intended to proceed with the laying and equipment of the track for the overhead trolley system of working as soon as the supply of current to consumers from the generating station is fairly under way, and sufficient progress has been made with the instalment of the traction plant now on order. It is, however, a misnomer to call the proposed lines tramways, since they will constitute a system of light railways, establishing communication with the several outlying townships of Bentley, Balby, Hexthorpe, and Wheatley, for the carriage of goods as well as passengers. The gauge of track will be 4ft. 8½in., while the total length of line contemplated amounts to seven miles. It is proposed to erect car sheds in close proximity to the generating station buildings. Mr. Shoolbred hopes that the present generating station will eventually form an important link between this system of light railways and the waterway behind the station. He proposes to adapt the coal conveyor described above for the transport also of other goods or materials from the river barges through the boiler-house to railway trucks outside. This idea, if put into execution, would prove an interesting, not to say novel, development of the undertaking, and we see no reason to doubt its feasibility.

In conclusion, we have to thank the consulting engineer to the Corporation, Mr. James N. Shoolbred, C.E., together with the resident engineer, Mr. Carl A. L. Prusmann, A.M.I.E.E., and several of the contractors concerned, for their courtesy in placing at our disposal the particulars given herewith.

THE "IDEAL" ELECTRICITY SUPPLY COMPANY, UNLIMITED.

(Incorporated 1910.)

BY R. M. W.

As a result of the general dissatisfaction which had been for some time expressed by the public owing to the unsatisfactory nature of the supply of current obtained from the electricity supply companies in London, a new company was formed upon entirely novel lines, having for its object the supply of electricity under such conditions as to give even the most confirmed grumblers no reasonable cause for complaint.

The company had for its directors men who were anxious to spend their superabundant fortunes in the cause of philanthropy, and who had (like Mr. Carnegie) found considerable difficulty in doing so through ordinary channels. The lucky proposer of the philanthropic electricity supply scheme was rewarded most lavishly for his idea, the delighted financiers at once recognising that there would not be the slightest difficulty in getting rid of their superfluous funds in a scheme of this nature, although all the other schemes formerly tried by them had not been successful in doing more than relieving them temporarily of only a small part of their monetary incubus.

The new company was fortunate in obtaining for their head engineer an ex-chief in the mercantile marine, who had added to his numerous accomplishments a wonderful knowledge of and insight into the art of recrimination as practised in many countries, both civilised and uncivilised.

The necessary parliamentary powers were obtained, and the new works erected about 50 miles out of London, with all the latest apparatus to ensure the supply of energy to consumers, so that there could be no possibility of the pressure fluctuating more than ¼ of 1 per cent. either way. It was assumed that a fluctuation within these limits would not be felt, except, perhaps, in the editorial departments of electrical journals, but the directors did not feel justified in setting up for their staff a higher standard than they could be quite confident of maintaining under all conditions.

The distribution was carrried out on the very latest etheric system, without conductors, which had been perfected by an American inventor shortly before the flotation of the company. A shaft was sunk in the boiler-house yard, it having been ascertained that there was an almost unlimited supply of coal immediately below the site adopted for the station. This enabled the company to give a supply at rates which had hitherto been considered absolutely impossible. It was agreed to charge ordinary consumers 1d. per unit for three hours' maximum demand per day, and to pay these consumers at the rate of 2d. per unit for all current consumed over and above that amount. For heating and power purposes consumers were supplied with current free, as a good day load was absolutely necessary to keep the ether in an ionised condition, ready for the time of heavy load in the evening. Also, consumers guaranteeing to use current at the rate of their average maximum demand for more than 24 hours each working day were paid 6d. per unit for all energy supplied. Churches, hospitals, homes for waifs and strays, and all deserving charitable institutions were paid at such liberal rates for all current used that they became almost self-supporting from this source alone. The system of charges adopted was carefully worked out by the company's chief engineer, who was the only man living who could understand it. There were some uncharitable people who even denied that *he* understood the system, although the allegation was manifestly absurd. Lamps were

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connected to such an enormous extent that the company's etheric mains became overloaded one week after supply was commenced. The chief engineer, however, after giving the matter his profound consideration, and giving his confidential clerk an admirable exposition of the manner in which a Russian bargee addresses the representative of a rival company who has just "bumped" his stern, solved the difficulty. His theory being that the ether was in some way becoming dissipated by the passage through it of so much electrical energy, he conceived the happy idea of leading a pipe 10 miles up by means of a captive balloon. By this means he obtained an unlimited supply of ether, and then things went on smoothly as before.

However, the apparently faultless arrangements of the station were completely upset by a strike among the miners who worked the private mine attached to the station, for an immediate advance of £1 per day in their wages. As this could not be done without first summoning a meeting of the directors, the chief was confronted with the fear of allowing perforce his supply pressure to fall. Nothing daunted, he addressed the deputation from the miners, and after giving them a scintillating exhibition of Hindostanee repartee, in which he assailed them with terms which were the reverse of complimentary to their maternal relatives, he sent them away wondering greatly, yet on the whole well pleased, for your average twentieth-century collier can appreciate "a man full of strange oaths." However, they refused to start work again, and the chief in sorrow, after burning all the coal to be had at the pithead, commenced to burn all the woodwork which he could lay his hands upon. After burning up the wood partitions, office furniture, and the available oil about the station, the chief, with genuine tears in his eyes, gave orders to send for his own private furniture from his house, which was situated near the station. Anxiously watching the clock to see if the emergency supply of coal (which had been aerographed for) would arrive in time to save at least some of his household gods, he walked backward and forward between the switchboard and the boiler-house watching the voltmeter needle as it crept down almost one volt below the mark which indicated the standard pressure. The chief, with averted gaze, but watching the firemen with the corner of his eye, gave orders to start to his wife's favourite Chippendale drawing-room suite, and as chairs, tables, couches, and ottomans one by one disappeared into the roaring furnaces his wrath gradually reached a climax, and he mentally recalled all the heated conversations which he had heard during his sea-going days, from the pleasantries of the London dock labourer when a craneman lowers a heavy crate on his foot, to the sulphuretted epithets used by a Yankee river pilot when he narrowly misses colliding with a pleasure boat without lights on a dark night.

Just as the chief was ready primed to open out with all his guns on the first unfortunate who afforded him a target, the sub-editor of the *Searchlight* (a leading London electrical weekly) rushed into his arms, and flourishing a chart from a recording voltmeter in the eyes of the seething chief, he commenced to state his grievances. The chief listened in silence for about 10 minutes, then he turned upon the astonished sub-editor, and having opened up by way of a preamble with something that the latter could understand—viz., addressing him as a "multifaced, Heavy-sided, short-circuited idiot"—he rang the changes on his almost inexhaustible stock of epithets till the whole station staff gathered round him in open-mouthed admiration. In masterly style he anathematised the sub-editor, touching on his ancestry in a feelingly personal manner, and having cursorily run over his neglected education, and criticised his personal appearance, he reeled it off for 35 minutes (by the storekeeper's stop watch), not minding the fact that the unfortunate "sub" had fainted dead away at the end of the first 10 minutes, but passing on to the editor-in-chief of the *Searchlight*, and attending to the whole staff of that journal, down to the very office boy.

When at last the chief stopped, the members of his staff shook hands with him in silence, but with a quite apparent heartfelt admiration for his powers which was too deep to be expressed in words. From the chief assistant to the lowest greaser they accorded their silent tribute, and after having done so they turned the boiler-house hose on the insensible sub-editor, and having roused him up in this fashion, they sent him on his way, a sadder and a wiser man.

The premium pupil, who told me the story, said that he never forgave himself for missing the treat, but he was at the time very busy at a piece of private consulting work, getting out a specification for a scheme of electric heating for his father's poultry-run. His father was one of the company's directors.

The visit of the *Searchlight's* emissary had a salutary effect, as the miner who had been leading the deputation of strikers happened to be hanging around the boiler-house door, and was so overcome with admiration at the chief's masterly treatment of an abstruse subject that he prevailed upon his fellow-strikers to recommence work there and then.

The staff of the *Searchlight*, however, determined to get even with the "Ideal" Company by fair means or by foul, "preferably the latter," said the sub-editor, when discussing the matter in his chief's sanctum. With this in view they requisitioned the services of the expert who had perfected the system of wireless transmission adopted by the "Ideal" Company.

One day, some time after the coal failure, the chief was sitting in his private room reading Bunyan's "Pilgrim's Progress" (he was a great reader of religious books when not engaged in his etymological studies), the secretary came to him with an enormous bundle of letters and telegrams, and hastily throwing them down on the chief's table, he precipitately left the room. The chief reluctantly laid aside his book, and proceeded to look over the communications. As he did so his expression became a sight to see. Every letter and telegram was a complaint from a consumer that the supply of current had completely failed, and several of the complaints were couched in language which the chief could not but admire, although at the same time he bitterly resented it. The chief was utterly at a loss to account for the failures, as the plant was all loaded as usual and the station wattmeters all showed their usual daily reading, yet here was a number of complaints which, if true, would almost represent the failure of the whole supply. The staff deliberated and the London section was communicated with, but nothing could be found at fault either at the station or at the consumers' connections. Experts were called in and tests made, but not a fault could be discovered, and still the plant was running away just as usual, though not a single consumer could get current from the company's distributing system. This went on for a week, and during that time the chief was shunned by the staff as if he was afflicted with some contagious disease. One day, however, the chief received a message stating that the supply was all right again, and that a fire had taken place in the offices of the *Searchlight*, which had been burnt to the ground. After this the supply was kept up as before, and the consumers obtained current as if no stoppage had occurred. The chief brooded over the affair for weeks, and then at his instance legal proceedings were instituted against the proprietors of the *Searchlight*. It was discovered that the American wireless transmission expert had at their instigation erected a receiving apparatus in their premises which intercepted all the current proceeding from the company's supply station. The energy thus intercepted had been dissipated by means of a very large resistance in the editorial premises, which had been the cause of the destructive fire which took place there.

The editor of the *Searchlight* was sentenced to two years' imprisonment for his share in the matter, and the wealthy directors of the "Ideal" Company ran a Bill through Parliament constituting the interception of electrical energy passed through the ether a penal offence. They also wisely offered the American expert a handsome retaining fee to act as consultant to the company, which offer he accepted. The chief's salary was trebled and each member of his staff received a substantial increase in his remuneration.

After that all went smoothly with the "Ideal" Electricity Supply Company, Unlimited, and the chief pursues his studies of theology and the science of "remonstrating" in peace and quietness.

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INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on the 5th inst., the President announced that extra meetings would be held on May 3 and 17 at the Institution of Mechanical Engineers.

Mr. E. J. Wade then replied to the discussion on his paper on "Storage Battery Problems." He stated that he must thank them for the leniency with which they had received some of his views even when not agreeing with them, for he was painfully aware that in advancing new theories not supported by more direct experimental evidence, he could not have complained had they been subjected to much severer handling. The first point he would deal with was the doubt expressed by Mr. Swinburne and Mr. Cooper as to the need for further attempts to explain what went on in lead cells. Had not the matter already been substantially threshed out and stated in its simplest terms, and was he not merely setting up imaginary difficulties in order to knock them down again with ingenious and complicated arguments? This question was most vital to the whole scope and purpose of the paper, for were the answer in the affirmative, he would stand convicted of having most unnecessarily occupied the valuable time of the Institution. Mr. Cooper thought that if secondary cells had only been used as primary cells, there would not have been all this bother about them. Possibly there would not. As long as their employment in the engineering and electrical world had been limited to that of primary cells, the general statements already available might have been quite sufficient for all practical purposes, but the speaker thought they might rather reverse Mr. Cooper's dictum, and say that if primary cells had been born secondary cells, many of the accepted explanations regarding them would long ago have had to be overhauled and far more explicitly stated. Mr. Swinburne considered that the discharge of a cell could be expressed, so far as the electrodes were concerned, in terms of the formation of normal lead sulphate, and that the cell's behaviour could in all respects be reconciled with that assumption. Here they came to what was, and always had been, the crux of the whole matter, and he had stated in his paper the chief and, to his mind, fatal objection to that view, where it was stated that "normal lead sulphate is probably quite irreducible, if not unperoxidisable, in a dilute sulphuric acid electrolyte of the strength ordinarily used in storage cells, provided all the materials are absolutely pure, for the smallest traces of impurities make a remarkable difference in this respect. But however that may be, there is no doubt as to its being acted upon with extreme slowness, under the most favourable conditions in admixture with other materials of a more conductive nature, and then only with an excessive outlay of energy in proportion to the result obtained; whereas both the active materials can be brought back to their original states of lead and lead peroxide with great rapidity and the expenditure of very little more current than is theoretically necessary. This discrepancy, as well as the almost complete masking of other properties of the normal sulphate, can hardly be explained as due to its state of extreme subdivision and intimate admixture with unaltered active material, for under certain well-known conditions of treatment it does appear in full possession of its distinctive colour and with its non-conductivity and irreducibility aggressively in evidence." Before writing that he had carefully considered all the experimental evidence bearing on the subject, and he did not think he had said anything that could not be justified. The most debatable part referred to the reduction of normal lead sulphate. Both Lord Kelvin and Dr. Lodge were unable to reduce lead sulphate electrolytically. Then Messrs. Gladstone and Tribe obtained its reduction, and later on Mr. Swinburne also found that it would reduce. But meanwhile Dr. Lodge, aware of the results obtained by Messrs. Gladstone and Tribe, carefully repeated his experiments and still could not reduce the pure sulphate. The speaker had several times tried to reduce it electrolytically without success, but, as before mentioned, had found that the result might be very easily modified by the presence of impurities. It appeared to him that all the evidence was against the possibility of the normal sulphate being either reduced or peroxidised with anything approaching the rapidity and efficiency with which these operations were performed every time a cell was charged; and he maintained that, if for no other reason, this alone would render it necessary to somewhat modify or supplement the usual explanation. At present they tried to explain the reaction of lead with sulphuric acid as if it were an exactly similar one to that of zinc and sulphuric acid, whereas there was an essential difference between them. In the latter case the resultant compound was a soluble one—that was to say, the molecules of zinc taking part in the reaction passed into solution and their relations with the remainder of the electrode were thereby entirely ruptured. But in the case of lead, the sulphate being insoluble, the lead molecules did not acquire the same freedom of motion, and were unable to change their position. This being so, it seemed extremely probable that, besides reacting with the sulphion ions in the electrolyte, they also remained in feeble and unstable combination with other lead molecules in the active material, and this was what the view he had ventured to put before them practically amounted to. He need hardly remind them that the question to be decided was not which was the simplest theory, but which was the true one. It was no use sticking to a simple theory on account of its simplicity if it did really explain the facts. At the same time he did not think, if properly looked at, that his account of the cell's reactions was really more complicated than the one generally accepted. All he proposed was that for any given output, instead of saying, as they should in the case of a zinc electrode, that so many molecules had been fully converted into normal sulphate, they should say that the whole number of molecules in the electrolytic circuit had passed through a certain degree of sulphation. He thought, perhaps, in his paper by assuming for illustrative purposes lead molecules of a specified constitution and working out a formidable series of compounds on that basis he had chosen a rather clumsy method of expressing himself, and had obscured his real meaning. If he had merely given the general case in the form of an algebraical equation, it would probably not have appeared nearly so complicated. Dr. Armstrong put the query as to whether the sulphated compounds really helped matters much, because they had to be assumed of such very unstable constitution. No doubt in some ways it must appear something of a quibble to attach so much importance to the difference between an extremely intimate mixture and an extremely feeble compound, but, all the same, the two phrases served as the basis for two entirely distinct lines of reasoning, and he thought that very important differences of physical structure and properties might sometimes result from most insignificant alterations of chemical equilibrium. As he had been somewhat reproached with introducing unnecessary complications into an extremely simple problem, he was very glad to hear someone who could speak with so much authority as Dr. Armstrong calling attention to the fact that there were other complications connected with the formation of lead peroxide and the changes occurring in the electrolyte, of which he had practically taken no notice at all. This was simply due to his endeavour to leave out everything that did not directly bear on the special points he wished to bring before them, but it was as well they should be reminded how much obscurity was still attached to what was, after all, the fundamental action in a storage cell—the electrolysis of dilute sulphuric acid. Mr. Hibbert had given several reasons for not considering the active materials to be in an allotropic condition. Of course, so far as he had obtained results opposed to those of Darrieus, he weakened the positive evidence in favour of allotropy, and, as was generally the case in all attempts to clear up those matters, they were left in the puzzling position of having to decide between conflicting data. The speaker, however, did not think his other two reasons applied to the case. He should certainly expect spongy lead precipitated from solution by zinc to give the same E.M.F. effects as ordinary negative active materials, for he believed lead obtained by all such processes to be in an allotropic state, and did not think there was any electrolytic method, such as the one in question essentially was, by which lead could be deposited in a normal condition, corresponding, for instance, with ordinary electrolytic copper. As to the comparison of the specific resistances of electrolytically and chemically prepared lead peroxide, he doubted the possibility of any conclusions bearing upon the question of allotropy being drawn from Dr. Shield's experiments on these substances in the form of compressed powders. The measurements were only incidental to an investigation carried out with quite another object, and the results would probably vary with every difference in the degree of pressure and the size of the particles of which the powders were composed, and the precise electrolytic powers by which the peroxide was procured. As it was, the results showed a difference in resistance of over 15 per cent., which might equally well be construed in favour of allotropy as against it, but had the difference been 50 per cent., or nothing at all, he should, under the circumstances, attach no value to it. He was sorry to find that the portion of the paper relating to the necessity for increasing the porosity of the active materials and the rate of diffusion into them, had been somewhat misunderstood. After giving some definite figures to show how defective the active materials of commercial cells were in this respect, he went on to say that "as long ago as 1889 Messrs. Duncan and Wiegand called attention to some of the results that must ensue if proper diffusion were not provided for; and Messrs. Gladstone and Hibbert, in their communication to this Institution in 1892, also indicated some of the effects probably due to this cause. In the latter instance, however, they were considering the matter chiefly in its relations to the E.M.F.'s of cells under various conditions; and I think it yet remains to be recognised how far-reaching are the consequences of defective diffusion, and how many of the faul s and shortcomings of the cells may be attributed to it." He thought that made his position in the matter quite clear, and he then proceeded to work out the whole case against insufficient porosity, indicating in what parts of the active materials and under what conditions the different effects occurred. Mr. Hibbert was quite right with regard to the extract he read at the last meeting from Dr. Gladstone's and his own paper of 1892, regarding the effect of the weak acid in the pores on a cell's output and the production of abnormal compounds. Although considerably elaborated, and with some important modifications, its substance did appear again in his (the speaker's) paper, and it was essential to his object that it should do so, for he was endeavouring to collect the previously scattered and sometimes indefinite statements and embody them all in a precise and definite whole. He did not think there was anything to suggest that he imagined he was the first person to study porosity and diffusion. As a matter of fact, the paragraphs quoted by Mr. Hibbert were in their turn covered by a still more general statement of the same points made by Mr. Swinburne in the paper he read before the Institution in 1886 There was a second point in the paper which appeared to have been still more completely misapprehended, and that was with reference to the gradual loss of capacity so often experienced by negative electrodes, and which he had said had never yet been satisfactorily explained. Mr. Hibbert had pointed out that this was due to the discharge or sulphating of the spongy lead by loca

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action with the electrolyte, and he gave quite a number of authorities who had previously mentioned the fact. He thought, perhaps, he might have made himself clearer, but it never occurred to him that he should be thought at that time of day to be still trying to explain that simple and well-understood effect. The loss of capacity referred to was one spread over a much longer period, and much more permanent in its nature. It was usually supposed that negative plates would outlast two or more sets of positives. Where the conditions of working were severe, and the life of the positives for this or other reasons short, such was generally the case, but if the battery had been well treated, and the positives had lasted a long time, it did not usually follow. Thus, after five or six years the capacity of a battery had fallen very low, and the negatives apparently were in as good condition as when first put in, but the positives had shed most of their active material, and were with difficulty prevented from buckling. Obviously the positives were at fault and must be replated, but when this had been done the capacity was found to be not a whit improved, and, finally, the negatives had to be renewed also. This was a very usual occurrence, and illustrated the phenomenon he was alluding to. Without any loss of active material, the capacity of all negatives of whatever type steadily decreased in the course of time. In some cases it would be an extremely slow process; in other cases a large proportion of the capacity would be gone in a year or two, and when a manufacturer had to guarantee a battery to still give a specified output at the end of a certain time, he would probably be considerably more anxious about the negatives and the margin of capacity he should allow in them than he was about his positives. It was also curious that the capacity might be restored by reversal, if the electrodes were of a construction which admitted of that treatment. The late Mr. F. King was, he believed, the first to call attention to that behaviour of negatives in the course of the discussion on Prof. Ayrton's paper on "The Chemistry of Secondary Cells" in 1892, and he then pointed out that it was accompanied by shrinkage of the active material. The effect was certainly not due to sulphation. The loss of capacity might be chiefly a matter of loss of contact with the support and such as Mr. King seemed to think it was, but even then it would only be the result, not the cause of the shrinkage, and he (the speaker) was inclined to put it down to some molecular change. He was relieved to find that the most trenchant portion of Prof. Ayrton's criticisms was directed against the Electric Cab Company, and not against himself. He, however, put two questions. The first was as to the cause of the rise in potential difference observed during the first few minutes of discharging a cell after a prolonged rest. He had often puzzled over the curves showing this effect, but had never been able to hit upon an explanation which was at all satisfactory. He might hazard something to meet the case, as had previously been done, were it not for two things. First, there were other curves in the series, from which those in question were taken that did not show rise of potential difference on discharge after a similarly prolonged rest, and, secondly, it took several discharges, each following directly on the previous charge, before the rise was wiped out, and the curve restored to its normal shape. The second question was how so much more energy could be put into a cell by constant potential charging than by constant current, especially having regard to his view that the higher the charging current, the more liability would there be for the inner layers to receive their proper share. The two certainly did not at first sight appear to fit well together, but he thought the explanation might be that he assumed the outer surface of the active materials worked in an electrolyte of the same, or nearly the same, strength as that contained in the main body of the cell. This must hold good for all ordinary charging rates, and if so, an unequal distribution of the current would necessarily follow. But when such relatively enormous currents were used as flowed during the first portion of a charge at constant potential, the acid would be released in the pores of the active materials with such extreme rapidity that the main body of the electrolyte would be pushed back, and every portion of the active materials would be surrounded by much stronger acid. When that happened, although the whole potential difference of the cell would rise rapidly, the distribution of the current throughout the active materials would become more uniform, and consequently the inner layers would receive a better charge. By the time the current had dropped down to what would under ordinary circumstances be considered a high charging rate, the whole charge of the cell would then be too nearly completed for the unequal distribution that then set in to make much difference to the final result.

Mr. Grove then read his paper on "The Electrical Equipment of Ships of War," the opening portion of which appeared in our last issue, and is continued as follows.

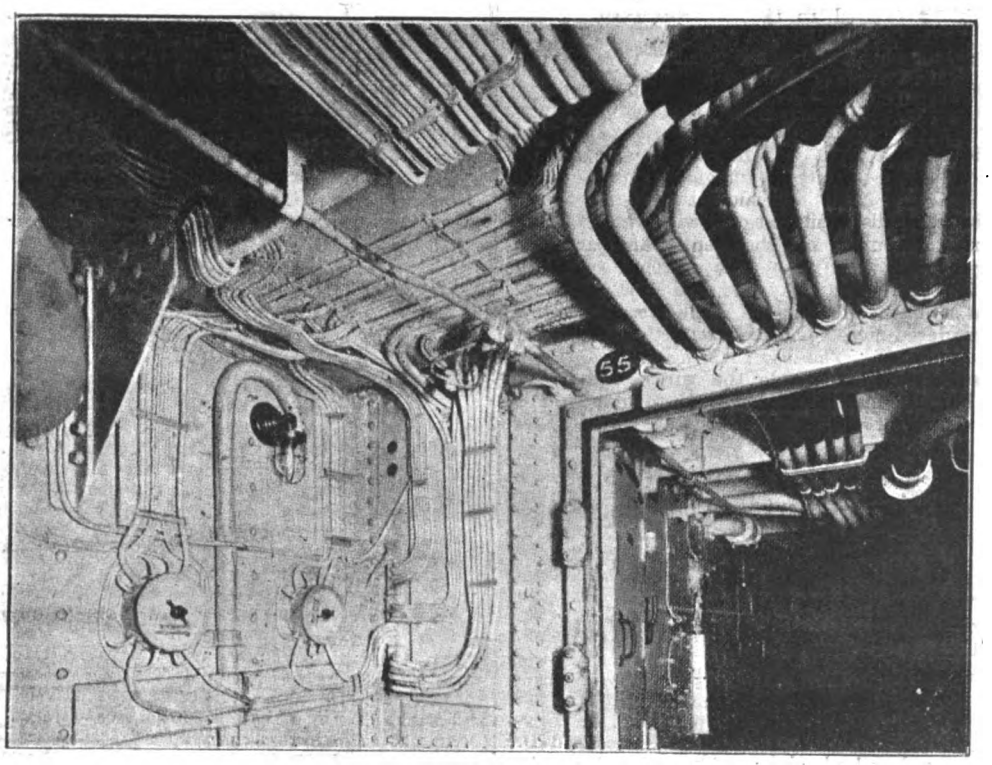

FIG. 11.—Cable Work at Entrance to an Ammunition Passage, showing Plate Watertight Glands.

The Electrical Equipment of Ships of War.

BY C. E. GROVE, MEMBER.

(Continued from page 491.)

Fig. 11 shows a grouping of cables through such glands at the watertight bulkhead alongside the entrance of an ammunition passage. Many ships fitted at Portsmouth have rubber-packed plate glands, though these are fitted only on one side of the bulkhead.

A new arrangement was introduced by the British Admiralty in 1898. Brass glands of tubular form screwed to take a nut at one end, and having central holes, previously tinned, about $\frac{1}{8}$in. larger in diameter than the cable intended to pass through, are inserted in the bulkheads and made watertight on the iron by means of red lead. The lead-covered cable is drawn through, and its tape stripped back to bare the lead at the gland, a split tinned ferrule is then inserted to fill the clearance space around the cable, and the whole is then sweated up solid by means of a blow-pipe. This is a rather tedious method until the men get accustomed to it, and there is some danger of overheating the installation unless care is used; once the cables are tightly drawn through and sweated up, they have a neat and solid appearance, but they cannot be drawn back, and when repairs become necessary it seems likely that the cables will have to be cut, which is a great disadvantage.

Distribution System.

The main circuit cables from the switchboard pass, in the

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case of the heaviest circuits, through "junction boxes," into which they split usually into two branches protected by fuses. Each of these branches then passes through a series of "section boxes," which are circular watertight boxes containing a switch and four pairs of terminals for the attachment of fuses and the branching of cables. Each of the four pairs of cables running from a section box terminates in a "distributing box," which is a similar box to the section box, and contains fuses and a double-pole switch. From each distributing box eight pairs of wires are taken, each pair leading direct to the terminals of one lamp. Fig. 12 illustrates the arrangement. As explained in

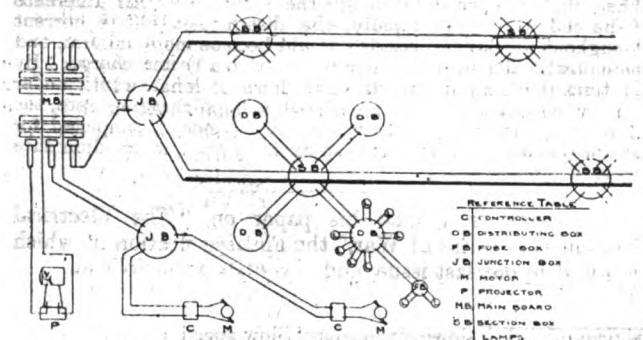

FIG. 12.—Diagram of Admiralty Distributing System.

the next section, no lampholders, properly speaking, are employed. This "distributing box system" was introduced into British warships about 1892. It is a modification of a method previously developed and used in wiring hotels, blocks of mansions, and such like places. Its advantages are that it enables the electric light system to be entirely laid out without any joints or branches in wires, thus dispensing at once with what is usually an important source of trouble. In the event of any part of the system becoming injured, it can at once be switched off at the nearest distributing or section box, and the working of the system in general is not interfered with. The system allows of the work being rendered more completely watertight than could otherwise be accomplished. The lead covering of the wires is stripped back sufficiently to enable the wires to enter the terminals in the box, the lead is then sweated to gland plates, which are made watertight with red-lead packing. While there

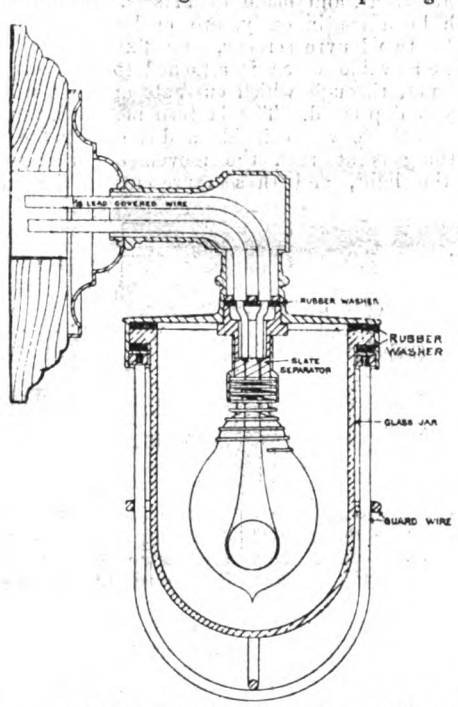

FIG. 13.—Admiralty Pattern Watertight Bracket.

are no single-light fuses employed except in distributing boxes, it is usual to employ single-light switches placed close to the fittings for all lights except those in crew spaces and magazines, which are controlled in groups. Double-wire lighting circuits are universal. H.M.S. "Polyphemus" was the only British ship in which single wiring was employed, and this was soon converted. Concentric systems, with or without the outer conductor earthed, have been frequently advocated for warships, but they do not lend themselves so readily to the repair of small injuries as the twin-wire circuits employed.

Fittings.

Fig. 13 illustrates a typical Admiralty watertight fitting, showing the method of wiring. The lead-covered wires are drawn through an indiarubber washer pierced with two holes, which fits tightly into the neck of the fitting, thus excluding moisture; the lead and the insulation are then stripped back, and the bare wires led through holes in a slate disc which forms a separator; no lampholder, properly speaking, is used, but the ends of the wires are turned back with pliers to form hooks, and on to these bottom loop lamps, having twisted spiral platinum loops, are hung. Loop lamps are used because they best stand vibration and shock due to gun-fire. But this method of wiring is capable of considerable improvement. If the hooks

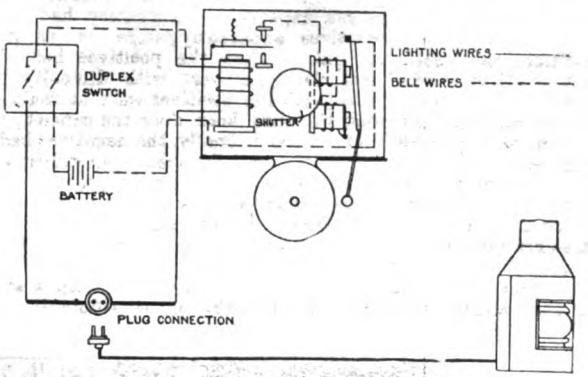

FIG. 14.—Navigation Lights Alarm, "Fuji" and "Shikishima."

in the wires are not properly formed, and are not of exactly the right length, bad contact and sparking result and the wires are burnt. If from any reason the hooks get injured or broken off, little pieces of wire have to be soldered on, which is not good. It would be much more satisfactory if the wires terminated in fixed contact blocks, and the fitting, wired complete and provided with spring contact plungers, were then

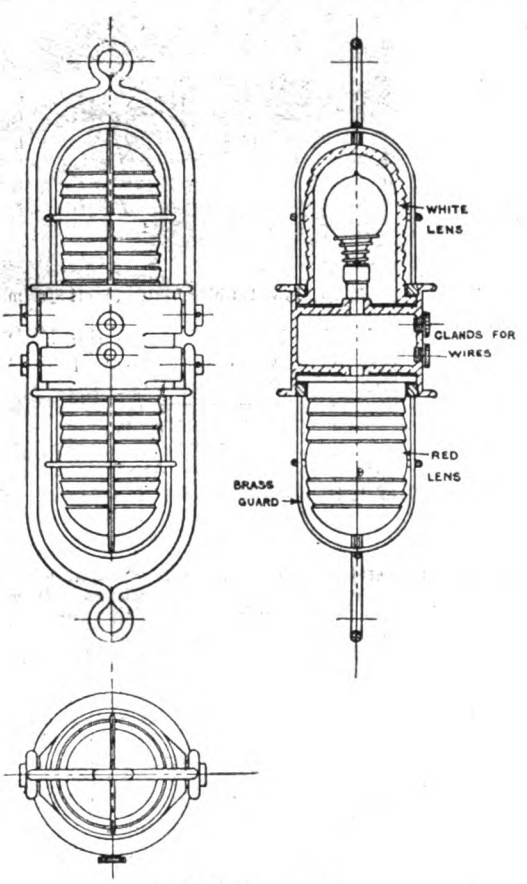

FIG. 15.—Ardois Lantern.

independently attached. In the "Shikishima" combination fittings, carrying electric lamps and candles, were wired in this way by the author with success, the removal of four fixing screws allowing the fitting to be bodily taken away without disturbing the main wiring.

Signal Lights.

Every ship, of course, carries the ordinary international navigation lights—port side red, starboard side green, and masthead white—which must be alight all the while the vessel is under way, together with white riding lights, which have to burn when the ship is at anchor. In British ships, so-called "position lanterns," two in number, are carried on the ensign staff when at anchor. In order to provide against failure of the navigating lights, the lanterns sometimes contain two lamps with an auto-

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matic switch for throwing the second into circuit if the first fails. This does not, however, make a good arrangement, because

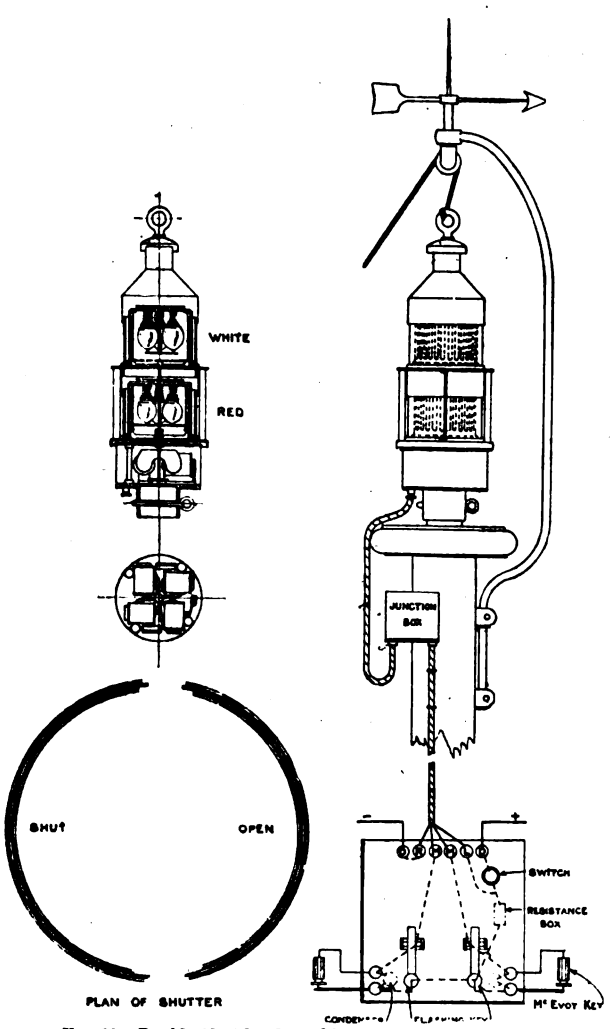

FIG. 16.—Double Mast-head Flashing Lantern, Scott System.

both lamps cannot be placed in the focus on the Fresnel lens, and if one is right the other one must be out of position. Tell-tale alarms (of which there are several kinds) are used on some ships to give warning if one of the navigating lights fails. Fig. 14 shows the arrangement devised by the author for the "Fuji" and "Shikishima." An electric bell is provided with a relay wound to one-tenth of an ohm and carrying the full current of the 50-c.p. lamp employed, say 2½ amperes. This relay magnet holds a spring contact out of connection with the bell circuit while the lamp current is on. On the failure of the lamp current the spring contact completes the bell circuit, and the bell rings continuously. A duplex switch in one watertight case switches both lamp and bell circuit on together. A plug connection is attached near the lamp position, so that the lamp can be removed without disturbing the wiring. The bell circuit can be tested by merely switching on with this plug connection out, when, of course, the bell will ring if all is in order. The Ardois lantern is largely used abroad for speed signalling. This lantern (shown in Fig. 15) is really a double lantern, one half having a white Fresnel lens and the other a ruby lens, each enclosing a 50-c.p. lamp. As used by the Japanese, the lantern is hung over a sheave from the fore starboard yardarm, this sheave being surmounted by a single lantern of similar design showing a white light. When the white light in the movable lantern is shown burning close up to the fixed light it means "Full speed ahead," while the red light in this position indicates "Full speed astern." If the white light is shown half-way between yardarm and rail it means "Half-speed ahead," a red light in the same position indicating "Half-speed astern." When the movable light is shown quite low down, it means "Slow speed ahead," and the red light in the same position "Slow speed astern." The white lenses are slightly obscured because it is thus more easy to see the two separate lights when close together than if clear glasses are used. Two white lights and a central red one, in lanterns on the afterbridge rail, are used for the same purpose, and screened so that the light shows only astern. Among minor signals may be mentioned that employed to indicate "Admiral aboard." On British ships, three lamps are hung respectively at the ends and centre of the afterbridge rail, and one from the military top; on Japanese vessels three lamps are hung in triangular fashion from the after military top. The same three lanterns hung in various positions are used by the Japanese for other signals.

For general fleet signalling, flashing lamps carried at the truck of the foremast are in fairly general use. They are designed so that any communication can be effected by the use of the ordinary Morse code. In one design of masthead lantern due to Captain Scott, and made by Messrs. Armstrongs, the lamps, which burn continuously, are enclosed in a lantern surrounded by two louvre screens, one fixed and the other movable. The movable screen is attached to the armature of an electromagnet, through which currents are sent when the signalling key is depressed. The lantern may be arranged so that openings in the louvres coincide and the lights are visible when everything is at rest, the movement of the screen cutting off the light, and thus representing the interval

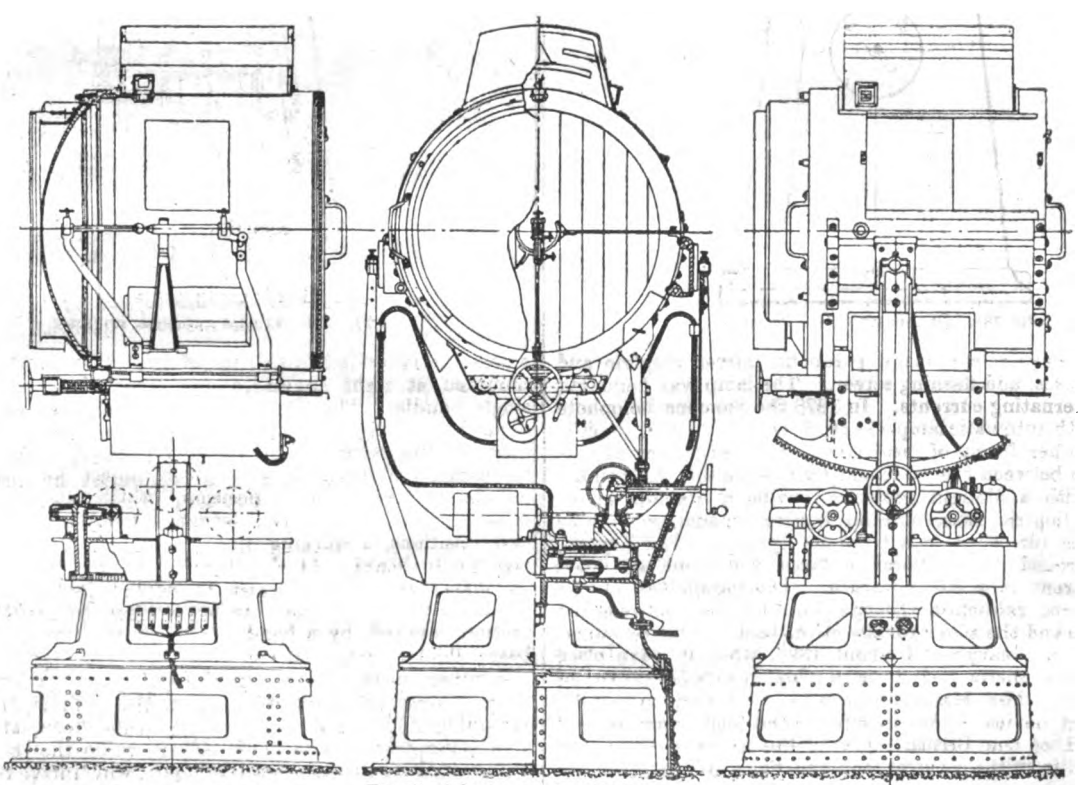

FIG. 17.—Schuckert Automatic Projector.

between the signals, or *vice versâ*. A modification of the Scott lantern as used by the Japanese is shown in Fig. 16. It consists essentially of two lanterns, one above the other,

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the lower one being enclosed in a ruby glass screen. There are independent signalling keys for the two lanterns, the contacts of which are shunted by a condenser and resistance to kill the sparking. In the figure the screen is shown to a larger scale for clearness. The British masthead lantern is of different design, the lamp current itself being interrupted by the signalling key. The United States navy uses for fleet signalling four Ardois lanterns, the upper light in each being red and the lower white. These are suspended about 10ft. or 12ft. apart on a couple of wire jackstays from the after-mast. A special controlling switch is used, having sets of contacts corresponding one to each possible combination of four lights, the two lights in one lantern never being used together. Each combination denotes a letter of the alphabet or a figure. By moving the switch-handle about the top dial of the switch and depressing at the proper contacts, words are spelt out.

Searchlights.

The searchlight installation is usually considered one of the most important sections of the ship's equipment, and use was found for searchlights five years before electricity was used for the general illumination of ships. The first projector was installed in 1876 in H.M.S. "Minotaur." It had a vertical

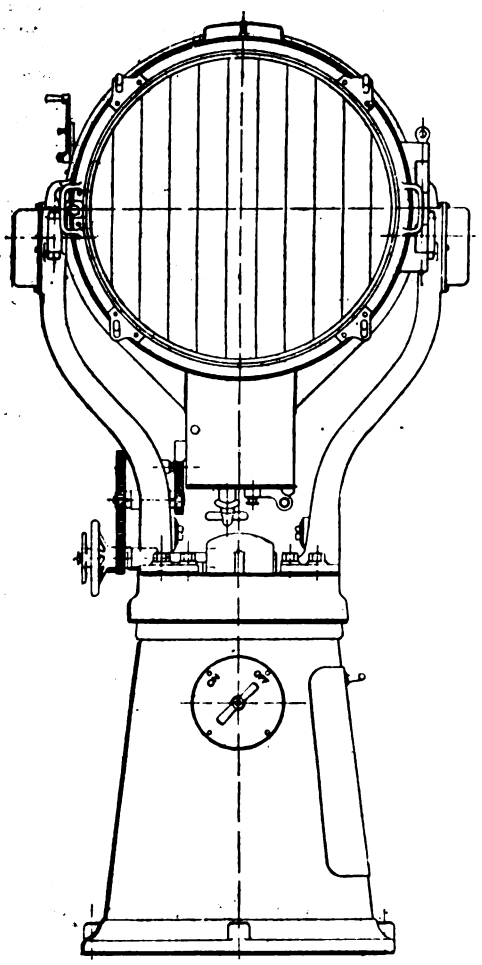

FIG. 18A.—Siemens Automatic Projector.

lamp burning square carbons, a parabolic mirror, dioptric and diverging lenses, and flashing screen. The lamp was hand fed and took alternating currents. In 1878 the Siemens holophote projector with automatic lamp was tried on H.M.S. "Triumph"; and many other forms of projectors and lamps were experimented with between that date and 1881, when the "Inflexible" was fitted with a Mangin projector, having a Mangin mirror instead of dioptric lens, and an inclined hand-feed lamp, current being furnished by a Gramme dynamo. The Mangin mirror is ground to spherical surfaces, the front and back having different radii of curvature. The parallelism of the beam is due to refraction through the thick glass between the front surface and the silver surface of the back. This remained standard in our navy until about 1893, when it gave place to the Parsons mirror, which is a thin parabolic mirror of high quality. The Mangan system is, however, in use by most foreign navies. The inclined hand-feed lamp is still the standard of the British navy; the carbons are tilted about 20deg. from the vertical, and the light falling upon the mirror has its maximum intensity at or near the centre of the mirror. On the Continent and in the United States automatic horizontal carbon lamps are coming into favour. The crater of the positive carbon is, of course, turned towards the mirror, the arrangement in this case giving the maximum intensity of the light at the outer edges of the cylindrical beam. The British War Office has also adopted the horizontal carbon lamp for its standard projectors. The ascending current of air is apt to displace the arc, which is specially inconvenient with horizontal carbon lamps. To get over this difficulty, the Schuckert projector (Fig. 17), which is the standard in the Austrian navy, is fitted with a soft-iron ring surrounding the carbon. This ring becomes magnetised when the current flows produces a magnetic field along its axis in which the carbon lies, and so keeps the arc in the proper position. It is now becoming common practice by foreign nations to operate searchlights from a distance. An observing officer can see the object illuminated very much better if he occupies some different position from that of the searchlight, so that he does not have to look along the beam. But as he must have a means of directing the light, it is becoming common to provide projectors with electric motors, one to train and one to elevate the projector barrel, including lamp and mirror, and also to fit projectors with automatic lamps. This operation is specially advantageous as regards projectors fitted at the tops of the military masts, which can be conveniently operated from the bridges. Fig. 18 shows a Siemens electrically-controlled projector of this kind. It is worked by

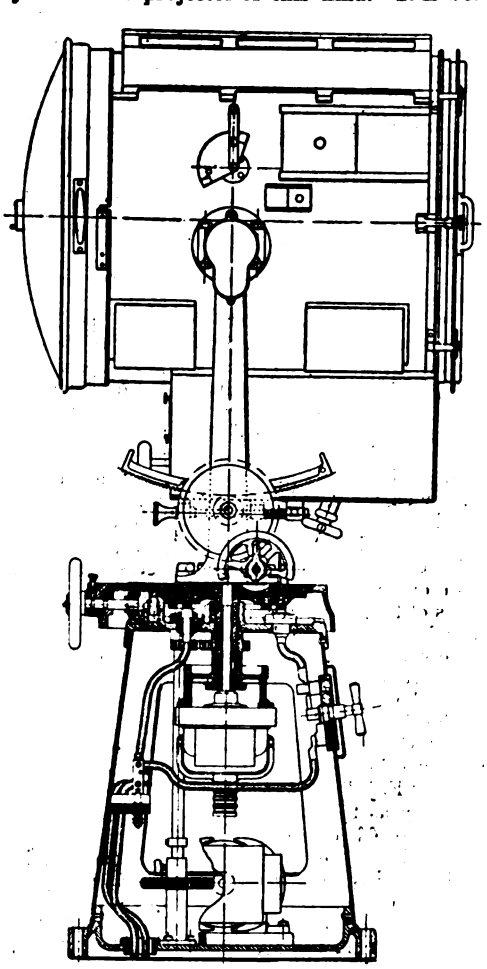

FIG. 18B.—Siemens Automatic Projector.

a combination switch consisting of two motor-starting switches mounted at right angles to one another and worked by a single handle. The operation of directing the searchlight is done by moving the switch handle precisely as if one had hold of the back of the projector itself. The projector is instantly stopped upon a given object by bringing the handle to the "off" position, which short-circuits the motors. As fitted on the bridges of ships, projectors have two positions, a working position right out, and a stowing position in board. At the stowing position they are secured by chains and turn buckles to anchor plates in the deck; in the working position they are secured by a small eccentric motion, worked by a hand lever, which lifts the projector base slightly from its trolley wheels and jambs it on to the underside of a flange in the rail on which the projector runs. Searchlights are used a good deal now for long-distance signalling, and very great distances indeed have been covered. The common way is to make use of a round disc suspended on a spindle running through the projector barrel between the lamp and the mirror, and vibrating this disc by means of a small lever handle on the spindle. The arrangement is seen in Fig. 18. In some recent foreign projectors a flashing screen, resembling somewhat a venetian blind with the laths vertical, has been fitted in front of the front glass; the laths are linked

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together, and their movement from the position in which the full light is shown to that in which all the light is cut off, is controlled by a small lever handle mounted at the side.

Voice-Pipe and Bell Communication.

The problem of maintaining communication between the several compartments, cabins, and military positions in a

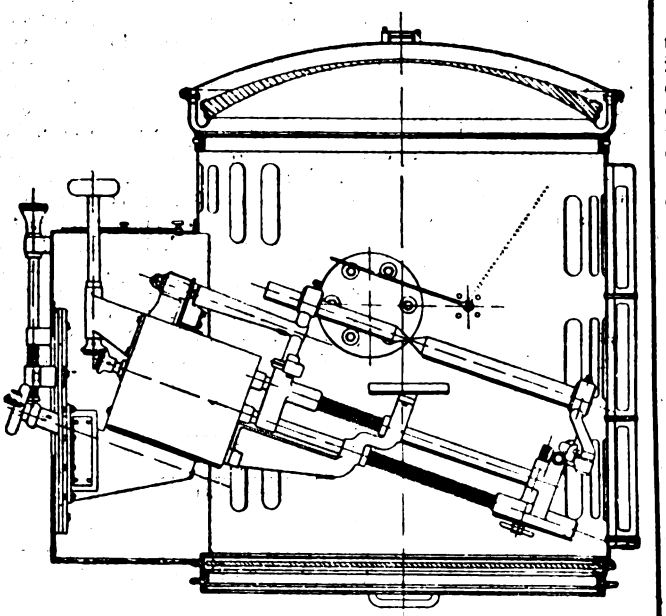

FIG. 18c.—Siemens Automatic Projector.

warship is not less important than the problem of maintaining general illumination, but it is far less successfully solved. As regards the communications between officers in their cabins and their subordinates and sentries, a simple system of bell signals with annunciators or "shutters" is all that is required; but communications between the navigating officers on the bridge and the engine-rooms, and between combatant officers in the conning tower and the gun and torpedo stations, for example, may often be of a much more complex and special character than can be easily given by a simple code of bell signals. Beyond a certain point, means of verbal or telegraphic communication becomes necessary. Such communications in our navy are effected by speaking through copper voice-pipes of 2in. diameter, fitted with whistles or electric bells, pushes, and shutters, the latter serving merely to direct attention to the voice-pipe. These electric bell communications are very extensive in a modern ship, the number of points from which verbal messages can be sent or received being about 100 in the battleships of our "Majestic" class and about 140 in the "Canopus" class. A greater elaboration, however, than in any other ships afloat was affected in the Japanese battleships "Fuji" and "Yashima," which were equipped with as many as 256 electrically-connected speaking points, in addition to 44 cabin bell-push points. The connections between stations are effected by four-core cable, the conductors being $^1/_{16}$, separately insulated with rubber, and covered with different-coloured cotton coverings to facilitate making and tracing connections. The electrical connections of a pair of instruments are given in Fig. 19. When, as is

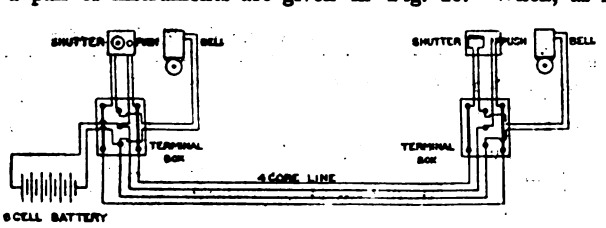

FIG. 19.—Voice-Pipe Bell Instruments—Diagram of Connections.

usual, several pipes and instruments occur at the same station, all the branching and jointing is done in terminal boxes. One bell is usually fitted common to the group, and one six-cell battery supplies several groups, the connections being made through suitable battery terminal boxes. The whole system is watertight, and no jointing of wires is done outside boxes. The problem of communication is, however, not solved by the present arrangements, the difficulty being that when the electric bells have done their duty, and the officers who wish to communicate are at the opposite ends of the voice-tube, there is often so much extraneous that it is impossible for them to hear one another. It has been usual in recent years carefully to insulate the tubes from the main structure of the ship, so that they shall not pick up sounds by conduction, and the device has been employed of leading the speaking-tubes to about six exchange stations where messages are received and transmitted, so that the length of tube spoken through between point and point is reduced to the smallest limits. The transmission of messages at exchange stations, however, introduces delay and sometimes error.

Telephones.

The failure of voice-tubes has given telephones their opportunity, the speaking qualities of the latter being practically independent of distance. Among the earliest to use telephones on warships were Russia and America. One of the best forms of naval telephone, and one that is now being largely used, not merely by the British, but by many other navies, is Alfred Graham's. It is a loud-speaking instrument, the transmitter taking the current of four or six large agglomerate Leclanché cells, and operating without an induction coil. The transmitter is of granular type, enclosed in a watertight case. It is turned half-round every time the telephone is used by the switch, which puts the line connections from "ringing" to "speaking." In spite of the large power employed there is no hissing. The receiver is contained in the same case. A considerable number of British battleships and cruisers are fitted with voice-tubes and bells between the port-engine room and the bridges and conning towers, and with these telephones between the starboard engine-room and the bridges and conning towers, the intention apparently being to gain extensive experience of the relative efficiency of voice-tubes and telephones under identical conditions. Telephone connections in a typical case are shown in Fig. 20. The most advanced instance of naval telephones yet fitted is to be found in her Majesty's new yacht "Victoria and Albert," which has a large telephone installation. Trials are also being made of the applicability of these telephones to communications between casements. It would appear, however, that during actual warfare, amid the noise and rattle of quick-firing guns, any instrument that depends upon the transmission of the human voice must fail. It is reported that in the battle

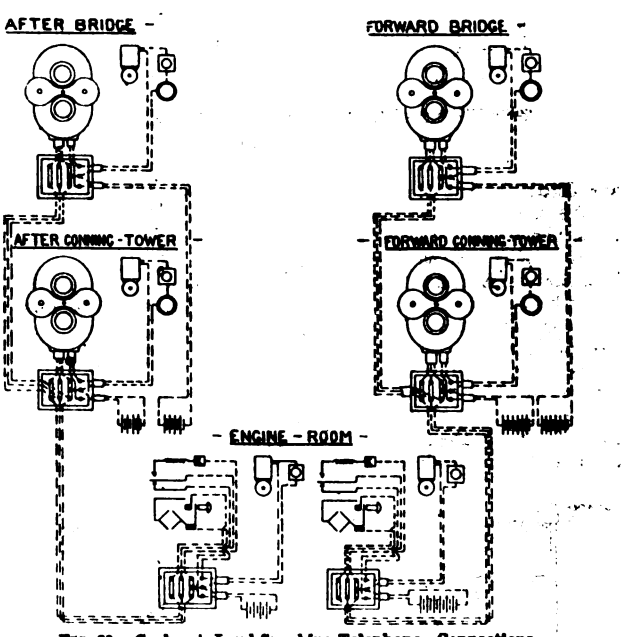

FIG. 20.—Graham's Loud-Speaking Telephone—Connections.

of Santiago the Americans found their telephones useless. Unless a large number of men are to be told off as messengers to carry orders, what seems to be wanted is a system of printing telegraphs, the instruments being of a not too sensitive character, so that they could work without giving false signals due to vibration and shock, the general design of the instrument being somewhat after the fashion of that used by the Exchange Telegraph Company, printing in ordinary Roman letters. Such an instrument would have a relatively slow speed of action, but its result would be more positive, inasmuch as the message could be read by a person without a telegraphic training, and if by chance a false letter were printed, it would not necessarily prevent the word from being recognised. Probably its speed—12 to 20 words a minute—is as quick, all things considered, as the average voice-pipe communication now. Of course, messages making enquiries or giving instructions in accordance with understood requirements could be transmitted by abbreviated signals. Before leaving the subject of communications, it may be mentioned that steps are being taken to introduce into the navy the "Sullivan" galvanometer for enabling ships at sea to speak with the land through ordinary submarine cables. There is some prospect also that warships will make general use of the Marconi telegraphic apparatus for fleet and ship-to-shore communication. This apparatus proved very useful in the 1889 manœuvres, and

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equipments have since been supplied to some of the battleships of the Channel Squadron. Among internal bell communications may also be mentioned alarms connected with thermometers for calling attention to the attainment of certain temperatures in magazines, coal bunkers, etc. The arrangement is obvious.

Gun and Torpedo Work.

Electricity is an indispensable adjunct to the armament of a man-of-war, being invariably used for discharging torpedoes and for firing modern breech-loading guns of all sizes. While all other circuits in the ship are twin-wired, gun and torpedo circuits are now universally single-wired. The following are the arrangements used in connection with Elswick equipments.

Torpedo-Firing Circuits.

Two batteries, one (A) of low and one (B) of high resistances, are connected with their positive poles towards one another, as shown in Fig. 21. The firing key and detector

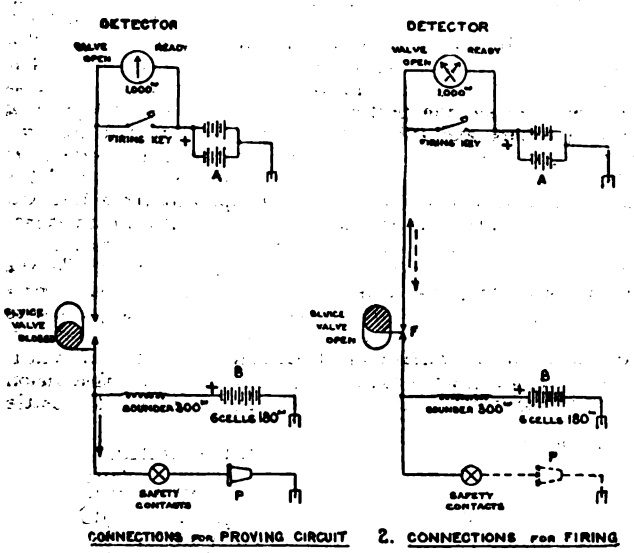


FIG. 21.—Torpedo-Firing Circuit.

are fitted in the conning tower, from which the discharge of the torpedo is controlled. The torpedo is placed in the tube, the sluice valve at the outer aperture of the tube being closed. The valves being closed, the firing circuit is open. The circuit is then "proved" by inserting a primer in the firing breech, when current flows from battery B, causing the sounder in the torpedo-room to start buzzing, thus indicating that all is right. The primary is then removed and the sluice valve opened, thus making contact at F, and completing the circuit through E, B, F, A, E, the two batteries being in opposition. The deflector needle in the conning tower deflects to the left, indicating "valve open." The firing charge is inserted in the discharge chamber, the primer restored, and the

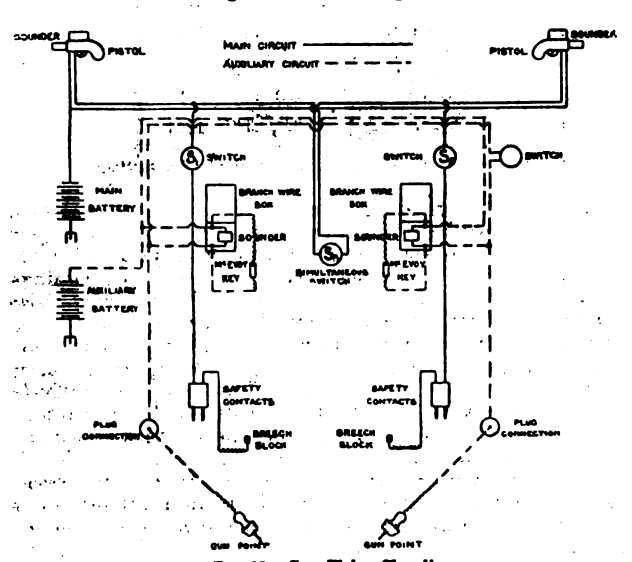


FIG. 22.—Gun-Firing Circuit.

breech locked. Current from battery A through the high-resistance detector then flows in unison with that from battery B in the circuit E, A, F, P, E, reversing the deflection of the detector and indicating "ready." The officer in the conning tower at the proper movement depresses his firing key, the two batteries send their full volume of current through the firing circuit in parallel, the fuse is ignited, and the torpedo discharged.

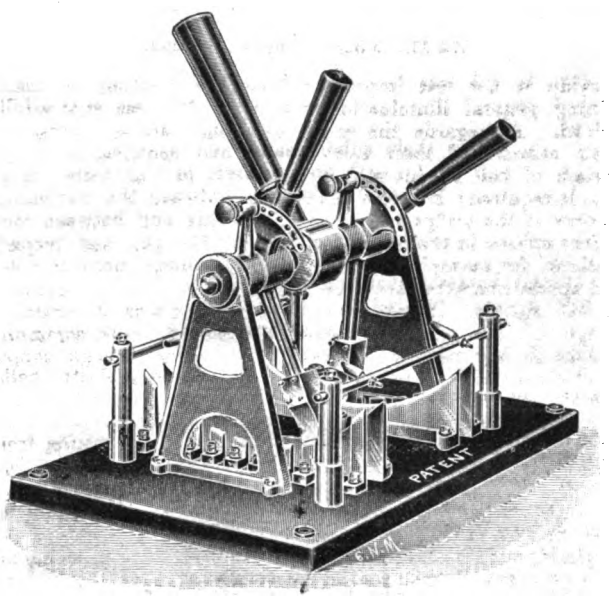
Gun-Firing Circuits.

Gun-firing circuits a few years ago involved a formidable amount of wiring, as the circuits from all the barbette and casemate guns were looped into the conning tower, where the firing keys were situated. The practice now is to fire all guns on short local circuits, the batteries, switches, keys, etc., being carried on the gun mountings. Fig. 22 shows the connections for a pair of Armstrong barbette guns. Following out the main (full line) circuit, it will be seen that if switches S_1 S_2 are closed and S_3 open, the left-hand pistol will fire the left gun and the right-hand pistol the right gun. If switch S_1 is open and S_2 S_3 closed, the left pistol fires the right gun; while if S_2 is open and S_1 S_3 closed, the right pistol fires the left gun. Finally, if all the switches are closed, both guns can be fired simultaneously from either side. An auxiliary circuit, shown in dotted lines, is fitted up as a stand-by to the main firing circuit. The latter is completed only when the gun is "right out"; the auxiliary circuit can fire with the gun in any position. The use of the sounders will be evident, as they buzz all the time the circuit is made. Whereas the firing pistols are usually fixed at the firing platform, the McEvoy keys, connected by flexible connections, enable the gunner to fire from any position.

(To be continued.)

THE LUCAS SWITCH GEAR.

The Edison and Swan United Electric Light Company, Limited, are now manufacturing the Lucas patent switch gear,



The Lucas Patent Switch.

which we illustrate herewith. The improvement in this switch gear consists in placing the multiple contacts of the switch, with their faces in a vertical plane, on the base, so that much less space is taken up than when these contacts are mounted flat on the base itself. The contact lever is so arranged that its axis can be conveniently extended in order that a number of switches can be worked in one line. The adjustable keys, which are seen at either end of the spindle, then provides that a large number of the switches can be coupled together and worked simultaneously. Another neat device in connection with this clamping gear is that two series of contacts on the same switch can be so placed that first one and then the other is operated. In this way a large number of contacts or steps in regulation can be obtained in a small space. The switch gear can also be readily adapted for the ordinary charge and discharge work of accumulators.

Damping Loving Ardour.—American swains who employ long-distance telephonic communication with their best girls complain of the excessive charges, which amount to a dollar or so for every amorous whisper over the wires. One swain, according to the *Evening News*, has put his grievance into rhyme, as follows:

O'er scores of leagues I speak to thee—
But brief must loving message be.
The rates hold ardour down, my own,
On this long-distance telephone!

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MANUFACTURERS' CARELESSNESS.

We have before us a report from Shanghai which affords considerable room for thought. The report deals with a good many other things besides electricity, but it is to one sentence of the portion relating to electrical matters that we here direct attention. Here is the sentence: "These new generating sets were supplied incomplete, the steam-engine governors not being fitted with suitable gear." Perhaps a search among back numbers would enable us to give the name of the person or firm answerable for this state of things, but we shall not search; we do not wish to know the name, and if we knew it should not venture to mention it—not from fear of consequences, but because such acts of negligence carry their own condemnation, and if persevered in damn any reputation. This is not the first nor the fortieth time that men thousands of miles away, having placed orders in this country, have been troubled and almost driven to despair because of plant being shipped in a happy-go-lucky style, and when erected being without some part essential to its full success. The makers of this steam plant, whoever they were, knew the purposes for which the plant was ordered, and knew the necessity of good governing; hence the excuse tendered, "that the congested state of trade in England prevented their obtaining delivery of certain patented gear," is of no value. An ironmonger might send home a kettle with a piece of wire gauze for a bottom, and excuse himself that he could not for the moment get the proper punched plate to make a good bottom. The buyer would be unable to use the kettle for the purpose of boiling water, though he might burn shavings in it. Thus he would not, could not, and should not excuse the ironmonger. Fancy being the engineer-in-charge at Shanghai, having upon your shoulders the responsibility of the station, and having to answer for its success, not only to the Municipality, but to the customers! The latter are the worse of the two, as the former can place the blame on the right shoulders, while the latter, knowing nothing of the inner working of the station, only blame the man in charge. The orders may be for the best kind of apparatus, may be duly placed, but if not properly fulfilled, the result, instead of a success, is failure. Customers who have patiently waited for months do not care to wait for more months, or to endure a marionette dance of light. Thus they at least get in their say, which is rather unpleasant to somebody, but not to the right somebody. Need there be any wonder that repeat orders are fewer than we desire, that new orders and repeat orders get into the hands of competitors? Would any engineer with responsibility upon his shoulders, living thousands of miles from the manufacturing centre, advise further trust to be placed in firms that had once led him through such a dance? We opine not; and he would be right. It may be said that these exceptional cases are local, are far off, and are generally unknown in this country. All that is true. The being known in this country does no harm; it is the local knowledge that is detrimental to British trade. What is the result at Shanghai? "The

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working of these engines has, in consequence, not been fully satisfactory, and, after connecting customers who had been waiting a considerable time for the supply, it was deemed expedient to await the arrival of the governor gear and fit same to engines before connecting any more customers." In other words, the station had necessarily to remain more or less unproductive for months after it ought to have been in full working order. The shareholders of a company would have kicked against this, but, of course, the Municipality was in a different plight. We imagine the sympathy of those interested in central-station work will be with the Municipality and its engineer.

OUR VOLUNTEERS.

We noted last week that the first detachment of the Electrical Engineers (Royal Engineers) Volunteers had arrived at Capetown. We now find that Colonel Crompton and eleven men, forming the second detachment, will spend their Easter holidays on the sea. They are to embark at Southampton on Saturday, April 14, in the transport "Canada," and will have as companions on the voyage several companies of the Imperial Yeomanry. We are yet under the impression, seeing the present position of the contending parties in South Africa, that there will be ample scope for the khaki-clad Electrical Engineers to distinguish themselves. The first detachment are, however, prevented from going to the front immediately, owing to the non-arrival of the ship containing the plant and stores. This, however, will probably shortly put in an appearance, and Colonel Crompton will probably find things getting into working order when he arrives.

THE ANNUAL STAFF DINNER OF THE BRITISH INSULATED WIRE COMPANY, LIMITED.

The above fixture, which has acquired considerable popularity since its innovation a few years back, took place at the Adelphi Hotel, Liverpool, on Friday, the 6th inst., commencing punctually at 7 p.m., when about 150 gentlemen seated themselves to what proved a very sumptuous repast. Mr. W. Marriner Brigg presided. The first courses of the feast were agreeably enlivened by an excellent programme of music, performed by the Euterpean Orchestra of lady artists, directed by the Misses Emilie and Annie Scott. Subsequently a programme of vocal music was rendered, this proving of equal merit. The after-dinner speechmaking was confined to reasonable limits, which fact enhanced perhaps the success of the evening's entertainment. A pleasing sign of the times was to be observed in the remarkable demonstration called forth by the usual loyal toasts, reference to the recent providential escape of the Prince of Wales giving rise to especially hearty cheers.

In the unavoidable absence of Mr. E. K. Muspratt, J.P., Mr. THOMAS PARKER proposed "The Electrical Industry," and in the course of a few remarks expressed an opinion that the action taken by Parliament in 1882 was mainly responsible for the slow progress which had been made by this country in electrical matters compared with what had been done abroad. He also referred to that red-letter day in the annals of Liverpool—namely, the occasion of the opening of the overhead railway for traffic, and the speech then made by Lord Salisbury. In his (Mr. Parker's) opinion we had not kept pace with the rest of the world as electrical manufacturers, but he was not despondent, and looked forward to the time with confidence when we should have overtaken and excelled American practice.

This toast was ably responded to by Mr. S. Z. DE FERRANTI, who alluded to the necessity which the cable business involved of moving ahead with the times, and at the same time of being conservative. He considered that more patriotism should be shown in giving orders for electrical apparatus. The position of the electrical industry had very much changed for the better since last year. The British Insulated Wire Company, Limited, had gone ahead particularly well, and a great and rapidly increasing field existed for their cables, but the lack of patriotism displayed in giving orders had caused the country to suffer. This lack was due to selfishness, ignorance, and want of thought.

In proposing "The Visitors," Mr. Alderman T. SNAPE, J.P., made some amusing references to wireless telegraphy and wireless telephony, expressing a fear that the progress being made in this direction would spoil the cable-makers' business.

To this toast Sir W. H. PREECE, K.C.B., F.R.S., responded. In the course of his remarks he gave some interesting figures to illustrate the rapid strides which had been made by the British Insulated Wire Company during recent years, from which it appeared that the firm in 1894 employed only 70 men, while the number employed at present exceeded 1,600. An indication of the tremendous progress made by the company was to be found in the great quantity of cable annually exported. He (Sir W. H. Preece) had heard a great deal about American competition, but could America or any other country compare with us in cable work? With regard to the question of legislation which had been mentioned, he did not agree with what Mr. Parker had said, but had, on the contrary, found legislation on the whole beneficial to the electrical industry.

The toast next honoured was "The British Insulated Wire Company, Limited." In responding, Mr. J. B. ATHERTON mentioned some investigations in cable work which had been carried on for several years by Mr. Ferranti, which might result greatly to the benefit of the cable industry should their issue prove successful. Continuing, he said that Sir William Preece had always been the firm's best friend, having entrusted them with one of their very first orders for cable. He (Mr. Atherton) thought that free wiring, if better conducted, would bring electric lighting within reach of the poorest, and thereby confer great benefit upon the electrical industry generally.

Mr. G. H. NISBET then proposed "The Directors of the British Insulated Wire Company, Limited," paying, in the course of his remarks, splendid tribute to their generous treatment of the works staff. He also mentioned incidentally the proposed erection by the company of a technical school in Prescot for the benefit of their workmen.

The toast having been suitably responded to by the CHAIRMAN, the official proceedings thereupon terminated with the toast of "The Chairman," which was proposed by Mr. JACOB ATHERTON and heartily accorded. Thus ended a most enjoyable evening.

On the following day (Saturday) many of the visitors took part in an inspection of the works at Prescot, where a couple of hours were profitably spent in studying the excellent arrangements and organisation of the works. Great interest was taken in the manufacture of a big cable for the Manchester tramways, 37 miles of which are on order. The steel armour was being put over a section of this cable at the time of our visit. Other items of especial interest were the telephone cable being manufactured for the Bristol-London service, and the wire-drawing department recently added to the works. All departments gave evidence of the vast quantity of work in hand.

STANSSTAD-ENGELBERG RAILWAY.

Everybody who professes to be somebody when going to Lucerne tries to get a room or rooms at the Schweizerhof, but, after all, only a limited number can have *the* rooms, so although holding a written promise and having a verbal promise of "better as soon as vacant," we turned from Mark Twain's famous hotel to its annexe,

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the Lucernerhof, finding there rest, peace, and comfort. Indeed, a somewhat lengthened stay at the Baur au Lac at Zurich, with its super-excellent position, not to speak of the continuous kind attention and cordiality given by its management to a wandering Briton, had rendered the individual fastidious in matters of accommodation. There are hotels where one can feel at home if one only knows them a little and allow on both sides for a few patriotic

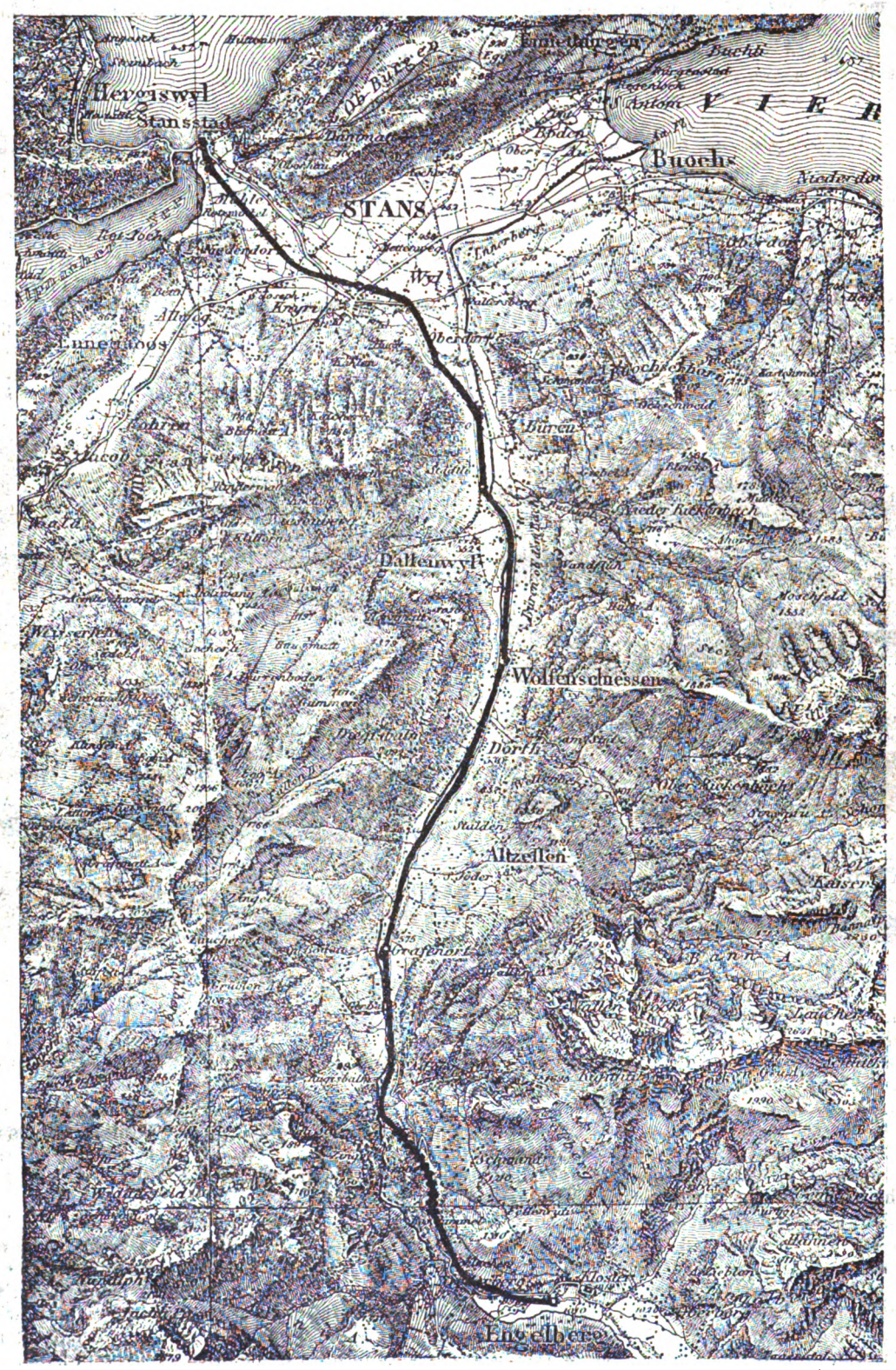

FIG. 1.—The Stanstad-Engelberg Railway Route.

prejudices, but the here-to-night-and-away-to-morrow guest scarcely ever realises how comfortable he could be if only his stay were longer. What a relief to a lazy man, who, merely expressing a desire to excurse (will that word pass?) to Engelberg, finds everything mapped out for him—times and places where boats or trains start or return ready to hand; in fact, everything done to make his journey the line of least resistance, and his return

heralded with a promise of immediate refreshment. Somewhere existed from Herr Kholb a courteous invitation to examine the Stanstad-Engelberg line, yet, like the wilful schoolboy who gets his apples round the corner rather than through the front gate, we took a trip entirely on our own account. There were no special trains, no extra care in working; just the ordinary everyday going and coming. We enjoyed it immensely, and, of course, the unexpected happened; but what that was, wild horses will not draw from us. Suffice to say, we had an experience such, as we think, no other wandering scribe could excel. It gave us more experience of Continental folk in 10 minutes than would be obtained by the humdrum travel of a lifetime. To resume. The boat starts for Stanstad at an earlier hour than we like and returns later than we like, but if people want to do too much in a

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day, why, they must take a little out of the night at one or both ends. However, if circumstances compel a hasty visit, the double journey can be comfortably made from Lucerne in 12 or 13 hours, going to Stansstad by boat. What memories cling around Stansstad! Just before the landing stage one sees an old weather-beaten tower, the Schnitz Tower, an old watch tower, while close to the landing stage is an hotel named after one of Switzerland's most famous men, Winkelried. Indeed, peace and war twine illustrious names around this spot in Pestalozzi, the apostle of education, and Winkelried, the devotee of freedom. Pilatus frowns across the lake, but we have already seen the beauties of the view from its top, and to-day are bound to Engelberg. Landing at Stansstad, we enter the electric car, and compose our minds to hear Nature's music:

Nay, tell me not of lordly halls,
My minstrels are the trees;
The moss and the rock are my tapestried walls,
Earth's sounds my symphonies.

There's mighty music in the roar
Of the oaks on the mountain side,
When the whirlwind bursts on their forehead hoar,
And the lightning's flash blue and wide.

Away, amid green fields and orchards, at times by the side of a purling stream, onward and upward till you gain glimpses of swifter-running water, even if it be not a

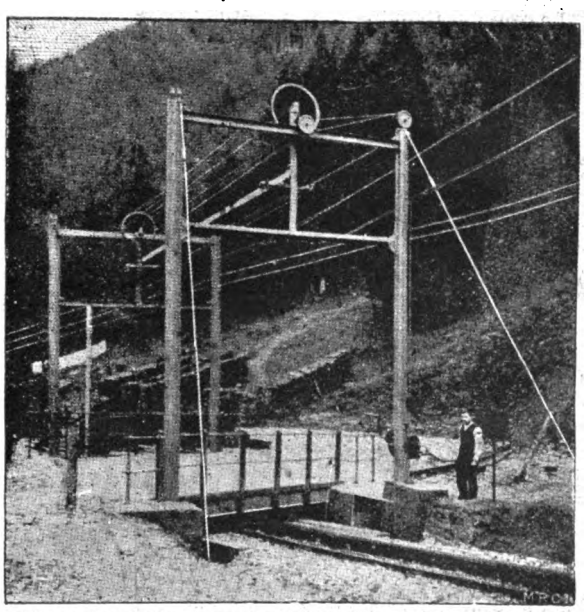

FIG. 2.—Drawbridge Lowered; Trolley Wires Raised for Passage of Vehicular Traffic—Stansstad-Engelberg.

miniature rapid, the hills draw closer, though still clothed in green verdure and foliage, till the ascent becomes steeper, the side rocks grander and gloomier, and the depths deeper. A halt is called for the smooth-rail to give place to the rack-rail section, and a climb similar to that on Pilatus has to be faced. Yet steadily upward, with the glint here and there of snow-capped summits and the wilder Alpine scenery. At last Engelberg—a valley in the midst of the beauty of the mountains, a health resort of no mean repute, the summer home of many an English family. Here the familiar speech of our island home is almost as common as in the valley of the Thames. Here flashes the blazer of an English tennis club; brother—or somebody else's brother—and sister playing tennis in the dusk, with a vigour that makes one's heart thrill to think that England's games are of a robust type. Then there are the everlasting hills calling you to invade their solitude, to brace up the nerves and educate the muscle, to drink your fill of silence and of beauty. But ours is a more homely task, to tell the tale of the line that carries us to and fro, and we turn from the sight of the glistening snow with regret to obtain details of construction and apparatus.

The Stansstad-Engelberg Electric Railway not only acquires more than ordinary interest from the fact that it represents one of the latest examples in which multiphase currents have been successfully employed for traction work, but, further, because the railway in its construction and working closely resembles a line of standard gauge. Numerous difficulties were encountered during the construction of the railway, and it will also be of interest to learn how these were overcome. The question of connecting Stansstad and Engelberg by means of a combined adhesion and rack railway was first mooted in the year 1890, when the practicability of utilising the waste water power of the Engelberg Valley for working such a line was recognised. It was originally proposed to employ continuous current, but the rapid progress made in the application of multiphase alternating currents to traction work led to the ultimate adoption of the latter system. A company was formed in 1896 with a capital of two million francs to finance the undertaking, the execution of the project being entrusted to Messrs. Locher and Co., of Zürich, which firm commenced the work of construction early in the following year. But while Messrs. Locher and Co. were responsible for the scheme as a whole, sub-contractors appointed by them contributed largely to the scheme. The firm of Bell and Co., Kriens, were entrusted with the hydraulic work, including the supply of turbines, etc., the order for the necessary rolling-stock being divided between the Schweizerische Lokomotiv und Maschinenfabrik, Winterthur, and the Schweizerische Industrie Gesellschaft, Neuhausen, while the electrical equipment was entrusted to Messrs. Brown, Boveri, and Co., Baden.

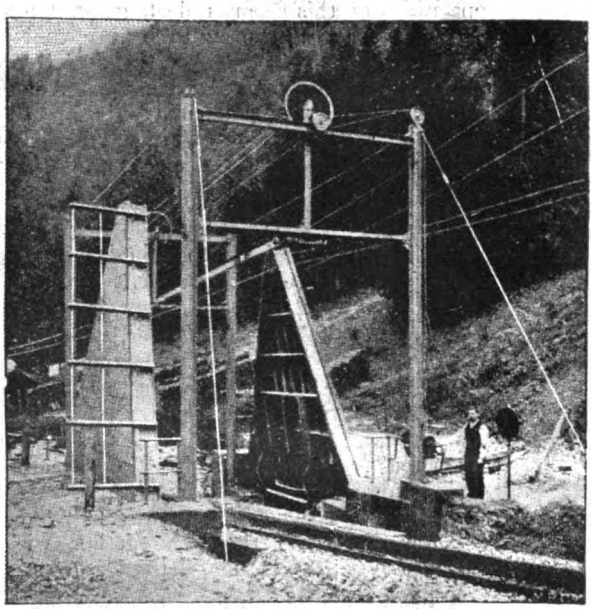

FIG. 3.—Drawbridge Raised; Trolley Wires in Position for Passage of Train—Stansstad-Engelberg.

The railway has an open track, with a 1m. gauge from the landing stage in Stansstad (Fig. 1), through level country to the neighbouring town of Stans. Until quite recently the latter place was practically isolated from the rest of the world, not possessing railway connection of any sort, but its inhabitants are now in the position to choose between two electric lines, for Stans is also connected with the shores of the Vierwaldstätter-See by an electrically-worked tramway, continuous current being employed in this case. The relative efficiencies of the two systems may furnish some interesting comparisons in the future. Beyond Stans the track passes by Oberdorf, thence along the left bank of the Engelberger Aa. In the neighbourhood of the Dallenwyl Station the railway crosses this river by means of a trestle bridge 104ft. in length, whence it proceeds *vid* Wolfenschiessen to Grafenort. At this point the first considerable incline, with a maximum gradient of 5 per cent., occurs. After crossing the Kaltebach by means of a viaduct, the track proceeds in the direction of the power-house at Obermatt, where the rack section of the line commences. This has a length of 9½ miles, and a maximum gradient of 25 per cent. In the centre of this section is the stopping stage, Grünenwald, where the Poststrasse crosses the track, which latter lies about 3ft. below the level of the street. The circumstance that both the railway and street curve at the point where they intersect, coupled with the fear that the vehicular traffic over the crossing might increase

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the difficulty of keeping the rack in repair, rendered it undesirable to construct an ordinary level crossing. On the other hand, the nature of the soil at the spot precluded any idea of a tunnel, so that a drawbridge remained the only alternative. But even this solution of the problem entailed considerable difficulties, for the necessary clear height above the roadway to enable vehicular traffic to pass considerably exceeded the height of the trolley wires over the railway track. Means had, therefore, to be provided whereby that section of the trolley wire over the bridge might be raised to allow of the passage of vehicular traffic, and lowered again to its proper level to admit the passage of a train. The arrangement of this drawbridge, with the adjustable section of trolley conductor above, is shown in Figs. 2 and 3. It may be mentioned that the bridge is moved entirely by hand, the time required for raising the bridge and letting down the trolley wire being about a minute.

(To be continued.)

ELECTRIC LIGHTING AT SHANGHAI.

We have just received from the Municipal Corporation of Shanghai the report for the year ending Dec. 31, 1899. The early appearance of this report reflects great credit on all the officials, as it had not only to be prepared and printed, but the length of time taken in transit from Shanghai to London is no inconsiderable one. Amongst the individual reports we are particularly interested in that of the electrical superintendent, which gives, amongst other things, the balance-sheet of the electrical works for the year 1899. This report, which is dated Jan. 4, reads as follows:

Gentlemen,—I have the honour to submit my second annual report upon the electrical department for the year ending Dec. 31, 1899.

Steam-Raising Plant.—The plant installed before the commencement of this year has given satisfaction, with the exception of defects to the furnace plates of the Lancashire boilers. It is probable that these plates will require replacing by new ones. A water-tube boiler of 350 h.p. was erected in August, and has worked fully satisfactorily. A new boiler feed-pump house and firemen's quarters have been erected over part of the coal yard, the two old and one new steam-pump erected therein, together with a complete duplicated system of suction, delivery, and steam-piping for these pumps.

Generating Plant.—The generating plant for arc lighting remains the same as last year. One 16-n.h.p. engine and 25-kw. alternator have been removed from the incandescent lighting machinery and two 150-kw. direct-coupled steam alternators have been erected in their stead. These new generating sets were supplied incomplete, the steam-engine governors not being fitted with suitable gear. The working of these engines has in consequence not been fully satisfactory, and, after connecting customers who had been waiting a considerable time for the supply, it was deemed expedient to await the arrival of the governor gear and fit same to engines before connecting any more customers. The makers explain that the congested state of trade in England has prevented their obtaining delivery of certain patented gear, and this is their reason for shipping the plant incomplete. Various minor troubles have been experienced with this new plant, partly from the defective governors. The present net capacity of the incandescent lighting machinery is 265 kw.; the maximum demand has at present reached 165 kw. The total number of incandescent lamps connected to the supply is equal to 13,000 8-c.p. lamps, being an increase of 2,224 lamps over the number connected last year.

Distributing Mains, etc.—The present high-tension mains for incandescent lighting are now at times utilised to their full normal capacity. The number of high-tension circuits remains the same as last year, extensions amounting to two miles having been added during the year. The present distribution system of isolated transformers in customers' houses is being changed in the more densely-lighted localities to the transformer sub-station system, the latter system being far preferable, and, indeed, absolutely necessary when the lighting in any locality gives promise of becoming fairly general. This new system has at present been installed as far as the materials at our disposal will allow, the majority of the additional lamps connected being supplied from transformer stations. Four stations in all have been constructed. It is hoped that the whole of this work will be completed by next summer; during the time of conversion of the system our men will be employed in positions where they will be liable to contact with high-pressure mains, so that the question of an all-day supply is for this reason alone definitely shelved until the new system is completed.

(Signed) J. PEEL NELSON, electrical superintendent.

Following the report there is an estimate from the superintendent of the expenditure and receipts for 1900, and then appears what is called the "working account" for 1899. This we reproduce below:

WORKING ACCOUNT FOR 1899.

Expenditure.

Charges	£341
Coal	6,160
Fire insurance	323
Interest	3,250
Rent and taxes	37
Repairs	2,050
Maintenance	1,598
Wages	4,200
Balance	8,230
Total	£26,189

Receipts.

Receipts for lighting and sale of material	£26,185
Dividend on one share, Union Insurance Society of Canton	4
Total	£26,189

It will be seen from the accounts that the undertaking has an income of over £26,000. The capital account of the undertaking stands at just over £70,000, which is not high considering the income above mentioned. From what we can gather, the interest included amongst the costs is interest due on the loan obtained for electric lighting purposes. If this is so, the balance of £8,000 is available for depreciation, and from the balance-sheet of the undertaking we find that they have provided liberally for depreciation during the last two years. As the number of arc lamps in the private lighting are not mentioned, it is not easy to ascertain the income per equivalent 8-c.p. lamp fixed. An approximate estimate, however, shows that this income is somewhere about 33s. 6d. per incandescent lamp per annum. We gather from the estimate for 1900 that the arc lamps used for public lighting are charged at £82 per lamp per annum, which seems an excessive price. At the end of the report it is stated that, in the early months of the year the Council was approached by Sir Charles Ross, who was prepared to purchase outright the whole of the municipal plant and privileges, and to undertake the supply of light to the settlement by means of a local public company. The Council held an exhaustive enquiry into the advisability or the reverse of accepting the offer, regarding the question both from an administrative and a financial point of view. Its conclusions, embodied in the following resolution, had the support of the ratepayers at the special meeting on June 20: "That due enquiry having been made into the financial and general conditions of the municipal electrical department, it is not at present expedient to consider the question of disposing of the plant and business of that department."

FORTHCOMING EVENTS.

FRIDAY, APRIL 20.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., at Sunderland, ordinary meeting.

SATURDAY, APRIL 21.

North-East Coast Institution of Engineers and Shipbuilders.—At Newcastle-on-Tyne, graduates' meeting.

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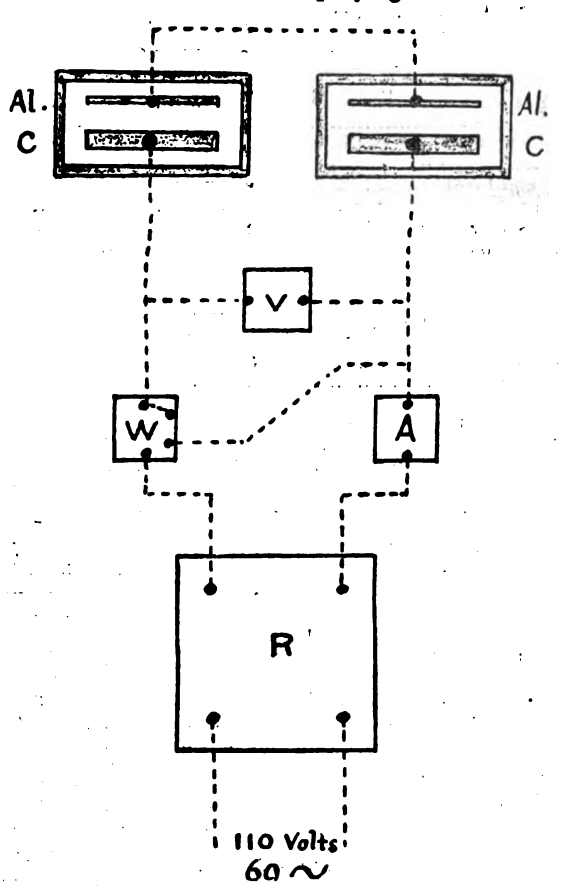
THE LUMINESCENCE OF ALUMINIUM ELECTRODES.*

BY W. S. ANDREWS.

While experimenting with two aluminium-carbon cells, I noticed a curious luminescence of the aluminium plates, which led to further investigation, a brief account of which may interest some of your readers.

The immersed surface of each plate was 4½in. by 4in. (one side), and the cells were charged with a saturated solution of Rochelle salts (double tartrate of potash and soda). Two cells were connected in opposition to each other, the aluminium plates being connected together, and the leading wires being attached to the carbon plates. (See sketch.)

The frequency of the alternating current used was 60 cycles, and the voltage could be varied by a regulating transformer. A voltmeter, ammeter, and wattmeter were connected as shown in the accompanying sketch, in which



Connections of Cells.

Al are aluminium plates; C, carbon plates; V, voltmeter; W, wattmeter; A, ammeter; and R a regulating rheostat. With this arrangement the following readings were taken:

Volts.	Amperes.	Watts.
90	·25	5
110	·25	10
120	·3	13
130	·35	15
140	·4	20
150	·5	25
155	·7	70
160	1·4	150
165	2·0	240

At about 90 volts the submerged portion of the aluminium plates became faintly luminous. At about 120 volts a number of little stars appeared on the luminous surface, which was now much brighter, and these stars increased in number and brilliancy as the voltage was raised. At about 150 volts a singing noise was audible, probably due to the rapid formation of bubbles on the surface of the aluminium. All the above phenomena increased in intensity up to 165 volts, when the liquid became so turbid with bubbles that the surface of the plates was hidden, and the voltage was not pushed any higher.

* From an article in the *Electrical World and Engineer*.

The stars and luminescence were not entirely confined to the immersed portion of the plates, but extended above the surface of the liquid as far as the salts had crept up the plates. Providing the cells are connected in opposition to each other, it is unimportant whether the aluminium or the carbon plates are on the outside.

The voltages as above given are only correct in connection with the series of phenomena described under conditions which obtained at the time of observation, which was about 48 hours after the cells had been charged. With newly-charged cells the luminescence and stars will appear at a much lower voltage, and the leakage of current through the cells will also be greater. Under this condition the current should be started at about five volts and gradually increased. If a much higher voltage is used at the start the rush of current will almost amount to a short-circuit, but after the cells have been in use for several hours the starting voltage may be as high as 50 volts.

The apparent high resistance of these cells to an alternating current may be due to the formation of a non-conducting film of oxide on the surface of the aluminium when the latter is an anode, and as each of the aluminium plates becomes an anode in its turn as the current alternates, the resistance is continuous.

The luminescence which appears long before any stars are seen may be caused by a large number of very small stars that are individually too minute for the eye to distinguish (like the stars in the "Milky Way"), and the phenomena may be traceable to the "electric" forge effect, which also finds a unique application in the Wehnelt current interrupter.

A Wehnelt interrupter can easily be made with these cells by touching one end of a piece of small copper wire to one of the aluminium plates and immersing the other end in the liquid. This experiment should, however, be performed very carefully, for if one cell is short-circuited from aluminium to carbon by a copper wire, the other cell will only hold back the current in one direction, so that the current in the other direction will be practically short-circuited through the copper wire.

SOUTHWARK LIGHTING.

CHANGE OF STANDARD PRESSURE.

The City of London Electric Lighting Company are proposing to increase the standard pressure of supply under the Southwark Electric Lighting Order of 1891 from 100 to 200 volts. The consent of the London County Council to such a change has to be obtained, and the matter has been reported on by the Highways Committee. This committee have come to the conclusion that the conditions attached to the Council's consent to the change should be more stringent than those imposed by the Council on Aug. 1 last in consenting to the alteration of the standard pressure of the Westminster Electric Supply Company, between which and some of its consumers difficulty has since arisen regarding the alteration. The final form of their consent as given on Tuesday last is as follows:

That the Council do give the consent required by the Board of Trade regulations under the Southwark Electric Lighting Order, 1891, to the alteration from 100 to 200 volts of the standard pressure given by the City of London Electric Lighting Company within the area specified in the schedule to the said order, such consent being, however, subject to the following conditions:

1. That when an installation in any consumer's premises is to be changed to the higher pressure, the undertakers shall themselves carry out, or bear the cost of, any alterations which may be necessary in the wiring or the fittings of such premises, and shall at their own cost execute any repairs and make good any damage or injury to such premises which may be rendered necessary, or caused by, the carrying out of such alterations. Provided that if any dispute shall arise between the undertakers and any consumer as to what alterations or repairs may be necessary or what damage or injury to such premises has been caused as aforesaid, such dispute shall be decided by an arbitrator to be agreed on between the undertakers and the consumer, or, failing agreement, to be appointed by the Board of Trade on the application of either party after notice to the

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other, and the expenses of arbitration shall be borne and paid as the arbitrator may direct.

2. That in the case of special fittings, and for lamps of small candle-power, the new lamps shall be arranged in series where so desired by the consumer.

3. That all the consumer's lamps in use and in stock shall be replaced by the undertakers, free of charge, with new lamps suitable for the higher pressure.

4. That when any such supply has been changed to the higher pressure, the consumers shall be informed, in writing, by the undertakers that all the necessary alterations have been made and that the installation is in a satisfactory condition.

5. That when any such supply is to be changed to the higher pressure, the undertakers shall offer to the consumer to communicate with the fire insurance companies concerned, and shall take all reasonable precautions to prevent the policies being affected; and, if any increase shall be made in the premium charged upon such policy in consequence of the change to the higher pressure, the consumer shall be entitled to deduct the amount of any such increase from the payment to the undertakers for electric supply.

6. That the undertakers shall make good, at their own expense, any defects which may develop in any installation within 12 months of the date when the pressure is changed or the alteration completed (whichever may be the later date), where such defect can reasonably be attributed to the increase of pressure. Provided that if any dispute shall arise between the undertakers and any consumer as to such defects as aforesaid, such dispute shall be decided by an arbitrator to be agreed on between the undertakers and the consumer, or, failing agreement, to be appointed by the Board of Trade on the application of either party after notice to the other, and the expenses of arbitration shall be borne and paid as the arbitrator may direct.

7. That if the supply be given by a three-wire system, then, subject to the approval of the Board of Trade, the middle wire shall be earthed as that Board may direct.

8. That when the supply is changed to the higher pressure on any consumer's premises, a reduction of not less than 15 per cent. shall be made in the price charged for supply at the time at which the change is so made.

9. That no increase shall be made in the price charged for supply to consumers who, under the powers conferred by the Board of Trade regulations, refuse to consent to the change in the pressure.

10. That in all cases where three wires are brought into any premises with any pressure above 220 volts between the outer wires, either one outer wire shall be removed or the two sides shall be separated by a reasonable distance, the middle wire being split and proper fuses placed upon it, thus making two pairs of undertakers' terminals at least 6ft. apart.

11. That the undertakers, when the supply is given by an alternating system, shall, whenever called upon by a consumer, provide upon the premises of such consumers a two-to-one transformer.

12. That a print of the foregoing terms and conditions shall forthwith be sent by the undertakers to all their consumers.

While some of the above regulations are fair and reasonable, others cannot be defended either on the ground of safety or common sense. For instance, by condition No. 10 there must be 6ft. between the fuses of the conductors, with 400 volts between them, where the supply is given on a three-wire system. From this one would assume that the electrical advisers of the London County Council considered 6ft. the minimum safe distance between conductors with that difference of pressure between them. Yet this is the standard pressure of the motor supply, and no one dreams of specifying a commutator 6ft. diameter for these motors, or even that the terminals shall be 6ft. apart. In fact, the regulation is as crude and absurd as the old attempt to distinguish a good fuse from a bad one merely by the length of the break. Taking another condition, No. 8, we believe that the London County Council have no jurisdiction whatever in the matter of the price to be paid by consumers for electric energy. The eleventh condition is also very objectionable, and entails unremunerative expenditure on apparatus which also entails a constant loss of energy. On the whole we should not be surprised to hear that the Board of Trade is to be asked by the company to prune down the above conditions of consent.

Cleethorpes.—The electric light provisional order has passed the Examiner of Private Bills.

LIVERPOOL ELECTRICITY WORKS ACCOUNTS.

The accounts of the Liverpool Corporation electric supply department just to hand show a total expenditure to date on capital account of £769,588. 16s. 3d. Abstracts of the revenue account and balance sheet are given herewith:

Revenue Account.

Expenditure.

Dr.				£ s. d.
Generation of Electricity.				
Coal, including cost of unloading, etc.	£10,116	0	8	
Oil, waste, water, and engine-room stores	1,636	6	10	
Wages at generating stations	4,542	8	2	
Repairs and maintenance: buildings, £697. 17s. 7d.; machinery, etc., £1,350. 10s. 3d.	2,048	7	10	
				18,343 3 6
Distribution of Electricity.				
Wages	1,370	10	1	
Repairs and maintenance of mains	1,082	5	6	
Repairs and maintenance of meters	537	4	4	
Repairs of machinery at distributing stations	479	15	4	
				3,469 15 3
Cost of change of pressure of supply				581 1 1
Rents, Rates, and Taxes.				
Rents	1,414	8	9	
Rates and taxes on buildings, plant, property, etc.	2,162	14	10	
				3,577 3 7
Management Expenses.				
Salaries—viz., engineer's department	4 946	14	9	
Contribution to the city fund	1,000	0	0	
Stationery, printing, and advertising	396	3	0	
General establishment charges	448	1	0	
				6,790 18 9
Special Charges.				
Insurances—buildings, plant, property, etc.	354	15	4	
Expenses for certification of meters	221	10	0	
Proportion of cost of management of Corporation stock	3	1	7	
Stamp duty on ditto	97	17	2	
Law charges	1	11	6	
Repairs and maintenance of property	107	2	0	
				785 17 7
Amount written off for bad debts				57 17 9
Balance carried to net revenue account				39,956 2 11
				£73,562 0 5

Cr.	Income.	£ s. d.
Sales of energy for lighting and power		59,713 2 9
Ditto public street-lighting		1,924 17 8
Ditto electric tramways		7 362 3 10
Rental of meters		1 686 15 4
Rents of property		806 8 6
Manufacturing account: sales and repairs, £19,500. 11s. 9d.; less wages and material, £17,431. 19s. 5d.		2,068 12 4
		£73,562 0 5

Balance-Sheet.

Dr.	Liabilities.	£ s. d.
Loans, as per capital account		350,000 0 0
Sundry creditors		34,747 4 2
Telephone rents suspense account		110 6 2
Surplus and sinking fund		78 789 5 11
Bank balance due to the Bank of Liverpool		373,176 17 0
		£836,823 13 3

Cr.	Assets.	£ s. d.
Land, building, plant, etc.—amount expended		769,588 16 3
Stocks on hand		3,519 17 8
Sundry debtors		28,166 10 9
Investment of sinking fund		35,548 8 7
		£836,823 13 3

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of

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any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

Questions.

261. Describe a periodical routine of testing for a system of underground mains, the instruments necessary, and method of keeping records.—G. Evans.

262. What would be the probable cost per kilowatt-hour of a continuous supply of electrical energy throughout the year to an electro-chemical process requiring, say, 2,000 kw. regularly, assuming that steam-engines are used and that coal costs 7s. 6d. per ton?—P. T.

Answers.

Question No. 255.—In an alternating-current station with a small day load, would it be advantageous to use a motor-alternator in conjunction with a set of accumulators? What is the usual arrangement when this is done?

Best Answer to No. 255 (*awarded* 10s.).—The answer largely depends upon the ratio of the full load of the smallest alternator in the station to the full-load output for which the complete plant is put down. For instance, if the plant consists of four large machines of equal power, one of these large machines will have to be run on a small day load, involving much waste of power. But if the station contains a large number of units, or one small plant specially reserved for day load and for use as auxiliary to larger machines, the small load can be taken by a small machine, this machine working at its best efficiency at or near full load.

In the first case stated, it is obviously necessary to have some auxiliary plant for reducing loss due to inefficiency, although the evil may be mitigated to a small extent by having main sets with their greatest efficiency at, say, three-quarter load. The alternative to having a motor-alternator is to put in a small-size steam alternator. In this arrangement the large machines could be kept at full load, the small machine giving any excess current, the total efficiency of the station thus being raised. Of course, the small plant could not be run on the exciting 'bus bars if a main exciter were used, as it would be uneconomical to run both exciting and main sets for the light day load.

A point in favour of using a motor-alternator and battery is that the capacity of the steam plant installed may be somewhat less than the demand at full load on the station, the battery being relied on to get over the peak. During the long hours of light load the motor-alternator can be used to supply alternating current to the mains, the energy being supplied from the battery. When the large machines are running they can be kept at or near their full output, the motor-alternator absorbing any current not demanded by the town and charging the battery, the continuous-current machine acting as a dynamo. The motor-alternator and battery should be of such capacity that they will run the light load for about 16 hours out of the 24, the battery being charged in the remaining eight. It is doubtful, however, whether much saving is effected by the use of a motor-alternator and battery, as it is an extremely inefficient arrangement.

For purposes of comparison, let us take the efficiency of the motor at 92 per cent., that of the alternator at 89 per cent. (These figures vary slightly with type and size of machine.) Efficiency of combined direct-coupled set therefore equals

$$\frac{92}{100} \times \frac{89}{100} = 82 \text{ per cent. (full load).}$$

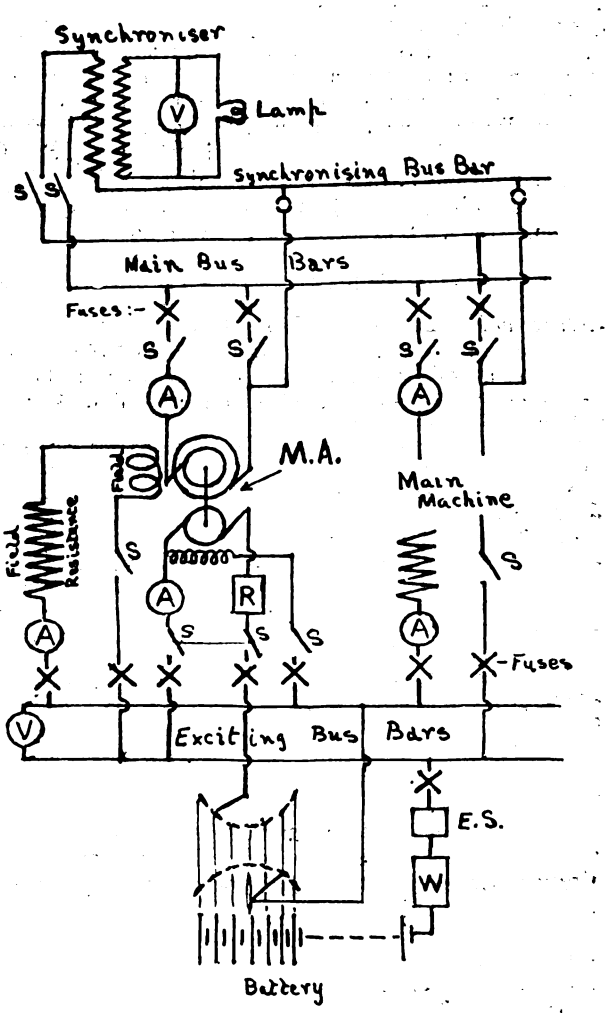
We are not safe in taking the battery efficiency—*i.e.*, the ratio of its charge to its discharge capacities—at above 80 per cent. even when new, and a battery deteriorates so rapidly that even old-established battery makers do not care to undertake the maintenance of a battery at its original output. The combined efficiency of the transforming plant may be taken, then, at about

$$\frac{82}{100} \times \frac{80}{100} = 65 \text{ per cent.,}$$

considering the discharge only. As, however, energy is previously lost in the main generating sets while running the alternator as a motor, the above efficiency is again reduced. The efficiency of a fairly large steam alternator at full load may be taken as 85 per cent. The total percentage of the power at the steam-engine stop-valve given back from the motor-alternator to the 'bus bars will, therefore, be only

$$\frac{65}{100} \times \frac{85}{100} = 55{\cdot}5 \text{ per cent.}$$

Against this we have the fact that a main generating set running at only quarter load would have an efficiency of about 65 per cent. The precise all-day efficiencies of the station—(*a*) using a motor-alternator, (*b*) running a main machine at light load—could be determined from the above, if we knew the number of main sets and the shape of the load curve of the station. It would not, however, be found that much saving is effected by the use of a motor-alternator.



It must be remembered that extra depreciation on plant and interest on capital must be met. A motor-alternator and switch gear for 200 kw. would cost, say, £3,700. For a storage battery of 1,600 kilowatt-hours capacity, connected up to switch gear, we may allow £4,500. Allow for interest at 5 per cent. on both the above, and maintenance of battery at 7½ per cent. Least annual charge on above capital equals

$$\frac{5}{100}(4{,}500 + 3{,}700) + \frac{7\frac{1}{2}}{100} \times 4{,}500$$

$$= 410 + 337\tfrac{1}{2} \text{ pounds sterling}$$

$$= £747.\ 10s.$$

Against this may be placed the cost of a small steam plant of the same output as the motor-alternator, to be used as suggested in the second paragraph. Such a set, complete with switch gear and erected, might cost about £4,500. The interest at 5 per cent. would be £225 per

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annum, the extra cost per year for the motor-alternator and battery being £522. 10s. (Depreciation is not allowed for in either case.) This heavy sum would require a considerable increase in units sold or decrease in running expenses to justify the introduction of a motor-alternator. The storage battery may be used on the exciting 'bus bars. If it is considered safe to trust to the good running of two machines and a battery instead of one steam-engine and dynamo, the cost of an exciting set may be put against the cost of the motor-generator.

A practical difficulty in using these motor-alternators may be mentioned. If by any chance the power on the 'bus bars fails while the alternator is being run as a motor (as when a fault short-circuits the bars), the motor-alternator goes out of step, impelled by the weight of the direct-current armature, making the lights jump badly and rendering it a horrible job to synchronise any other machine.

The usual switchboard connections for an arrangement of motor-alternator are shown diagrammatically. In the diagram M A indicates the motor-alternator, the alternator slip-rings being shown at the top, the motor-commutator and field beneath; S indicates a switch; V, a voltmeter; A, an ammeter; R, the starting resistance for the motor; E S, the emergency switch for the battery; W, the differential watt-hour meter (preferably provided with a compensating adjustment for the loss in the battery). Of course, the arrangement shown in the diagram (which does not profess to be complete) has to be modified to suit particular purposes. Some engineers prefer to have as few fuses as possible; others have a spare alternating current 'bus bar, and so on.—WHITE.

Answer to No. 255 (*awarded* 5*s.*).—That it is an advantage to use a motor-alternator in an alternating-current station will be seen from the following considerations: (1) The load factor of the day-load engine is increased during the

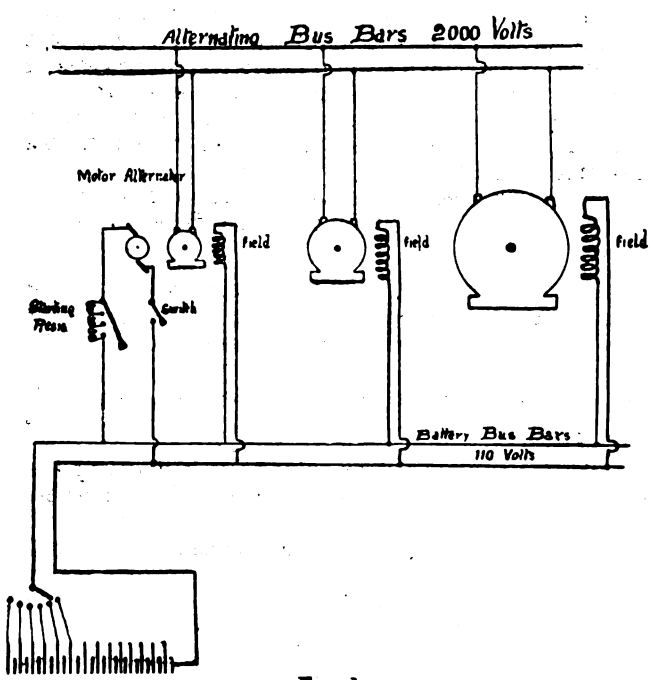

FIG. 1.

period of light load. This is due to the engine being arranged to drive, through suitable clutch gear, the continuous-current machine as well. Hence any surplus power not taken by the alternator is utilised to put a charge in the cells. (2) If the capacity of the cells and motor-alternator is sufficient to run for eight hours, then no steam plant is required to run during the night from 12 to 8 a.m. There is consequent saving of fuel and wages, as only two shifts of men are required for the stokehole and engine-house. (3) By the use of a motor-alternator in conjunction with cells an advantage is gained by arranging all the fields of the alternators to be excited from the cell 'bus bars. This does away with the necessity for a separate exciter for each machine, and the consequent wear and tear of brush gear. There is therefore more security against the larger units being put out of action through faulty exciters. (4) Lastly, another advantage which should not be overlooked in an alternating station is that of being able to change the works lighting by means of a throw-over switch from the transformer to the battery in the event of sudden interruption in the supply. The station motors required for driving fans, scrapers, mechanical stokers, etc., can also be run from the battery 'bus bars permanently.

As to how the above arrangements are carried out, the sketch (Fig. 1) will make clear the connections. Where a motor-alternator is used in conjunction with a battery, the following are the usual combinations obtained: (1) Engine driving alternator and dynamo during daytime, the dynamo charging cells, the alternator supplying the day load. The engine is kept up to a full load, and as the alternator load increases the dynamo load is decreased. (2) Engine disconnected by clutch, and alternator running as a motor (from one of the larger sets) driving the dynamo, which may be either charging cells or exciting the whole of the running plant in case the cells are out of circuit. It, therefore, acts as a reserve exciting plant. (3) Engine disconnected and the dynamo (motoring from the cells) driving the alternator, which can supply the small lighting load during the night from 12 midnight till 8 a.m.—D. M. A.

Question No. 256.—In winding the armature of a continuous-current transformer is it necessary for the primary and secondary windings to be wound in opposite directions—*e.g.*, assuming the primary winding to be wound in a clockwise direction looking on the primary commutator, must the secondary winding be wound in a clockwise direction looking at the secondary commutator? This question applies, of course, to a transformer with two windings on a single core.

Best Answer to No. 256 (*awarded* 10*s.*).—In a continuous-current transformer, one of the *sine quâ nons* under ordinary working conditions is that it shall run sparklessly without alteration of lead for any change of load, and machines of the type mentioned in the question happily fulfil this condition whether the winding of the primary and secondary be in either the same or opposite directions. Considering Fig. 1, which is an ordinary right-handed ring-wound motor, it will be seen that armature reactions will cause the top of the ring to become a north pole, and the line of neutral field or point of sparkless collection will be shifted from A B towards the line C D, or, in other words, the motor will require a backward lead. Now, looking at Fig. 2, in which

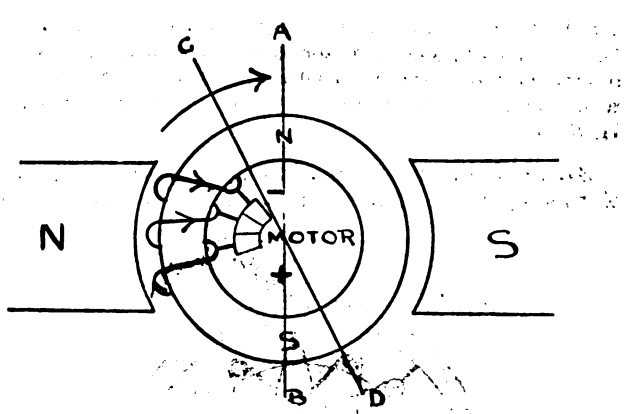

FIG. 1.—Right-Handed.

exactly the same conditions as to field and direction of motion exist, it will be seen that as a generator, instead of the top terminal being positive, as before, it is now negative, the direction of the current is reversed, and thus the distortion of field is in the opposite direction—that is, from A B towards E F—so that if these two windings were superimposed, the effect of one would neutralise that of the other. This is the condition of things which must exist in practice so as to obtain sparkless collection.

Leaving all the factors in Fig. 1 as before, suppose we substitute a left-handed for a right-handed winding in the case of the generator, as in Fig. 3. The general direction of the current is reversed, the top terminal now being positive, but looking at each individual inductor, it will be seen that the direction of flow in it is still the same—

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namely, from front to back—and the distortion of field is the same as in Fig. 2. The top part of the ring is a south pole, causing the brushes to have a forward lead. Exactly the same conditions would exist if the winding of the motor side of the transformer were changed from right-handed to left handed; for then if the top terminals were still kept negative, the top part of the ring would now become a south pole, the machine would run in the opposite direction, and the polarity of the generator side would be reversed, causing

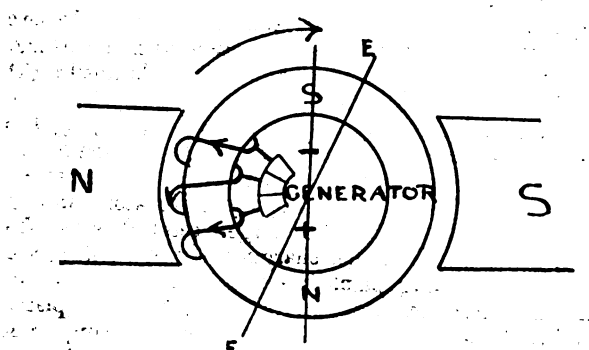


FIG. 2.—Right-Handed.

the two armature reactions to again neutralise one another. This argument applies equally well to drum armatures, which are the more usual in practice, though the ring type has been selected here as affording a simpler illustration of the mutual balancing effect of the two windings. If the primary and secondary are both in the same direction viewed from their respective ends, then the polarity of the

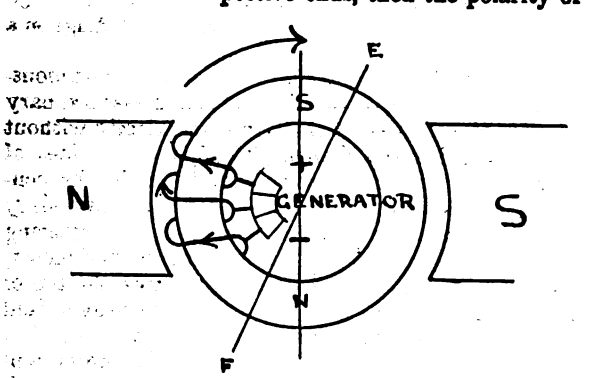
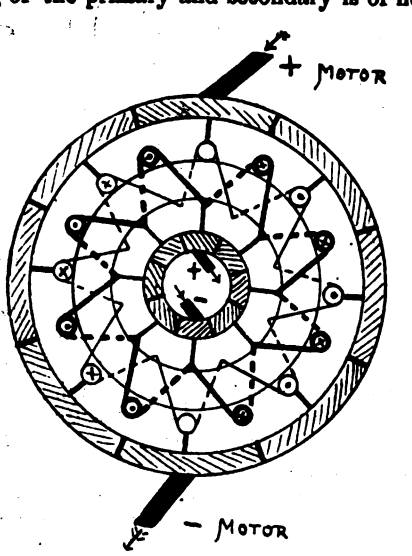


FIG. 3.—Left-Handed.

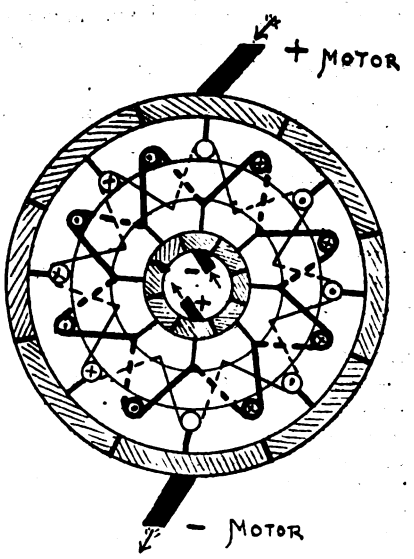
terminals on one side of the machine will be the same in both armatures, which for simplicity may be an advantage; otherwise there are no mechanical reasons why the two windings should be disposed in any particular manner.—H. F. C. B.

Answer to No. 256 (*awarded* 5*s.*).—The relative direction of winding of the primary and secondary is of no practical



Both Windings Right-Handed.

importance. The only way in which a change in this particular becomes noticeable is in the relative positions of the brushes of the same sign on the two commutators. Thus if both windings are of the same "hand," the top brush on both commutators will be of the same sign, say +—*i.e.*, current will enter the motor winding at the top brush on one commutator and current will leave the dynamo winding at the top brush on the other commutator. If, on the other hand, one winding is right-handed and the other left-handed, the top brushes will be + and − respectively. That the direction of winding has no effect on the



Motor Right-Handed, Dynamo Left-Handed.

direction of current in the conductors or on the armature reaction can be seen from the following two diagrams. Gramme windings are shown for clearness, but the result is the same with drum windings. It will be noticed that in whatever way the wires are wound, the currents (as shown by the crosses and dots) arrange themselves so as to produce practically no external magnetising effect—the two sets of conductors cancelling one another. This results from the fact that though all the wires under one pole have E.M.F.'s induced in them in one direction, yet the current on the motor side is forced through the winding in opposition to this induced voltage, whilst the dynamo current is the direct result of, and flows in the same direction as, the induced E.M.F.—Q.

Answer to No. 256 (*awarded* 5*s.*).—It is not a matter of necessity that the primary and secondary windings on the armature of a continuous-current transformer should be wound in any particular direction relative to each other, though it is desirable for several reasons that a degree of uniformity in this matter be always observed in practice. Fig. 1 is a diagram of the primary part of a ring armature wound clockwise; the direction of rotation is shown by the arrow, and the direction of the current in the conductors by arrowheads. Note that the + brush is at the top and the − brush at the bottom of the commutator. Fig. 2

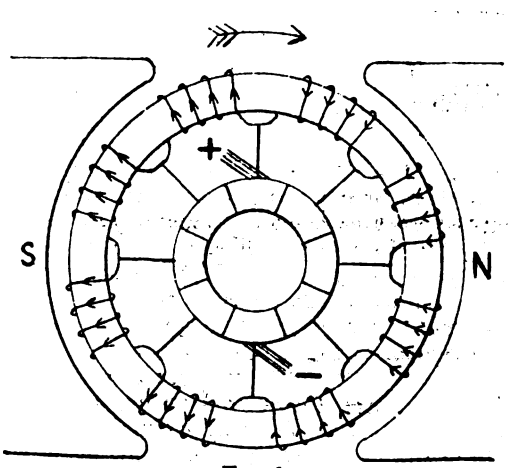


FIG. 1.

represents the secondary winding, and as it is considered looking at the secondary commutator, the position of the

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magnet poles and arrow showing direction of rotation appear reversed. In this case also the + brush is at the top and the – brush at the bottom; in other words, if the windings are arranged as suggested, brushes of the same sign are on similar sides of the respective commutators. Thus there is not the confusion which might occur if brushes of one sign were on different sides, especially if they were not marked. The direction of the current in the secondary is opposite to that in the primary windings, and for this reason the magnetising force of both windings being almost equal in amount there is little, if any, armature reaction, and the brush position is constant at all loads with no sparking. If the generator winding were counter-clockwise the direction of current round the core in each individual coil, and, therefore, the relative directions in the two

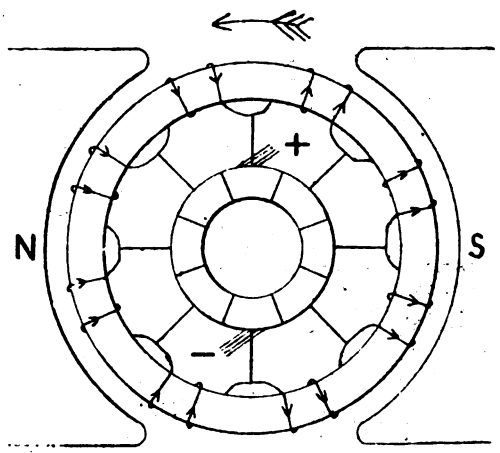

FIG. 2.

windings, are not altered, so the case of armature reaction remains the same. But as an end of any coil which in the first place is connected to the beginning of the coil to its right, is in the second joined to that on its left, the circulation of the secondary current round the armature as a whole is reversed. Consequently the + motor brush would come in line with a – generator brush. Another reason arises in practice for putting on both windings in directions which, when considered looking at the armature from the side where the respective commutators are placed, are similar. An armature winder will always be more expeditious in his work, and less liable to mistakes, the more uniform the work is which he has to do. Further, repairs are simplified.—G. EVANS.

LEGAL INTELLIGENCE.

PORTSMOUTH CORPORATION v. TRAMWAY COMPANIES.

In the Queen's Bench Division on Tuesday, before Justices Ridley and Darling, **Mr. Balfour Browne, Q.C.**, moved *ex parte* for a rule *nisi* for a mandamus directed to the Portsmouth Street Tramways and the Provincial Tramways Company calling on them to show cause why they should not give up possession of the tramways and undertakings belonging to them to the Corporation of Portsmouth. Besides the tramways which the Corporation were seeking to purchase, the companies had established a business in hearses, funeral and wedding coaches, omnibuses, cabs, and various other things, and they insisted on the Corporation purchasing those as well as the tramways. The Corporation declined, saying they had no power to purchase anything beyond the tramways.

Mr. Justice Ridley asked if the tramway companies contended that the Corporation were compelled to buy all their conveyances and stock?

Mr. Balfour Browne said that was the contention. Though the companies were not authorised by statute to carry on any other business than that of a tramway company, by their articles of association they were empowered to carry on the other business.

Their Lordships thought there ought to be a rule, which was accordingly granted.—*Morning Post.*

AUTOMATIC TELEPHONE COMPANY.

In the Court of Appeal, before the Master of the Rolls and Lords Justices Rigby and Vaughan Williams, judgment was given on Monday on the appeal by the plaintiffs from an order of Mr. Justice Cozens-Hardy, who had declined to make an order in the plaintiffs' favour in an action which had been brought against three of the directors of the company (Mr. Max Margowski, Dr. Schwann, and Mr. J. W. Cohen) for a declaration that they were bound to pay prior to, or at the date of, the action the application and allotment money due on shares which were held by them.

We quote from the *Financial Times*: The **Master of the Rolls**, having reviewed at some length the facts of the case, said he must come to the conclusion that the defendants were not justified in acting as they did. The agreement was one which could not be held to be binding upon the company. The charges of fraud, however, which had been made against the defendants had not been sustained, and the proper order, therefore, would be to allow the appeal and reverse the judgment appealed from; a declaration that the three defendants directors of the defendant company were guilty of a breach of their duty as such directors in not paying to the company in respect of the shares allotted to them 3s. per share, being the amount which had been paid by other members of the company, and leave to apply for an order for payment if necessary. The defendants would pay the costs of the appeal and also the costs of the action except such costs as had been occasioned by the charges of fraud, with respect of which the costs must be paid by the plaintiffs. There would be the usual set-off with respect to these costs.

COMPANIES' MEETINGS AND REPORTS.

BABCOCK AND WILCOX.

The ordinary general meeting of this Company was held at the offices, Queen Victoria-street, on Tuesday. Mr. J. Dewrance presided.

The report (already published by us) was adopted, the proposed dividends were declared, and the addition to the reserve fund was agreed to.

An extraordinary general meeting was held subsequently, when the reconstruction of the Company, the appointment of liquidators, and the transfer of the business to a new company was agreed to. Under the reconstruction scheme the preference shareholders will receive 10 £1 shares fully paid up for every £10 share now held, and the ordinary shareholders 20 £1 shares in the new company fully paid for every £20 share now held. Both classes of shareholders are to have the option of subscribing for £90,000 ordinary shares of £1 each at the price of £1. 10s. per share, in the proportion of one share for every six now held, the premium of 10s. per share to go to the reserve fund.

BROCKIE-PELL ARC LAMP.

The fourth ordinary general meeting of this Company was held on Monday last at their new works at 60, Worship-street, E.C.

Lord Suffield, who presided, stated that the hope which he expressed at the last meeting, that they would be able to submit a better balance-sheet, had been realised, and he trusted that at no distant date the accounts would warrant the payment of a dividend. The business had shown a steady rate of progress throughout the year. Further contracts had been made, and those in hand had been satisfactorily carried out. There had been a large increase in the output of lamps, and the lamp had well maintained its reputation. The works were and would be for some time fully occupied with existing orders. The shareholders would probably have noticed from the accounts that care had been taken to make special provision for depreciation. The Company had suffered in profits by the very high price of materials, and these high prices still continued. The directors had reduced their fees by three-fourths, and every effort had been made to limit expenditure, but the necessary technical and staff expenses were naturally heavy. These, however, would not be increased, except in a small ratio, as the trade extended. He was sure that the shareholders would agree with him in the greater suitability of their new premises for the special business of the Company. Three times as much trade could be done in the present premises than in the former ones, which were most unsuitable, and in which it was impossible to execute their orders as quickly as they should have done, and prevented them from keeping any large number of lamps in stock. The removal of such a business as theirs was a very heavy matter, but the change had been carried out without any stoppage of the works. The great improvement in the position and prospects of the Company was principally owing to Mr. Shrimpton and Mr. FitzGibbon. The Company had had a hard time, but they had now turned the corner, and he felt convinced that they would continue to make progress.

Sir F. D. Dixon-Hartland, M.P., seconded the motion, and showed that from the previous year a debit balance of nearly £1,500 was brought forward, whereas the present accounts showed that in the year under review a profit of about £1,250 had been made. Twelve months ago they were confronted with many difficulties, owing to their not then being a united body, but these difficulties had now passed away, and they had now turned the corner.

The motion was carried unanimously.

Sir F. Dixon Hartland afterwards referred to the financial position of the Company, and stated that there were two ways in which they could obtain more capital—by issuing debentures or by reconstructing the Company. He was himself in favour of the latter course, which would enable the directors to extinguish the debit balance of £5,647, and to write down the item of patent rights and goodwill, £60,197, while more capital might be provided by the shares in the reconstituted company carrying a certain liability.

It was finally decided that the directors and a few of the largest shareholders should meet after Easter to consider the question.

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BROMLEY ELECTRIC LIGHT.

The annual meeting of shareholders of the Bromley Electric Light and Power Company, Limited, was held last week, Mr. F. E. Gripper (chairman and director) presiding.

The directors submitted a report and statement of accounts, which were adopted. The latter showed a profit of £1,099. 12s. 1½d. The directors recommended that a dividend at the rate of 2½ per cent. be paid for the year ending Dec. 31, 1899, that the preliminary expenses (amounting to £161. 17s. 8d.) be written off, and that the balance (£861. 11s. 3½d.) be carried forward to next account. The directors' report stated further that up to the present time more than 22 miles of cable have been laid in the principal streets and roads where the demand is likely to justify the outlay. The plant is in first-class condition and meets the present demand, but in view of the difficulty in obtaining delivery, the directors have already put on order further extensions, which they are advised will soon be necessary. The supply since the establishment of the permanent plant has given satisfaction, and in many instances consumers have added to the number of their lamps. The demand for electric lighting in Bromley having largely exceeded the directors' anticipations, a resolution was passed authorising an increase of the capital of the Company to £50,000, and the issue of a further £10,000 of 5 per cent. debentures, which will in the first place be offered to the shareholders.

Mr. F. Medhurst was re-elected a director.

The proceedings concluded with votes of thanks to Mr. Gamlen (the engineer), Mr. Dickins (secretary), and to the whole of the staff for their services, and to the chairman for presiding.

CAMBRIDGE TRAMWAYS.

The half-yearly meeting of the shareholders of this Company was held on Friday at the Lion Hotel, Petty Cury. Mr. Barnabas Gibson, chairman of the board of directors, presided.

The directors presented a report and statement of accounts, showing a profit of £231. 17s. 7d., which sum it is proposed to carry forward. The report continued as follows: "The directors in their last report stated that the Corporation of Cambridge were expected to take advantage of their right to purchase the undertaking under Section 43 of the Tramways Act, 1870. It now appears doubtful whether or not this will be carried out. Under these circumstances the directors, in conjunction with their friends the British Electric Traction Company, have gone carefully into the question of the improvement and extension of the tramways, and have intimated to the Town Council that they are now desirous of reopening the negotiations with the view of making such improvements and extensions of the tramways as may be agreed between them, so as to afford the inhabitants of Cambridge the advantages of the latest improvements enjoyed by other towns where electric traction has been adopted."

The report and balance-sheet were adopted, and Messrs. J. Burford and J. Sturton were re-elected auditors. Mr. J. Catling was reappointed auditor, and a vote of thanks to the directors closed the meeting.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Birkenhead.—The Corporation invite tenders for various plant. Tenders by April 23.

Plymouth.—The Corporation invite tenders for overhead line construction, etc. Tenders by May 2.

Belfast.—The Electric Committee invite tenders for the supply of electric motors for a period of 12 months. Tenders by April 19.

Barrow-in-Furness. — The Corporation invite tenders for erection of extensions to the existing electricity works in Buccleuch-street. Tenders by 23rd inst.

Whitechapel, E.—The District Board of Works invite tenders for the construction of an electricity supply station at Osborn-street, Whitechapel, E. Tenders by 3 p.m. on 24th inst.

Sunderland.—The Corporation invite tenders for the supply of two additional switchboard panels, with instruments, etc., complete. Tenders by April 27. Details in our advertisement columns.

Wimbledon.—The Council invite tenders for an installation of electric wiring and fittings at their new isolation hospital. Tenders by 24th inst. Full particulars in our advertisement columns.

Dundee.—The Town Council invite tenders for the supply and erection at the electric station, Dundee, of a traction switchboard and equipments. Tenders by April 25. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of telephone cables (including drawing into conduits and jointing of same) and telephone instruments (wall and table). Tenders by April 18. Details in our advertisement columns.

Ilford.—The Urban District Council invite tenders for the construction and erection of (1) shaft, height 180ft.; (2) electric light station, comprising engine and boiler, battery-room, and the necessary offices for an electric lighting station. Tenders by 23rd inst.

Southampton.—The Corporation invite tenders for the supply and erection of one 300-kw. continuous-current generator, coupled direct to a medium-speed vertical compound steam-engine. Tenders by May 1. Full particulars in our advertisement columns.

London, S.E.—The Bermondsey Vestry invite tenders for erection of a chimney shaft, about 150ft. high, of brickwork, on the site of their new electric generating station in "Neckinger," Spa-road, at the rear of the public baths and wash-houses. Tenders by May 4.

London.—The Streets Committee of the Corporation of London invite proposals from firms or persons experienced in the manufacture and use of electric motorcars for the hire of an electrically-driven dustcart. Tenders by June 1. Full particulars in our advertisement columns.

Liverpool.—The Select Vestry invite tenders for an installation of about 100 lights in connection with the nurses' home of the workhouse, Brownlow-hill. Specification may be seen at the office of Mr. H. J. Hagger, vestry clerk, Parish Offices, Brownlow-hill, Liverpool. Tenders by 25th inst.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and erection of the following: boilers and accessories—viz., six Lancashire and four water-tube boilers and two economisers; polyphase generators—viz., two 1,000-kw. and two 500-kw. low-speed generators. Tenders by April 26. Details in our advertisement columns.

Mariupol.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Taganrog stating that tenders are invited by the Municipality of Mariupol not later than May 16 (29) for the construction and exploitation of an electric tramway and the installation of electric light in that town. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Barking. — The Urban District Council invite tenders as follows: (Contract No. 1) for the supply, construction, and erection of about 365 tons of cast iron and 235 tons of steel in an opening bridge over Barking Creek, 45ft. in clear opening, and to carry a double line of railway, together with two shore spans of 45ft. each, and the embanked approaches, and with all the electrical and other machinery and appliances incidental thereto and required for opening and closing the bridge by electrical power supplied from the generating station of the Council; (No. 2.) the construction of 73 chains of 3ft. 6in. gauge single-line railway (82lb. tramway rails) and 38 chains of double-line railway, with granite sett paving on concrete, electrical rail bonding, etc. Tenders before 12 noon on May 7.

RESULTS OF TENDERS.

Dundee.—The Tramways Committee have accepted the offer of Messrs. Dick, Kerr, and Co. to supply 20 cars of the Liverpool type at the price of £630 each.

Brancepeth.—The following tenders for electric light at New Brancepeth have been received: Messrs. Spoor, 24 lamps for £5. 10s. a lamp (accepted); Messrs. Scott and Mountain, £6. 10s. a lamp.

Dudley.—The Electric Lighting Committee recommend that the tender of Mr. Mallin for buildings and shafts at the new generating station, and of Messrs. Spencer, Limited, for roofs, be accepted.

Liverpool.—The City Council have accepted the tender of Messrs. R. W. Blackwell and Co., Limited, London, for carrying-out the overhead electrical equipment for the Aintree and Fazakerley tramway routes.

Barrow.—The tender of Messrs. Babcock and Wilcox, Limited, has been accepted (subject to the approval of the Local Government Board being obtained for the necessary borrowing powers) for further extensions to the electricity plant (Contract No. 7). Amount, £4,540.

Leeds.—The Tramways Committee have accepted the tender of the Electrical Construction Company, London, for an additional steam dynamo at the tramway electrical generating station. The amount is £10,000, and the committee have the option of ordering two more steam dynamos from the firm at the same price.

London County Council.—The offer of the Wireless Telegraph and Signal Company, Limited, to instal and maintain for a period of two years the necessary electric instruments to enable communication to be maintained between the street fire station at Streatham Green and the temporary sub-station in Mitcham-lane, at an annual payment of £50, has been accepted.

Fulham.—The following tenders have been received for the supply of 250 meters:

British Thomson-Houston Company, Limited (Thomson meter)	£1,277	10	0
British Westinghouse Electric and Manufacturing Company, Limited (Shallenberger meter) (part square)	900	0	0
British Westinghouse Electric and Manufacturing Company, Limited (Shallenberger meter) (all square)	1,300	0	0
Electrical Company, Limited (Hümmel meter)	1 250	0	0
General Electric Company, Limited (Aron meter)	1,280	0	0
Johnson and Phillips (Hümmel meter)	1,250	0	0
Venner and Co. (Hookham meter) (part round)	861	2	6
Venner and Co. (Hookham meter) (all square)*	1,071	2	6
Witting Bros., Limited (Hümmel meter)	1,062	10	0

* Recommended for acceptance.

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Gloucester.—The Corporation have received the following tenders for the wiring of the guildhall, public baths, and electricity works; also for the necessary electric light fittings for these buildings: National Electric Wiring Company, wiring of guildhall £360, fittings £366; Beavan and Sons, wiring of public baths £188, fittings £68; R. Alger and Son, wiring of electricity works £92.

Rainhill (Lancs.).—The following tenders have been received for electric lighting works at the County Asylum, Rainhill:

Contract No. 1.—Three Lancashire boilers and superheaters and a Green's economiser.

Lowdon Bros.	£2 550 0 0
A. Anderton (accepted)	2,735 0 0
Clayton, Sons, and Co.	2,824 0 0
Tetlow Bros.	2 845 0 0
E. Danks	2,965 0 0
British Insulated Wire Company	2 987 5 0
J. Thompson	3 050 0 0
J. Musgrave and Sons	3,124 0 0
Tinkers, Limited	3 210 0 0
P. Dewhirst	3,320 0 0
Yates and Thom	3,334 0 0
G. H. Woods and Co.	3,350 0 0
C. Hamilton	3,437 0 0
International Power Company	4 300 0 0

Contract No. 2.—Three 175 b.h.p. steam dynamos, with booster, switchboard, feed pumps, piping, tanks, crane, etc.

Bow and McLachlan (own engine)	6,426 10 0
T. Scott Anderson	6,436 0 0
P. Dewhirst (Browett engine)	6 509 10 0
G. H. Woods (Allen engine)	6 552 0 0
J. Dewhirst (Browett engine)	7,301 0 0
Thames Ironworks Company (Reavell engine)	7,108 0 0
Thames Ironworks Company (Allen engine)	7,116 0 0
Thames Ironworks Company (Browett engine)	7,564 0 0
Thames Ironworks Company (Belliss engine)	7,779 0 0
Thames Ironworks Company (Willans engine)	7 809 0 0
Lowdon Bros. (Reavell engine) (accepted)	6 749 0 0
Lowdon Bros. (Browett engine)	7,211 0 0
Lowdon Bros. (Belliss engine)	7,260 7 0
Phœnix Dynamo Company (Reavell engine)	7 260 0 0
Phœnix Dynamo Company (Browett engine)	7,534 0 0
Phœnix Dynamo Company (Belliss engine)	7,921 0 0
Phœnix Dynamo Company (Willans engine)	7 903 0 0
Lea and Warren (Allen engine)	7,407 0 0
Donnison, Berlyn, and Sillem (Willans engine)	8 117 0 0
C. Hamilton (Paul engine)	7,191 0 0
C. Hamilton (Browett engine)	7 489 0 0
C. Hamilton (Belliss engine)	7 705 0 0
F. Suter (Allen engine)	7,576 0 0
F. Suter (Browett engine)	8,226 0 0
F. Suter (Belliss engine)	8,226 0 0
F. Suter (Willans engine)	8 226 0 0
Lancashire Dynamo Company (Musgrave engine)	8 184 0 0
Lancashire Dynamo Company (Reavell engine)	7,679 0 0
Lancashire Dynamo Company (Browett engine)	8,187 0 0
Lancashire Dynamo Company (Belliss engine)	8,466 0 0
Lancashire Dynamo Company (Willans engine)	8 526 0 0
Johnson and Phillips (Allen engine)	7,750 0 0
J. Dewhirst (Browett engine)	7,790 0 0
Clayton Engine Company (own engine)	7 802 0 0
T. Parker, Limited, (Allen engine)	7,857 0 0
T. Parker, Limited (Browett engine)	8 222 0 0
T. Parker, Limited (Belliss engine)	8,222 0 0
British Insulated Wire Company (Browett engine)	8 654 0 0
British Insulated Wire Company (Belliss engine)	8 830 0 0
British Insulated Wire Company (Willans engine)	8,830 0 0
Crompton, Limited (Peache engine)	8 378 0 0
Crompton, Limited (Allen engine)	7,994 0 0
Crompton, Limited (Browett engine)	8,546 0 0
Crompton, Limited (Belliss engine)	8 608 0 0
Electric Construction Company (Reavell engine)	8,119 0 0
Electric Construction Company (Allen engine)	8 608 0 0
Electric Construction Company (Browett engine)	8,618 0 0
Electric Construction Company (Belliss engine)	8,608 0 0
Electric Construction Company (Willans engine)	8 863 0 0
W. B. Haigh	8,291 0 0
P. R. Jackson (Belliss engine)	8 376 0 0
R. Holliday and Sons (Belliss engine)	8 409 0 0
G. Hill (Browett engine)	8 497 0 0
Clarke, Chapman, and Co. (own engine)	8 680 0 0
Clarke, Chapman, and Co. (Browett engine)	8,834 0 0
Clarke, Chapman, and Co. (Willans engine)	9,044 0 0
International Power Company (own engine)	8 686 0 0
Mather and Platt (Browett engine)	8 770 0 0
Mather and Platt (Belliss engine)	8,890 0 0
Mather and Platt (Willans engine)	9,002 0 0
Brush Company (own engine)	9,452 0 0
Brush Company (Browett engine)	8,874 0 0
Musgrave and Sons (Musgrave engine)	8,876 0 0
R. W. Blackwell (Browett engine)	8,881 0 0
Musgrave and Sons (own engine)	9,021 0 0
Walsall Company (Browett engine)	9,042 0 0
Warrington Electric Company (Browett engine)	9,135 0 0
Walsall Company (Browett engine)	9,404 0 0
Musgrave and Sons (own engine)	9,598 0 0
B. Goodfellow (own engine)	9,735 0 0
Musgrave and Sons (own engine)	10,021 0 0

Contract No. 3.—Accumulators.

	Price of battery.	10 years' maintenance.	Cost and maintenance capitalised.
G. H. Woods and Co. (Pritchetts and Gold)	£1,482 0 0	£85 0 0	£2,332 0 0
Rooper and Robins (Epstein)	1,681 14 0	75 0 0	2 431 14 0
Chloride Company (accepted)	1,730 0 0	£104 for 5 years £120 for 5 years	2,850 0 0
British Insulated Wire Company (Chloride)	1,816 13 0	110 0 0	2,916 0 0
Tudor Company	1,861 0 0	108 0 0	2,941 0 0
P. Dewhirst (Chloride)	1,730 0 0	120 0 0	2,930 0 0
A. B. Pease	1 299 0 0	195 0 0	3 249 0 0
Marquand Company	1,869 18 0	140 5 0	3,272 8 0
Drake and Gorham (Chloride)	2 211 0 0	134 0 0	3,556 0 0
Hart Accumulator Company	1,844 0 0	181 0 0	3,654 0 0
Electrical Power Storage Company	1,984 0 0	193 0 0	3,915 0 0

Incomplete tenders.

		Five years' maintenance.	
D.P. Battery Company	1,542 0 0	—	—
Drake and Gorham (D.P. battery)	1,568 0 0	—	—
Lea and Warren (D.P. battery)	1,680 0 0	—	—
T. Scott Anderson	1,700 0 0	140 0 0	—
Lowdon Bros.	1,730 0 0	110 0 0	—
C. Hamilton	1,760 0 0	133 0 0	—

Contract No. 4.—Feeders (solid system).

T. Scott Anderson	1 597 11 0
Rooper and Robins	2,184 15 10
St. Helen's Cable Company, 10 years' free maintenance (accepted)	2 336 5 10
British Insulated Wire Company	2 407 4 2
Callender Cable Company	2 442 5 0
P. Dewhirst	2,456 2 6
W. T. Glover and Co.	2 467 10 10
G. H. Woods and Co.	2,529 14 6
C. Hamilton	2 586 6 8
W. T. Henley and Co.	2,603 5 2
Drake and Gorham	2,742 5 0
Pratt and Keith	2,828 15 0
Lea and Warren	2,833 7 0
G. Hill and Co.	2,923 5 0
Lowdon Bros.	2,940 3 4

Contract No. 5.—Wiring of buildings.

J. Bakewell	2 896 10 0
Lowdon Bros. (accepted)	3,460 0 0
P. Dewhirst	3,559 4 0
Campbell and Isherwood	3,565 0 0
J. Dewhirst	3 646 0 0
Lummis-Patterson	3,707 19 0
Middleton and Co	3,735 0 0
Donnison, Berlyn, and Sillem	3,927 0 0
G. H. Woods	4,055 0 0
Drake and Gorham	4,149 0 0
Lea and Warren	4 257 15 0
Rooper and Robins	4 626 13 0
Parr and McLachlan	4,760 0 0
C. Hamilton	4 794 0 0
T. Scott Anderson	4,860 0 0
Walsall Electrical Company	5,065 0 0
Ensor, Brentnall, and Co.	5,239 0 0
National Electric Wiring Company	5,452 10 0
N. Hirst	5,500 0 0
British Insulated Wire Company	5,514 1 2
Pratt and Keith	5 747 10 0
L. Kendall	5,820 0 0
G Hill and Co.	5 850 0 0
Eckersley and Co.	6 045 10 0
Sharples, Taffs, and Co.	6,068 10 0
A. Dickenson	6,115 0 10
F. Suter	6,158 0 0
Rochdale Electrical Company	6 193 0 0
Alliance Electrical Company	6 210 9 6
Warrington and District Company	6,493 0 0
Gilchrist and Co.	7 600 0 0

BUSINESS NOTES.

LIGHTING AND GENERAL.

Accrington.—The electricity works will be ready shortly.

Canterbury.—A quarter of a mile of ·05 cable and 220 yards of ·1 cable is to be purchased.

Barrow.—Mr. Charles M. Davis, of Scarborough, has been appointed mains superintendent.

Stockport.—The substitution of electric lighting for gas in the police offices and cells has been completed.

Bowness-on-Windermere.—The Urban District Council are considering the appointment of an electrical inspector.

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Leigh.—Estimates for extensions at the gas and electricity works, amounting altogether to £13,500, are being considered.

Grantham.—The Board of Trade have agreed, with certain modifications, to the provisional order for the electric lighting of the borough.

Book Received.—"Pratique industrielle des Courants Alternatives: Courants Monophasés," par C. Chevrier, Paris. Georges Carré et Cie., Naud.

Nantwich.—The Bill to confirm the provisional order for the electric lighting of Nantwich has been read a second time in the House of Commons.

Doncaster.—The cost of the proposed electric lighting plant for the new workhouse is estimated at about £2,000. Sanction has been obtained to the loan.

Hampstead.—The Vestry have made arrangements to construct an artesian well at its electric lighting station. It will be 400ft. deep and yield 5,000 gallons per hour.

Epsom.—Mr. Hawtayne has been instructed by the Urban District Council to proceed at once with the electric lighting scheme, for which a loan of £16,100 is to be raised.

Erdington.—The Urban District Council's Bill for the confirmation of the provisional order for the electric lighting of the district has been read a second time in the House of Commons.

Grimsby.—The Postmaster-General has decided to extend the public telegraph system to the post office at Stallingborough, and permission to erect the necessary poles has been granted.

Hertford.—The deed of transfer between the Corporation and the North Metropolitan Electrical Power Distribution Company, and the supplemental agreement between the same, have been sealed.

Alfreton.—The electric light scheme has been finally adopted. At the recent poll 287 were favourable to the electric light, some of these the principal ratepayers and consumers in Alfreton, and only 56 against.

Patents, etc., Acts.—Thomas Joseph McTighe, of Bath Beach, New York, has applied for leave to amend the specification of letters patent No. 19,285 of 1899 for improvements to rail bonds for electric railways.

Agency.—Messrs. Charles Joyner and Co., Limited, of Birmingham, have appointed Messrs. Fry and Co., Limited, of 19, Farringdon-avenue, E.C., to be their sole representatives for London and South Coast.

Egremont.—At the last meeting of the Urban District Council, a letter was read from Messrs. Baker, Lees, and Co. regarding the electric light, and stating that a provisional order had now been introduced into Parliament and read for the first time.

Waterloo-with-Seaforth.—The Urban District Council have agreed to appoint a sub-committee to ascertain the lowest figure at which the Waterloo undertaking of the Liverpool District Lighting Company, Limited, could be purchased by the Council.

Colne.—The borough surveyor has been instructed to prepare plans, specifications, and estimates for the erection of the required buildings to be used as a generating station, preparatory to application being made to the Local Government Board to sanction the necessary loan.

Bradford.—At Tuesday's meeting the Council sanctioned the application for a loan of £56,000 referred to in our last issue. The proposed expenditure will cover the purchase and erection of boiler-house, boilers, economiser, engines, dynamos, battery, switchboards, mains, and meters.

Western Australia.—We beg to refer to an announcement in another column referring to a visit to England of Mr. Wall, of the firm of Splatt, Wall, and Co., of London and Melbourne, which firm are open to undertake agencies in Western Australia of electrical machinery and appliances.

Kilmarnock.—At a meeting of Kilmarnock Town Council last week the Watch and Lighting Committee recommended that an electric lighting scheme be proceeded with at an estimated cost of £25,000. The report was adopted. Mr. Bryson, Leith, was appointed engineer for the undertaking.

Sheffield.—On the appointment of Mr. H. S. R. Parton as commercial manager of the electric light department, the Electric Light Committee recommend that Mr. P. M. Perry be appointed chief clerk and cashier, that the commercial manager be authorised to engage a clerk, and that the various salaries of the staff be increased.

New Issue.—The Edison and Swan United Electric Light Company, Limited, are making a new issue of £100,000 5 per cent. second debenture stock, part of an authorised total of £300,000, secured upon the uncalled capital, the real estate, and other assets, subject to the prior rights of the £350,000 4 per cent. debentures.

Darlington.—At the last meeting of the Council it was stated that the various works in connection with the electric light installation were proceeding satisfactorily. The Corporation intend to supply the electric light outside of the compulsory area, and any substantial or reasonable demand is to be supplied as soon as the works are in order.

Indo European Telegraph Company.—The directors recommend a dividend for the six months ended Dec. 31 of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent., and a bonus of 20s. per share, both free of tax, making in all 10 per cent. for the year, payable 1st prox.; £25,000 has been added to the reserve fund.

Barking.—An exhibition of electrical appliances was opened on Friday last at the Public Offices, Barking, under the auspices of the Barking Town Urban District Council. The exhibition remained open until April 11, and was free to all. The exhibits consisted of electric light fittings, electric heating appliances, cooking appliances, fans, arc and incandescent lamps, etc.

Colne.—The borough surveyor has received instructions to proceed with plans and estimates for the erection of the electricity generating station which is to be built in connection with the electric lighting of the town, and also the proposed electric tramway for the borough, and it is expected that application will shortly be made to the Local Government Board for sanction for a loan to carry out the same.

Ashton-under-Lyne.—The Corporation have given notice that, owing to the large demand made for electricity, they will be unable to meet further applications for supply until the capacity of their works is increased. Arrangements are in progress for making the necessary extensions, which will be completed in the earliest possible time, and are such that will place them in a position to cope with a considerably increased demand.

Nuneaton.—At the last meeting of the Urban District Council the Clerk read a letter from the Board of Trade granting the electric lighting order. He assumed that the Local Government Board had granted permission for the borrowing of the loan, as the Board of Trade were waiting for the sanction of the Local Government Board before they granted the order. He had, however, not received official notification from the Local Government Board.

East Molesey.—While discussing the price of gas, the District Council at their last meeting also considered the question of electricity, and it was suggested that they should obtain a provisional order and lease it to a company on condition that they provided them with the current for their lamps at an agreed price, and that they had the power to purchase after a certain period on fixed terms. Finally, it was decided to ascertain the relative cost of oil, gas, and electricity.

Appointments Vacant.—A foreman in charge of the mains is wanted at the City of Carlisle electric lighting station. Salary 30s. per week.—The Peterborough Corporation invite applications for the appointment of an engineer in-charge, under the city engineer, at the electricity works. Particulars of these and other vacancies referring to appointments of electrical engineer, telephone superintendent, telephone foreman, mains superintendent, etc., will be found in our advertisement columns.

Hereford.—The following report of the Electric Lighting Committee has been adopted: "The Silvertown Company have complained of the expression in the last report that they had been profuse in promises as regards the supply of meters and cut-out boxes. It is right to say that it is for cut out boxes only that the Silvertown Company are responsible, and though the delay seems to the committee to have been such as may properly be complained of, the promises seem to have been less definite than the committee supposed."

Eastbourne.—The report of the telephone inspector is to be printed, and the best thanks of the committee and a salary of £20 per year will be given to Mr. Wells in respect of his services as telephone inspector, the same being an addition to his ordinary duties. With regard to certain applications for renewal of motor-car licenses, two strongly-worded memorials have been received asking the Council not to license the cars on the ground that they were dangerous and were objected to by visitors. The matter has been referred back to the Watch Committee.

Sleaford.—The Electric Lighting Committee's report states that Mr. B. Smith, of Oswestry, had estimated the cost of providing an installation of the electric light for Sleaford at £5,700. Mr. Veesy Brown, the electrical engineer for Lincoln Corporation, had estimated the cost at £10,759, or, with probable extensions, £13,000. The committee considered that Mr. Brown had calculated for the requirements of a town larger than Sleaford, and asked that Mr. Smith, their engineer, be requested to submit plans and specifications of his proposed scheme. This course was adopted.

Rickmansworth.—In a recent report to the Urban District Council the Works Committee stated: "The committee having considered the letter of Mr. Warden-Stevens, dated March 6, 1900, with reference to electric lighting, recommend that an electric lighting committee be appointed by the new Council to consider the whole question, and that such committee be requested to approach various electric lighting authorities as to the most suitable scheme, and also that the Council purchase for general use and for three months some periodical dealing with electric lighting generally."

Boiler Settings.—Mr. W. Stokes, of Queen's-road, Reading, has forwarded us some sections of fireclay boiler settings, which are specially adapted for use with water-tube boilers. The new feature in these is the section of block adapted for the cover, and which rests against the frame of the boiler slightly below the water-line. These covers are so designed that a minimum amount of heating surface is covered by them in one particular case. The maker claims that with his type of cover over 28ft. more heating surface was obtained in the boiler, with practically the same general design of the setting, but with his covers added. These cover blocks are made 1ft. long and of various sizes, to correspond with different requirements.

Hornsey.—At last week's meeting of the District Council the Highways Committee reported the receipt of a letter from the superintending engineer of the Post Office, expressing a hope that the Council would take steps to obviate any possible interference

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with the telegraph poles on Crouch End-hill, which could only be done by the trees being trimmed there. The Council's surveyor informed the committee that the difficulty could be met by the raising of the poles or the use of insulated cable. The Local Board in 1890 declined to have the trees cut, and the committee recommended that that decision should be adhered to. A special meeting of the Council is to take place with reference to the supply of electric light in the district.

Kensington.—In the minutes of the meeting of the Vestry on March 28 we note a report of the Law and Parliamentary Committee, stating that the committee have had before them a copy of the arbitrators' award in the matter of the price to be paid by the Kensington and Notting Hill Electric Lighting Companies, and find that the sum to be received by the Vestry thereunder for the land is £7,929. In a report which the committee have received from the surveyor it is pointed out that the total area of the Vestry's land was 12 acres 1 rood 13¾ poles, for which the sum of £17,500. 12s. 6d. was paid, and that the cost to the Vestry of the area of the land taken by the companies (3 acres 1 rood 4¼ poles) was £4,649. 6s. 10d. The committee therefore consider that the terms of the arbitrators' award may be regarded by the Vestry as quite satisfactory.

Colchester.—The Electric Light Works Committee have agreed to become a member of the Municipal Electrical Association. The committee have further agreed to drop the matter relative to the financial provisions in the suggested agreement between the National Electric Wiring Company, Limited, and the Council with respect to the wiring and fitting of the premises of persons who may wish to avail themselves of the company's system. Correspondence is taking place between the borough surveyor and the gas company respecting the accumulation of a considerable quantity of coal-gas in the cable conduits. Several applications from intending consumers for supply of energy for lighting and motor purposes have been received, including one for 28 arc lamps and several motors of 30 h.p. and 16 h.p. A main is to be extended at a cost of £71 to meet this application.

Warrington.—The report of the Electric Lighting Committee, recently adopted, contained the following minute: "A letter having been received from the secretary of the Lancashire Electric Power Company, with a copy of the Bill amended in accordance with the undertaking given by the company to the President of the Board of Trade on second reading, and which now only contains power for the company to carry their mains through one district in order to reach another district, and power being reserved to local authorities to determine the route and to carry out the work at the cost of the company, it was resolved that on the company giving a clause not to oppose any future extension of the borough boundary, and to cease to supply within the extended area on terms to be mutually agreed upon, or in default to be settled by arbitration, the Corporation will not appear on the petition presented against the Bill."

Electric Bells.—We have received from Messrs. Cassell and Co. a copy of a small volume by Mr. P. N. Hasluck on "Electric Bells." The book is a very complete *résumé* of electric bell work, and will be very useful to anyone who wishes to fit up his house with a bell system. The book starts by giving useful information as to the electric current and the laws connected with it. The wiring for the bells is then proceeded with, and burglar alarms are specially described. The various kinds of batteries which can be used for bells are described, and then the construction of the bell itself. Pushes and switches occupy yet another chapter, and the book ends with a chapter on indicators for bell systems. The book is profusely illustrated, the illustrations averaging over one per page. The volume is sold at the popular price of 1s., and we can recommend it to anyone wishing to gain a fair knowledge of the subject with which it treats.

Stockton.—The whole of the plant and boilers for the electricity works are now ready, and an effort is to be made to prepare for immediate delivery. A joint report by the gas manager, borough engineer, and the electric works manager has been agreed to showing the suggested extension of the public street-lighting. The number of lamps are to be 24, meaning a capital outlay of £760. 4s. for lamps and posts. The cost of maintenance of these lamps would be, if 24 were burned until midnight and 12 from midnight to dawn, £679 per annum. Mr. Vesey Brown, the consulting electrical engineer at the gasworks, agreed with the joint report, but instead of choosing 27 arc lamps with a candle-power of 27,000, he was in favour of having 36 arc lamps giving the same candle-power. This method would give a better distribution of light. The cost of the 36 lamps to the Corporation would be £660 per annum for current and attendance, against £622 for the 27 arc lamps of the previous report. The District Fund Committee's recommendation that Mr. Brown's suggestion be adopted has been agreed to.

City (London).—At the Court of Common Council on the 5th inst. the Streets Committee recommended that the electrical engineer should confer with the promoters of the City of London Electric Lighting Company's Bill with a view to obtaining the insertion of a clause giving power to the Corporation to purchase the whole of the company's undertaking outside the City on the same terms and at the same periods as are stated in the City of London Electric Lighting Orders, 1890 and 1891, and the Electric Lighting Acts with regard to the portion of the undertaking within the City. The committee also recommended that, in the event of a suitable clause being inserted in the Bill, the opposition of the Corporation thereto should be withdrawn. The same committee recommended that the remembrancer should be instructed to lodge a petition against proposed alterations in the Bill of the Charing Cross and Strand Electricity Supply Corporation. Both recommendations were adopted. The Streets Committee, in their report, stated that in their opinion the present was not an opportune time for changing the type of electric lamps now in use. This report was agreed to.

Whitechapel.—A deputation from the Charing Cross and Strand Electric Supply Company waited upon the District Board of Works on Monday evening to endeavour to induce that authority to withdraw its opposition to the company's Bill in Parliament. By this Bill the company seeks power to lay mains from Bow, where the station is situated, along the Mile End and Whitechapel roads to the borders of the City. Mr. Fladgate, chairman of the company, acted as spokesman, and pointed out that the main would prove most useful should at any time the municipal installation fail. It would also bring in money, as it would be liable to be rated. In reply to a question, Mr. Fladgate said he could offer no monetary consideration for disturbing the streets. The Board afterwards decided to reaffirm their opposition to the Bill. It was also agreed to borrow £10,000 from the London County Council on account of sum as may be necessary to carry out that portion of the work of erecting the electric lighting installation in the district, as contemplated by the report of Mr. Wright, the electrical engineer of the Board, and such further work as may have been since determined upon.

Fulham.—At the Vestry meeting on the 11th inst. the report of the Lighting, Electric Lighting, and Dust Destructor Committee was considered. It contained the consulting engineer's report on the question of additional mains, arc lamps, and machinery required in connection therewith, that it is contemplated to put down, and which was referred to him some few weeks ago. The streets in which it is proposed to lay the additional mains, and to light by means of arc lamps, are as follows: the whole of Lillie-road, the remainder of Dawes-road, the whole of King's-road, High-street from Fulham-road to Putney Bridge, the whole of Fulham Palace-road, Wandsworth Bridge-road from King's-road to Wandsworth Bridge, and the whole of Munster-road. In these roads arc lamps and a distributing main for supplying private consumers down both sides are contemplated. The arc lamps will be arranged as before, so that the lamps on one side of the street will be on a different circuit to those on the other, to avoid total darkness in the event of a circuit failing. In all 150 additional arc lamps are provided, fed by four new circuits. The posts are provided with two incandescent lamps and automatic switches, which come into operation on turning off the arcs at the central station. The total scheme is estimated to cost £49,540. The committee have adjourned the further consideration of this report for two months.

Tunbridge Wells.—The Town Council have received the following letter granting the telephone license: "General Post Office, March 30, 1900. Sir,—I am directed by the Postmaster-General to say in reply to your letter of the 10th inst. that he is prepared to grant to the Corporation of Tunbridge Wells a license to carry on telephone business within the area marked on the map enclosed in your further letter of the 22nd inst. He will not raise any objection to the period of 25 years proposed by the Corporation, but I am to point out for their consideration that a license for a period of 19 years would be sufficient to secure the right of local intercommunication with the system of the National Telephone Company under Section 3 (5) of the Telegraph Act, 1899; and that, under the same section of that Act, the company will, if they accept the conditions therein specified, be entitled during the whole period of the license granted to the Corporation to the continuance of agreements with local authorities in the area giving them power to lay underground wires, as well as to an extension of their license for the area during the same period. The Postmaster-General understands that the current rate of the National Telephone Company for unlimited user within the area is £10 a year for subscribers whose premises are within one mile of the exchange and that an additional charge of £2. 10s. is made for every additional half mile. He proposes to fix this rate as the maximum rate for inserting in the license, but otherwise he accepts the table of maximum and minimum rates proposed by the Corporation. I am to enclose for the information of the Corporation six copies of a specification showing the conditions on which the Postmaster-General is prepared to approve the character and construction of the apparatus and circuits to be used in the municipal exchange system.—I am, Sir, your obedient servant, (signed) G. H. MURRAY."

Brighton.—We quote from the *Sussex Daily News* the following report, which was submitted to the Town Council on the 5th inst.: "In a special report the Lighting Committee stated that they had received letters from Mr. Arthur Wright, the electrical engineer, suggesting the appointment of Mr. Joyce as acting manager during Mr. Fowler's absence, and an alteration in the terms of his own engagement. Mr. Wright stated that while being very willing to continue to take full responsibility under the Lighting Committee for the proper carrying on of the electric lighting undertaking, he now felt that it was hardly necessary, or even possible, for him to continue to be nominally responsible for all the ordinary routine work of the business, as the heads of the different departments were now perfectly able, with the help of the acting manager, to carry out this everyday routine work. On all important commercial questions, and in cases of serious difficulties, he would, of course, prefer to be consulted, as the continued success of the Brighton electricity undertaking would always be his first consideration. He therefore proposed that the terms of his appointment be redrawn, so that he should, in future, be the consulting manager and engineer, whose duty it would be to superintend the design of new extensions, advise the

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Lighting Committee on commercial and technical developments, and arrange, through the acting manager, the organisation of the staff for the proper carrying on of the supply business. Should he at any time have to be absent from England, he would undertake to appoint a fully qualified electrical and civil engineer to act for him in case of emergency. As an earnest of his desire to continue to superintend and be mainly responsible for the carrying on of the Brighton electric lighting, with which he had been connected for the last 19 years, he was willing to enter into an agreement, should the Council desire it, to act as consultant for a minimum period of five years at an annual fee equivalent to his present salary, and subject to the Corporation being able to determine such an agreement by three months' notice, if thought desirable. Under this new arrangement he would be willing to pay his travelling expenses, and thought the result of his wider experience in other towns would be of material service to the Brighton Corporation. As he had at present no intention of moving his residence from Brighton, and certainly not his chief interest in its electrical welfare, he felt the only real effect of his proposal on the Corporation's electricity undertaking would be to develop a greater sense of self-reliance and responsibility in the acting manager and other members of the staff, without in any way endangering the continued success of the electricity works. The committee adopted Mr. Wright's suggestions, and recommended that Mr. Wright should be retained as consulting engineer to the electricity undertaking at his present salary (£600 per annum), provided he entered into an agreement in a form to be approved by the town clerk, binding himself to remain in the service of the Corporation for a period of five years, the Corporation, on their part, to be at liberty to terminate the engagement on three months' notice. The committee also recommended that Mr. Joyce should be appointed acting manager *pro tem.*" Upon a vote being taken there were 19 for and 21 against, and the report was declared rejected.

TRACTION.

East Barnet Valley.—It is proposed to construct a light railway from Enfield to Cockfosters.

Middlesex Light Railways.—The Commissioners will continue their enquiry on the 25th inst.

Wolverhampton.—The Board of Trade have sanctioned the borrowing of £26,750 for tramway purposes.

Newcastle.—A commencement was made on the 9th inst. in opening up the roadway for the new tramline.

Yorkshire.—The Light Railway Commissioners have made an order for the construction of a light railway in the North Riding, from Sinnington to Rosedale.

Worsley.—Negotiations with the Salford Corporation with respect to the proposed tramways are continuing, and a committee has been empowered to complete an arrangement.

Golborne.—The clerk and surveyor of the District Council have been authorised to give evidence before a Parliamentary Committee in favour of the South Lancashire Tramways Bill.

Derby.—The Tramways Committee have decided to renew their present agreements for the period of three years, or until such time that the tram system shall be reorganised on the electric car basis.

Birmingham.—At a meeting on April 5 of the Public Works Committee the overhead system was approved for the Bristol-road tramways. The report of the committee, referred to by us in a previous issue, will be brought before the Council at its meeting in May.

Glasgow.—The Tramways Committee of the Corporation recommend the appointment as assistant electrical engineer of Mr. M. B. Field, London, whose experience in three-phase work has been gained chiefly in the service of Messrs. Brown, Boveri, and Co., of Baden.

East Ham.—It is reported that in the event of the West Ham Corporation obtaining powers to construct a tramway from the Barking-road to the Romford-road along Green-street, the East Ham Council would waive any powers granted to it, should the Corporation so desire.

Worcester.—Owing to the proposal to use electricity as the motive power for the tramways, the Electricity Committee wish to be prepared beforehand with a site upon which to erect works to supply the current. A valuation is to be taken of the Six Masters' property with that object in view.

Finchley.—It is proposed to construct a light railway from Enfield *vid* East Barnet to Bushey or Edgware. The railway would touch the Finchley parish at Whetstone. A letter enquiring whether the Finchley Urban District Council would approve of such a scheme is before the Highways Committee.

Grimsby.—After once agreeing to municipalise, and twice to re-lease to the present company, the Grimsby Corporation last Friday rescinded a previous resolution and again decided to take the necessary steps for taking over the tramways, as the company refused to reopen the question of further concessions.

Longton.—At the last meeting of the Town Council the Tramways Sub-Committee reported that they had lodged with the Board of Trade an appeal with reference to the alterations of the levels of the roadways in connection with certain of the tramways constructed by the Potteries Electric Traction Company.

Paisley.—We understand that Mr. Murphy has altered considerably his original proposal, and that on the 5th inst. he delivered over the agreement between the Corporation and himself binding him to withdraw the Bill from Parliament if terms cannot be agreed on, and gave his formal undertaking that he still intends to observe that agreement.

Swansea.—On the 5th inst. a successful trip was made to Cwmbwrla, the section with the heaviest gradient on the new electric tramways. It is not expected that the cars will be running till next month. All sections are to be opened at once, and it is ultimately intended to run 21 small cars and 15 large ones. Mr. F. de Guerrier, electrical engineer to the company, was present at the trials.

Bridlington.—The question of a tramway on the North Side from the Royal Albert Drive to the Cliff Top has been again under the consideration of the Council Committee, and, according to the local Press, the committee favours the construction of a tramway by the Corporation itself, and has authorised the borough engineer to obtain expert opinion as to the best method of meeting the requirements of the North Side residents and visitors.

Swinton and Pendlebury.—The town clerk of Salford (Mr. S. C. Evans) having intimated that the Corporation would take over the lease and work the proposed new tramway lines in the Swinton and Pendlebury district on similar terms to those which had been arranged with the Eccles Corporation, the District Council have resolved that the terms are unacceptable, and that the Council await the result of the South Lancashire Tramways Bill in Parliament.

Tramway Across the Ribble.—The Board of Trade in their report on the Southport and Lytham Tramroad Bill consider that the proposed conveyor bridge across the navigable channel of the Ribble leading to Preston, and the method of working the bridge, coupled with the insufficient height of the girder, will be detrimental to navigation to and from Preston Docks. Objection is taken to several of the clauses of the Bill, as encroaching on the jurisdiction of the Preston Corporation.

Leeds.—It is expected that the second large steam dynamo which Messrs. Fowler are constructing will be completed shortly. The Tramways Committee will then be able to extend the electric system of tramway traction in the city, and probably in a month or so electric cars will be running along York-road and Beckett-street. When the Electrical Construction Company, Limited, have carried out their contract, referred to in another column, it will be possible to have electric cars on all the routes in the city.

Lytham.—The arrangements between the tramways company and the Council have now been completed. The draft scheme embodies practically all that the committee considered necessary in the interests of Lytham. The company will widen Clifton-drive. In a number of places wood pavement is to be laid. If the overhead system is introduced, they will place six electric arc lamps in places to be chosen by the Council, and fix two incandescent lamps on each pillar. Various other concessions have been made.

Glossop.—The Town Council have accepted a proposal from Edmundsons' Electricity Corporation, Limited, Westminster (to whom the Glossop Council have transferred the electric lighting order for the borough of Glossop), who are prepared to take the risk of establishing an electric tramway in the borough, believing that by combining the electric lighting and tramways they would effect such economies in the management and working expenses as would make the tramway undertaking a success, the fare to be 1d. per mile, and the maximum fare for any distance 2d.

Carlisle.—The town clerk, on behalf of the Town Council, and Messrs. Sherwood and Co., parliamentary agents to the Carlisle Tramway Company, with the company's engineer, Mr. Dickinson, recently waited upon Sir Thomas Blomfield, of the Board of Trade, at the offices of the department in London with regard to the present position of the Carlisle tramway scheme. The proposals of the company were laid before Sir Thomas, and the town clerk explained the attitude of the Corporation. Colonel Yorke, the engineering inspector to the Board of Trade, is to report on the matter.

Sowerby Bridge.—At the last meeting of the District Council a letter was read from the town clerk of Halifax stating that, notwithstanding the decision of the Parliamentary Committee on the Huddersfield Corporation Bill, the Halifax Corporation were determined to persevere with their Bill, and it would strengthen the Halifax case if the Sowerby Bridge Council would pass a resolution in support of the Bill. The Council resolved: "That, notwithstanding the decision in the Huddersfield case, the Halifax Corporation be requested to persevere with their Bill relating to tramways outside the borough."

Brighton.—The Tramways Committee have instructed the borough engineer and surveyor to prepare specifications for laying the concrete foundations and wood paving in the roads forming the tramway routes, together with the necessary detail drawings, and resolved: "That the Works Committee be informed that, in the opinion of the committee, the construction of the whole of the tramway routes should be put in hand at the same time, and that they be requested to consider the question of paving with wood the portion of the roads forming such routes not covered by the tramlines wherever the gradients admit of its practicability."

Rhyl.—At a recent special meeting of the Council the Electric Light Committee brought forward a proposal for the extension of the Rhyl and Prestatyn light railway system through Rhyl, travelling the length of the sea-front, touching the marine lake, and returning through the principal thoroughfares to the starting point at the Grand Pavilion. The overhead wire system was objected to by some members, and it was contended that trams on the sea-front would be a source of danger to children. The

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Council decided by the casting vote of the chairman to sanction the scheme. It is stated that a ratepayers' meeting will be called to protest against the proposal.

Parliament.—In the House of Lords on April 6 the Southport Extension and Tramways, Stockport Corporation Tramways, City and South London Railway, and Glasgow District Tramways Bills were read a second time. In the House of Commons on April 2 the Reading Corporation Tramways Bill was considered. On April 6 the Airdrie and Coatbridge Tramways Bill was read a third time. On April 9 the Lincoln Corporation Tramways Bill, which has already passed the Lords, was read a second time. The Southport and Lytham Tramroad Bill was also read a second time. The Committee of Selection in the House of Lords have nominated a Select Committee to consider the Taff Vale Railway Bill. The committee will meet on Wednesday, May 2, to hear counsel and take evidence.

Aberdeen.—A committee of the House of Commons have now come to a decision with regard to the Corporation Tramway Bill, which was announced by the Chairman as follows: "We are unanimous that the tramway ought not to go through Market-street. The only question to be discussed is whether to give power for line No. 4 to Torry to go to the corner of Victoria Bridge and the North Esplanade or to go through higher up towards Palmerston-road. But I suppose that is not a very important point. It ought not to go down a crowded thoroughfare. With that exception we pass the preamble, and wish a clause put in that no brackets be put against houses without consent. We do that in every case of the kind." The clauses are now being considered.

Bury.—The report of Messrs. Lacey, Clirehugh, and Sillar has been received. The adoption of the overhead system is proposed, and a sub-committee has been appointed to enter into negotiation with the outside authorities as to obtaining their consent to run in their districts, and to make the necessary preliminary arrangements for entering into a provisional agreement, and report to the committee. Plans are to be prepared showing the proposed system, and the sub-committee has been empowered to approach the tramways company as to the terms upon which they will be prepared to dispose of the present tramways. It is stated that the proposed scheme will cost £250,000, and it is proposed to extend the tramways in the direction of the workhouse. The resolution as to the overhead system has been referred back for further consideration.

Nelson.—The town clerk has prepared a statement on the subject of the opposition of Nelson to the Burnley Corporation Tramways Bill. With regard to the Bill of 1900, it appears that the local authorities feel that, before consenting to the expenditure of £160,000 on the trunk line in reconstruction, they should be assured of the necessity and reasonableness of the proposals. The present tramway is undoubtedly a profitable undertaking, and the local authorities have only asked for fair treatment, and are sanguine that the last offer they made to Burnley will ultimately be found to be moderate and reasonable. The preamble of the Bill has been proved, the net result being that Burnley is authorised to construct some new tramways in Burnley, and the local authorities are authorised to double the present line on a 4ft. gauge.

Birkenhead.—The Tramway Committee's minutes with regard to the taking over of the tramways by the Corporation from the company were agreed to last week. During the debate it was stated that the committee were of opinion that the first business they ought to undertake in this electrical equipment was the New Ferry line, and they hoped the Wirral Company might be able to run their trams in some form or other, but when they came to consider the cost of maintaining another line of horse trams alongside their reconstructed line it was looked upon as impossible. The committee also considered that Rock Ferry and New Ferry were well served with ferry boats, the joint railway, and the tunnel, and all those things suggested that the district for a few months could do without horse trams. But they believed if the Wirral Company did not start a service, another service might be started with 'buses.

Renfrew.—At a recent meeting of the Upper District Sub-Committee on Parliamentary Bills, the Glasgow District Tramways Bill was again under consideration. The committee agreed to stipulate, as regards the purchase clause, that the same clause as shall be accepted by the burghs of Paisley, Johnstone, and Renfrew shall be applicable to the portions of the tramways within this district. Finally, it was decided to insert various stipulations agreed upon into a draft agreement. A letter from Sir J. D. Marwick, town clerk of Glasgow, stating that the Corporation Tramways Committee desire to open negotiations with the District Committee with reference to the formation of a line of tramways from the boundary of the burgh of Partick westward along Yoker-road to the county boundary, was read, and it was agreed to recommend that the matter be remitted to the sub-committee for consideration and report.

Cheshunt.—The Light Railway Commissioners have held an enquiry into the application made by the Hertfordshire County Council and the Metropolitan Tramways and Omnibus Company, Limited, for an order to authorise a light railway commencing at the Middlesex and Hertford county boundary in the Hertford-road at the termination of the proposed Waltham Cross and Enfield light railway, and running thence in a northerly direction along the Hertford road, the various portions of which are known as Crossbrook-street, Turner's-hill, New-road, Cheshunt-street, Cheshunt Wash, and Turnford. The Earl of Jersey said the question of competition had arisen, and there was a certain amount of competition in the matter; but the Commissioners thought the question had better be decided by the Board of Trade—it was not of such large importance as to justify the Commissioners throwing the scheme out on that ground. There would be an opportunity for the railway company to approach the Board of Trade. As that was the only serious opposition to the scheme, they should be prepared to recommend the Board of Trade to grant the order.

Proposed Tramway for Tarves District.—At a recent meeting of the Tarves Literary Society Mr. J. D. Webster, Tarves, read a paper on a tram railway for the districts of Pitmedden, Tarves, and Methlick. Dr. Munro, Tarves, vice-chairman, presided, and Lord Aberdeen and Lord Haddo were present. The opening part of Mr. Webster's paper emphasised the point that what the district required was not a railway, but a tramway on the roadside of sufficient weight to carry goods and cattle traffic as well as passengers. To execute this the consent of three important powers had to be got—viz., the landlords, the County Council, and the railway company. There seemed no reason why all three should not be willing, as such a tramway would in no sense compete with the railway, but would bring grist to the railway mill. It would also be a great relief to the roads in the district. If these parties were willing, Mr. Webster made the proposal that a public company be formed to carry out the scheme; that an extension of 4ft. be obtained to the public highway between Methlick and Logierieve Station *viâ* the villages of Tarves and Pitmedden, on which extension the rails could be laid. Following the idea of a similar tramway near Portrush, in the North of Ireland, the driving power suggested was electricity. The power would be developed by turbine wheels at Methlick. The water could be brought from the River Ythan, tapping the stream opposite the Little Water, and bringing it down the west bank to Methlick. Mr. Webster estimated the total cost at £45,000. He concluded with an appeal to all interested to agitate for this much needed facility.—*Aberdeen Journal.*

Hull.—The application of the Corporation for a provisional order to authorise the reconstruction of the Drypool and Marfleet tramway is to be opposed by the North-Eastern Railway Company, who have lodged notice of objection with a view of preventing the tramways passing over their level crossings on the Hedon-road. On the 9th inst. new electric cars were taken from the Hessle-road sheds to the Holderness-road section, which has just been completed. According to the *Leeds Mercury*, the cars worked admirably round the curve from St. John-street to Junction-street, and thence passed along Savile street for the journey to Holderness-road. This section has presented some difficulties in construction, the road being over the North Bridge, which spans the River Hull, and which was at one time the only means of communication between the east and western portions of the city. The difficulty here has been overcome by the erection of two posts, one at each end of the bridge, and when it is opened for the passage of vessels, that portion of the trolley wire passes over the land lines. On the bridge being replaced across the stream, there are automatic couplers, which ensure at once an unbroken electric current. There was also extra work on the Holderness-road section, for the reason that, in the first place, the level crossing of the North-Eastern branch had to be passed; and, in the second, the high-level bridge carrying the Hull and Barnsley line to the Alexandria Dock had to be passed under, and for this purpose the road had to be slightly lowered, so that there would be room for the overhead trolley wires. All these difficulties have been at length overcome. On the 10th inst. Major Yorke, R.E., was taken over the route, and we understand the Holderness-road section was declared open at noon for the conveyance of passengers. The electric trams go eastward to a point adjoining the East Park, and during the coming summer they will prove a great boon to the persons visiting this, the largest park in Hull. On the two lines which opened in July last, the Anlaby and the Hessle roads, the weekly takings in penny fares amount to close upon, and sometimes exceed, £700 per week. Up to the present there has been no statement made to the Council as to the percentage of working expenses.

Gloucestershire.—At the recent quarterly meeting of the Town Council a long discussion took place on the report of a committee as to the proposed Witney, Burford, and Andoversford light railway, the cost of construction being estimated at £130,000. The promoters hope to obtain half this amount from the Treasury as a free grant, and applied to the County Councils of Oxfordshire and Gloucestershire to contribute, as loans, £15,000 each, repayable, with 3 per cent. interest, in 40 years by means of a sinking fund, and hope to obtain the balance of £35,000 in the locality by the issue of debentures and ordinary shares. Mr. G. S. Bayley, a member of the committee, said a good deal of evidence was taken at the enquiry, one of the witnesses saying that it would for one thing enable the stone quarries to be worked. St. Paul's Cathedral was built principally from stone out of one of the quarries in the district, which the witness said contained sufficient to build "ten million more cathedrals." The committee recommended that one month's notice be given for the next meeting of the County Council in accordance with the first schedule of the Light Railway Act, 1896, to consider the advisability of making application to the Light Railway Commissioners for an authority to advance the sum asked. The report of the committee was agreed to. We understand that the Joint Streets and Electricity Supply Committee of the Corporation have had the terms suggested for the supply of power to the tramways company under further consideration this week. The company sought an abatement of the terms offered, and it was proposed in committee that a reduction should be made. On a division, however, this proposal was negatived, and it was decided to adhere to the original terms. It so

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happened that on the day that the matter was under consideration it was reported to the Worcester City Council that terms had been come to with the British Electric Traction Company in respect of a light railway scheme of a similar extent and to serve a similar population. The terms of supply were as follows: the first 200,000 units per year, 2d. per unit; the second 200,000 units, 1¾d. per unit; the remaining units, 1½d. per unit. The agreement as to price is to be subject to revision at 14 years. We understand that the terms offered by the Gloucester committee to the local company are approximately the same, with one important exception—viz., that Worcester secures a contribution of £5 000 from the company in respect of necessary works of street improvement. It may also be remarked that no rental is asked from the Gloucester company in respect of wayleave, as in some other towns, and that the only charge proposed is that for the supply of electricity. We further understand that the successful issue of Worcester's negotiations has converted some of the Gloucester committee—previously all but unanimous on the matter—who voted at the Council's meeting last week in favour of waiving some part of the charges.

Salford.—Mr. A. P. Trotter has held an enquiry into an application by the Town Council for sanction to borrow a sum of £227,892, being the balance of the amount required for the reconstruction and electrical equipment of the Salford tramways under the powers of the Salford Corporation Act, 1899. Mr. L. C. Evans, town clerk, in stating the case for the Corporation, explained the method under which the working of the tramway system of the borough was leased to the Manchester Carriage and Tramways Company. In 1901 the Corporation would, he said, enter into possession of the tramways and work them on their own account. The Corporation were authorised to reconstruct the tramways and to construct additional tramways and equip them for electrical traction, and the enquiry had special reference to that part of their powers. Under their Act of 1899 the Corporation were authorised to borrow for the construction of tramways £250,000. The amount comprised in their application was made up as follows: For poles, spans, wires, etc., £42,892; tramcars, £95,315; land and buildings, £83,380; legal and professional expenses in connection with the whole matter, £5,305. The Corporation under their Act had entered into an agreement with the Urban District Council of Swinton and Pendlebury to work their tramways for a period of 21 years, and they also had an agreement with the Eccles Corporation to work their tramways for a period of 35 years. It was desirable, to say the least, that the tramway equipment of the borough should be laid down by April 29, 1901. It might be a little beyond their powers to carry that out, but at all events that was their desire. And if they could prevail upon the Board of Trade to give the matter of the present application early consideration, the Corporation would be gratified, because they were now negotiating with the authorities of the Swinton and Pendlebury district and with the Corporation of Eccles as to the reconstruction of their tramways, and before they could make final arrangements with those authorities they would like the sanction of the Board of Trade to purchase the land and to erect the buildings necessary for an undertaking of the character proposed. It was essential that this should be done, so that when the lease with the Manchester Carriage and Tramways Company expired the tram service might continue without any block or hindrance. Mr. E. Hutton, tramways engineer to the Salford Corporation, explained the details of the scheme and the various items of expenditure. The Town Clerk said certain contracts in connection with the work were already let, and others were being prepared. Arrangements would probably be made, as in other places, to light the streets along the tram route by electricity. Three Corporation committees were concerned in the present scheme, but there was no doubt ultimately that an arrangement could be come to between those committees. Mr. Clirehugh, electrical engineer, also gave evidence. Mr. Trotter said he would report to the Board of Trade in the usual manner, and, in view of what the town clerk had said as to the urgency of the matter, he would make his report at once.—*Manchester Guardian.*

PROVISIONAL PATENTS, 1900.

APRIL 2.

6161. **Improvements in and connected with microtelephones.** Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

6163. **Improvements in and relating to shade rings for use in connection with electrical and other lampholders.** Robert O'Brien, 44, Brazennose-street, Manchester.

6129. **Improvements in and connected with the production of paste carriers for collectors of electricity.** Richard von Grätzel, 47, Lincoln's-inn-fields, London.

6141. **Improvements in magneto-electric generators for electric ignition purposes.** Arthur Frederick Evans, 18, Southampton-buildings, Chancery-lane, London.

6153. **Improvements in and connected with electrically-propelled motor vehicles.** Philip Middleton Justice, 55, Chancery-lane, London. (Columbia and Electric Vehicle Company, United States.) (Complete specification.)

APRIL 3.

6165. **Improvements in incandescent lamps.** James Swinburne, 82, Victoria-street, London.

6188. **Improvements in armoured conduits for electric wires.** Jacob Benjamin Routjillier and William Benjamin Hunter, 100, Wellington-street, Glasgow. (Complete specification.)

6204. **Improvements in and appertaining to switches for electromotors.** Henry Crofts Longsdon and Sydney Dale, 17, Hanover-street, Keighley.

6209. **Improvements in electric bonds for street mains.** Griffith Brewer, 33, Chancery-lane, London. (Adolphus Alvord Knudson, United States.)

6217. **An improved compound or material for bearings, valves, cells for storage batteries, and similar purposes.** Philip Hyman Rosenbach, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6218. **Improvements in machines for electrically heating, welding or working metals.** Charles Lewis Coffin, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6237. **Improved electrical gas-igniting apparatus.** Jacob Schwarzenbach, 322, High Holborn, London.

6244. **Improvements in and apparatus for manufacturing plates for secondary electric batteries.** Louis David, 45, Southampton-buildings, Chancery-lane, London.

6261. **Improvements in electric switches and resistances.** Claude William Atkinson, 1, Queen Victoria-street, London. (Complete specification.)

APRIL 4.

6276. **Improvements in shade or globe holders for electric lights.** John Gordon Beevers, 4, Corporation-street, Manchester.

6296. **Improvements in electric furnaces.** Wilhelm Borchers, 78, Fleet-street, London. (Complete specification.)

6301. **Improvements in or connected with means for electrically igniting miners' safety lamps.** William Best, 33, Chancery-lane, London.

6312. **Improvements in and in apparatus for the production of soda and chlorine by the electrolysis of chloride of sodium, the invention being also applicable for the production of potassium, sodium, aluminium, or other metals of the same class.** Henri Albert Cohu and Edmond Giesenberger, 53, Chancery-lane, London.

6317. **Improved automatic interrupter for overhead conducting wires and the like.** William Phillips Thompson, 322, High Holborn, London. (Enea Vittani, Italy.)

APRIL 5.

6348. **A new and improved insulation for electrical wires.** Hartwell William Webb, 9, Queen Victoria-street, London.

6385. **Improved methods of and apparatus for electrically separating the relatively volatile liquid component from the component of relatively fixed substances of composite fluids.** John Francis Cooley, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6405. **Improvements in switches for use with electric motors.** William Harding Scott, 47, Lincoln's-inn-fields, London.

APRIL 6.

6475. **A self-contained electric incandescent lamp and method of charging same.** Edward Harnett, 61, Chancery-lane, London.

6478. **Improvements in electromagnetic mechanism.** Walter Frederick Jones, 322, High Holborn, London. Complete specification.)

6479. **Improved accumulator plate.** Paul Ribbe, 322, High Holborn, London. (Complete specification.)

6488. **An improvement in apparatus for simultaneously actuating from one point the controlling switches of the several electrical motorcars of a train.** Siemens Bros. and Co., Limited, Birkbeck Bank-chambers; Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Aktiengesellschaft, Germany.) (Complete specification.)

6496. **An improved automatic circuit breaker for use in connection with electric railways.** Johann Skopec and Moriz Orel, 19, Holborn-viaduct, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published April 28, 1900.

1899.

7105. **Apparatus for controlling the reversing mechanism for rudders or the like by means of electrical waves.** Orling and Braunerhjelm. (Date applied for under International Convention, Feb. 27, 1899.)

7761. **Telegraphic transmitting instruments.** Gardner.

7863. **Electric incandescent lamps and their manufacture.** Cazin.

8075. **Electrical double-pole fused lamp-post (or bracket) watertight switch to prevent fusing of main fuses.** Carter.

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8223. **Apparatus for testing electric primers, batteries, and cells.** Fraser and Elphinstone.

8665. **Portable electric riveting machine.** Dudgeon. (Von Kodolitsch.)

8672. **Electric motor carriages or vehicles.** Lewis.

8975. **Safeguard against screw loosening on electric incandescent lamp shade holders.** Schloesser and Moeres.

9272. **Telegraphing graphic or other matter automatically without wires, and apparatus therefor.** Greville-Williams.

9367. **Process for the production of accumulator plates.** Lehmann.

9681. **Electric circuit breakers.** Belfield. (Stillwell.)

10246. **Portable telephones.** Ericsson.

10336. **Controllers for electric motors.** Belfield. (Davis, Wright, and Wurts.)

10393. **Electro-mechanical impulse devices, applicable to clocks and for other purposes.** Campiche.

11418. **Electric arc lamps.** Pomeroy.

11445. **Electric circuit breakers.** Davis. (Date applied for under International Convention, Nov. 4, 1898.)

11446. **Systems of electrical distribution.** Scott. (Date applied for under International Convention, Nov. 4, 1898.)

11780. **Mould for casting plates or grids for secondary batteries.** Gent and Jevons.

12478. **Electrical accumulators or secondary batteries.** Behrend.

12787. **Devices for breaking electric circuits and protecting the same from excessive currents.** Thompson. (Rolfe Electric Company.)

13991. **Monophase electric motors.** Thompson. (Cantons.)

16040. **Electric fuses and electric detonator fuses.** Smith and Corrie.

22028. **Electrodes for electrolysers.** Eycken, Leroy, and Moritz. (Date applied for under International Convention, May 23, 1899.)

23738. **Regulating electric alternators.** British Thomson-Houston Company, Limited. (Steinmetz.)

25452. **Means for cooling electric and other brakes.** British Thomson-Houston Company, Limited. (Ekstrom.)

25453. **Alternating electric current motor systems.** British Thomson-Houston Company, Limited. (Davis.)

25745. **Method of regulating dynamo-electric machines.** British Thomson-Houston Company, Limited. (Steinmetz.)

25748. **Electric railway systems worked with alternating currents.** British Thomson-Houston Company, Limited. (Armstrong.)

25752. **Electric meters.** British Thomson-Houston Company, Limited. (Haskins.)

1900.

213. **Manufacture of electric accumulator plates.** Stanecki.

2356. **Apparatus for regulating the electric lights on theatre stages.** Siemens Bros. and Co., Limited. (Siemens und Halske, Aktien-Gesellschaft.)

2797. **Coherers for telephonic and telegraphic signalling.** Popov.

3361. **Manufacture of secondary batteries.** Hathaway.

3545. **Insulation of electrical conductors.** Frank.

3731. **Manufacture of electrically conducting material.** Sanders.

3753. **Electrical secondary batteries.** Commelin and Viau.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Apl. 7	4 280	4,505	− 225	55,514	53,311
Blackpool-Fleetwood	,, 9	206	602	− 396	2,278	3,123
Bradford City Trams	,, 8	385	351	+ 34	541	—
Bristol Tramways Co.	,, 6	2,738	3 587	− 849	—	—
City & South London	,, 8	1,380	976	+ 404	17,319	15,215
Dover Tramways	,, 7	160	214	− 54	2,028	2,109
Dublin U.T., elec. cars	,, 6	5,016	1,268	+3,748	—	—
Dublin S.D. Electric	,, 6	1,753	1,034	+ 721	—	—
Halifax Corporation	,, 1	588	564	+ 24	30,304*a*	11,274*b*
Hull Corporat'n E.S.	,, 7	752	—	—	—	26,665*c*
Liverpool Corporat'n	,, 1*d*	7,122	6,455	+ 667	86,628	76,010
Liverpool Overhead	,, 8	1,317	1,674	− 357	19,454	18,699
Sheffield Corporation	,, 8	1,921	—	—	—	—
South Staffordshire	,, 6	678	923	− 245	8 505	8,588

a Since April 1, 1899. *b* Since June 29, 1898. *d* Partly electrical.
c Since July 5, 1899.

NOTE.—Apparent decreases due to Easter falling in corresponding week last year. Other returns, received too late for classification, will be found amongst our "Business Notes."

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	..	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 6¼
—— 5 per cent. Mortgage Debentures	100	..	98-103
British Electric Works, Ordinary, 50,001-95,000	1	..	¾-1
—— 6 per cent. Cum. Pref., 1-50,000	1	..	¾-1
—— 4½ per cent. First Mortgage Debentures	108	..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	4½-5
Brush Electrical Engineering, Ordinary	2	..	1½-2
—— Non. Cum., 6 per cent. Pref.	2	..	2-2⅛
—— 4½ per cent. Debenture Stock	100	..	108-113
—— 4½ per cent. 2nd Debenture Stock	100	..	103-105
Callender's Cable, Debentures	100	..	113-116
—— Ordinary	5	..	14½-15½
—— 5 per cent. Pref.	5	..	5-6
Crompton and Co.	5	..	3½ 4
—— 5 per cent. Debentures	—	..	99-103
Edison and Swan United, Ordinary	2	..	2-2½
—— 5 per cent. Debentures	5	..	2½-4½
—— 4 per cent. Deb. Stock, Red.	100	..	93-96
Electric Construction	2	..	2½-2⅝
—— 7 per cent. Cumulative Pref.	2	..	2½-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	104-107
Giffre Electro-Chemical and Power, Ordinary	1	..	½-¾
W. T. Henley's Telegraph Works, Ordinary	5	..	13½-14½
—— 4½ per cent. Preference	5	..	5½-5¾
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 6 per cent. Debentures	100	..	100-103
Telegraph Construction and Maintenance	13	..	36-40
—— 5 per cent. Bonds	100	..	103-105
Telegraph Manufacturing, Ordinary	5	..	9½-10½
—— 5 per cent. Cum. Pref.	5	..	5½-5¾
Willans and Robinson, Ordinary, 1-80,000	5	..	12-13
—— 6 per cent. Cum. Pref., 80,001-60,000	5	..	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
Bournemouth and Poole, Ordinary	10	..	11½-12¼ xd
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8 xd
—— 7 per cent. Preference	5	..	8½-9½ xd
Charing Cross and Strand	5	..	9½-10½
—— 30,001-50,000	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	..	5½-6
Chelsea Electricity Supply	5	..	6½-7½
—— 4½ per cent. Debentures	100	..	103-111
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9½-10½
—— 6 per cent. Cum. Pref.	10	..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4½-5½
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	10-10½
London Electric, Ordinary	2	..	1½-2
—— 6 per cent. Pref.	5	..	4½-4¾ xd
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	13½-14½
—— 62,501-85,000	10	..	14-17
—— 4½ per cent. First Mortgage Debenture Stock	100	..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1½-1¾
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6½-7
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	1½	..	170-190
—— 4½ per cent. First Shares Mortgage Debentures	100	..	103-105 xd
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2½-2⅝
—— 4 per cent. Debenture Stock	100	..	95-98
South London, Ordinary	3	..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 40,081-52,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	8½-9½
Westminster, Ordinary	5	..	15 16
Electric Railways.—			
Central London, Ordinary	10	..	10½-10¾
—— Pref. Half-Shares	5	..	4½-5½
—— ,, ,, deferred	5	..	5-5½
City and South London, Consolidated Ordinary	100	..	67-70
—— Ordinary	10	..	6-7
—— 4 per cent. Debenture Stock	100	..	125-130
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	..	13½-13¾
Waterloo and City, Ordinary	100	..	101-104
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17-18
Brisbane Tramway	100	..	104-106
British Electric Traction, Ordinary, 1-80,000	10	..	17-18
—— 60,001-75,000	10	..	16½-17½
—— 6 per cent. Cm. Pf. 80,001-60,000	10	..	12½-13½
—— 5 per cent. Perpetual Debenture Stock	100	..	124-127
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4½-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	105-108
Isle of Man Electric Power, 1-95,000	1	..	11/16-¾
—— 6 per cent. Preference, 100,001-170,000	1	..	¾-13/16
Kidderminster and District Lighting and Traction, Pref.	10	..	10-10½
New General Traction, Ordinary	5	..	3½-4½
—— 6 per cent. Cum. Pref.	5	..	5-5½
North Staffordshire Trams	6	..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	18-19
—— Preference	10	..	10½-10
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	½-¾
National Telephone, Ordinary	5	..	5-5½
—— 6 per cent. Cum. First Pref.	10	..	14-15
—— 6 per cent. Cum. Second Pref.	10	..	14-15
—— 5 per cent. Non. Cum. Third Pref.	5	..	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	..	97-100
Oriental Telephone and Electric Company	1	..	¾-1

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NOTES.

Strike of American Telegraphists.—The Central News Agency says that a great strike has taken place on the Southern Railway, all the telegraphists having come out. The gravest inconvenience has been caused, the strike affecting no less than 6,000 miles of road.

An Electrical Deal.—We learn from America that a large deal has just taken place on that side with respect to the American Siemens-Halske Company, the whole of the share capital of which has been bought up by the General Electric Company of America. It is interesting to note that the Siemens-Halske works and plant at Chicago are to be kept open as a western branch of the buying company.

The American Institution of Electrical Engineers. — In view of the annual election of council members of this institution, which this year is to be held on May 15, the following gentlemen have been nominated: for president, Mr. Carl Hering; vice-presidents, Messrs. Gano S. Dunn, Arthur V. Abbott, and W. L. R. Emmet; managers, Messrs. W. S. Barstow, Calvin W. Rice, C. T. Hutchinson, and R. D. Mershon; treasurer, Mr. G. A. Hamilton; and secretary, Mr. R. W. Pope.

Telephone Rates.—The many enquiries of the Postmaster-General have failed to elicit any definite statements as to the telephone rates to be charged when the new London telephone system is ready. The policy of the Post Office officials in this respect is sound, as in competition it is not well to prematurely show one's hand. As soon as the equipment of the exchanges and the underground wires are ready, there will be a rush of subscribers if the rates are reasonable and rapid connections can be made.

Perpetual Motion. — Mr. A. E. Gilbert, whose machines for obtaining perpetual motion from gravity were illustrated in some of our recent issues, writes to us to say that he has now made arrangements for the building of a working model of his latest type of machine. The principle of this machine, he states, is distinctly different from those illustrated in the *Electrical Engineer* of March 9 and 16. He now guarantees to produce within two months a machine to run continuously for 24 hours with ordinary bearings. We trust that the guarantee has not any penalty clauses attached to it.

Tramways in Cheapside.—Mr. J. W. Benn, of the London County Council, has no objection to making the users of tramways pay more than their share of the rates. Thus he estimates the ultimate profit of an electric tramway system in London at 1½ millions, giving a relief of 10d. in the pound to the rates. As regards tramways in the crowded London streets, he proposes to sink them into subways under the streets, but he does not add his opinion as to the cost entailed by this procedure. After all, are not the deep-level lines, such as the Central London Railway, an anticipation of Mr. Benn's suggestion?

Sheffield Trams.—We are glad to notice that on Good Friday yet another portion of the Sheffield Corporation tramways was opened. The portion opened was the Ecclesall-road route, and has just been electrically equipped. The route taken by the trams is a favourite one for holiday makers, as the Endcliffe Woods lie in that direction. In consequence of this a six minutes' service was given, eight cars being used. This is, however, on account of the holiday, two above the number which are regularly to do this journey, the proposed arrangement being an eight minutes' service with six cars. There are on the new section seven halting places in all.

The American Patent Office.—The American Patent Office are arranging an interesting exhibit in the Paris Exhibition of models which have been deposited with them in connection with applications for patents. Amongst the 200 odd models which have been dispatched from the States, and which should now be almost ready for view, are the early models of Edison, Brush, Thomson-Houston, Maxim, etc. The first electric motor, designed in 1834 by the late Prof. Joseph Henry, will be on view, as will also the first printing telegraph, invented by Edison in 1873. The exhibit is under the charge of Mr. E. P. Moore.

The Pollak and Virag Telegraph.—The inventors of this system have been making extensive experiments at the request of an American cable company, and they have equipped lines between Chicago, Milwaukee, and other places in the States. The highest speed they have been able to obtain with clear and readable signals has been 155,000 words per hour, or, to put this figure into a more common unit, they obtained almost 2,600 words per minute. Trials were made between New York and Chicago, and, in spite of most unfavourable weather, over 1,000 words were sent and received each minute. We do not yet gather whether the American cable company has decided to take up the system commercially.

Electricity on Warships.—As was mentioned in Mr. Grove's paper before the Institution of Electrical Engineers, the double turrets of the United States battleship "Kearsage" are operated by electricity. These have just been subjected to severe tests, and have come out of them with a satisfactory record. Captain W. Folger, of the United States Navy, in telegraphing the results to the United States Navy Department stated that the experiments were a complete success from all standpoints, structural and military. There was, he states, no interference between the planes of guns or inconvenience from smoke. The structure was also strong enough to withstand the united discharge of the four guns carried in either turret.

Automobiles.—In view of the gradually extending use of motorcars in our own and other countries, we are led to wonder why these vehicles have yet retained their original form and look just as though the horse, which should have been in front, has somehow been lost. The forlorn look of the ordinary type of motorcar, especially when it is stationary, cannot help striking one, and we think some change might be made in the upper construction of the car which would give it a complete appearance. The question is an old one, having been raised when the first cars began to appear in our streets, but in spite of the time which has elapsed since the passing of the Motorcar Act, we notice no change for the better in the shape of new motorcars.

Institution of Mechanical Engineers.—At the meeting to be held on April 26 we notice that the paper down for discussion is one by Prof. H. S. Hele-Shaw, LL.D., etc. The subject to be brought before the institution is to be "Road Locomotion." Motorcars, of course, are to be the principal subjects dealt with in this paper, and the author will raise, we should say, a great many points upon which discussion may take place. In the first place, he will show that the charges with motorcars exceed those of railway haulage. He will then speak of the advantages of motor vehicles, and also of the construction of the wheels and the weight placed upon them. The various rival motive powers are to be compared, and ignition, balancing, governing, cooling, etc., in the machines dealt with. Steam, oil, and electrical are to be described, and a comparison made, and the author will also state his views on the legislation

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affecting motorcars, and also some results obtained with machines on trial.

Accumulator Traction. — Within a few weeks accumulator traction will be in Chicago a thing of the past. The Chicago Electric Traction Company, which up to the present time have continued to run their trams with storage batteries as the source of energy, have now decided to change over to the overhead trolley system. The conversion of the system from accumulators to the trolley system will without doubt greatly improve the finances of the company, as the accumulators were used, we believe, in the first place somewhat as an experiment in order to show their great value for tramway work. The directors have at last recognised that this system is a much more costly one than other methods of using electricity for traction, and, as stated before, the last accumulator line in the States will shortly change over.

Radium Rays.—At the last meeting in March of the Academie des Sciences in Paris Mr. Henri Becquerel gave some further information as to his experiments on the nature of the rays given off by radium, and their deviation in an electric field. His experiments, extending over several months, have shown that the properties of the part of this radiation which can be deflected by a magnetic field have a remarkable similarity to those of the cathode rays. In order to demonstrate completely the identity of the two kinds of variations it was necessary to establish in the case of the rays emitted from radium, either that they carry a negative charge of electricity or that they are deflected by a magnetic field. These two properties are, of course, co-relative one of the other. Mr. Becquerel showed the excessively delicate experiments which he had devised to study this question, and the deductions which he had been able to draw from their results. He has arrived at the conclusion that the energy given off by all substances in these radiations might be taken from the materials themselves without one being able to detect any appreciable diminution in the weight of the same.

A Question of Words —The decision of the Brighton Town Council, in referring back the report of their Electric Lighting Committee, is exceedingly difficult to understand. This report has to do with the retention of Mr. Arthur Wright as consulting engineer to the electric lighting undertaking at a certain salary, which could only be looked upon as a quite inadequate one in view of the large expenditure which the committee is expected to undertake within the next four or five years. The Electric Lighting Committee and Mr. Wright have done such good work in Brighton that it is difficult to see what real cause of complaint the members of the Town Council have, and yet the report, which would enable the Council to retain the services of Mr. Wright, and to still profit by his great experience in connection with the electric lighting in Brighton, has been referred back. The wish of the Council seems to be that Mr. Wright should be content to confine his energies to Brighton alone, and one would not be surprised to hear that as a result of the resolution the reverse of this will occur. We can only hope that, in the face of the great success of the Brighton undertaking, the Corporation will not in the future have to learn the bitter lesson that the cheapest is not always the best.

Batley Tramways.—There have been great rejoicings in Batley because the Board of Trade have seen fit to sanction the scheme of the Batley Town Council for a system of tramways within the borough limits. In giving this consent in spite of the objections of the British Electric Traction Company, the proviso is made that the Batley Town Council should grant running powers to the company over a certain section of the road which will allow of intercommunication between the adjoining districts. The terms under which these running powers are to be granted are subject to an agreement between the two parties, or in case of disagreement the questions in dispute are to be subjected to arbitration. In this way the common objection to municipal traction, in that the system is confined to a limited area, is removed. Another advantage is that the inhabitants of Batley will be able to compare the convenience and facilities offered by the company on the through routes with those they obtain from the Corporation tramways on those routes on which the company have not running powers. This comparison will act in both ways, and we trust that it will result in both the company and the Corporation maintaining a thoroughly efficient system of tramway communication throughout the district.

Tramway Franchises.—We recently had occasion to refer to a proposal by an American millionaire towards municipalisation of tramways in the United States. This gentleman proposed to tax the tramway undertakings to such an extent as to make them practically bankrupt, and then to buy up the undertakings for the benefit of the ratepayers. At Detroit last August the Common Council tried to move in this direction by passing a resolution that the fares of the lines of the Citizens' Street Railway Company should be reduced from 2½d. to 1½d. The company naturally objected to making any such reduction, which the Common Council claimed to have the right to enforce, under a provision in the franchise, which stated that the city has the right to make "such further rules, orders, and regulations as may be deemed necessary to protect the interests, safety, and accommodation of the public in relation to such railways." The United States District Court, to whom the matter was referred, found in favour of the tramway company, the judge remarking that the resolution of the Common Council was practically an attempt to deprive the railway company of a vested right without compensation, which, summed up in one word, was "confiscation."

Meter Supervision in Germany.—The question of the official supervision and guarantee of electricity meters is claiming considerable attention in Germany. It is sought to determine the permissible error corresponding to different loads in connection with such meters; also to what extent they should be officially guaranteed or subjected to periodical inspection. In order to test the feeling on the subject which prevails in interested circles, an appeal has been made to manufacturers, their opinions being also sought as to when it would be advisable to introduce compulsory standardisation of meters. The *Elektrotechnische Zeitschrift* contains a leading article upon the subject, in the course of which some interesting data are given with reference to the extent to which meters are employed in Germany. The figures are the result of careful enquiries, no less than nine manufacturing firms, besides 950 central stations and private installations, having been appealed to for information. From the information so obtained it was estimated that on July 1, 1899, there existed throughout Germany some 126,000 electricity meters, though the enquiries showed that 60,000 only of these were in actual use. The returns given by the manufacturers further proved that the increase in the number of meters employed amounted in 1898 alone to 20,000. With regard to compulsory standardisation, it would appear from the answers received that the manufacturers concerned would like this delayed as long as possible.

The Electric Tramway in Perth, W.A.—The April number of the *Street Railway Journal* contains an interesting article on the street railway system in the

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capital of Western Australia. From the photographs given of the streets of Perth before and after the introduction of electric traction, one sees that the streets of Perth have been considerably improved by the change, in spite of the fact that the overhead trolley system has been used. Previous to its introduction the electric light, telegraph, and telephone wires were festooned along the streets in a most unsightly way. As these wires prevented the erection of the overhead span wires for the electric tramways, the tramway company had to place a number of the wires underground, and to erect new poles in order to support the few remaining overhead wires. We gather from the description that the general appearance in looking upwards is not the only improvement, as the company undertook to repave with wood blocks a large width of all the streets traversed. The whole of the machinery supplied is of American manufacture, and from the description given we should say that it has been an unqualified success. The work was carried out in a very expeditious manner, as the first section, consisting of five miles of double track, was completed between March 10 and June 15, 1899. In order to supply this first portion quickly, a temporary power station was equipped, but this will soon be replaced by a permanent station in which galvanised iron will not figure so prominently.

Calcium Carbide.—We notice amongst the abstracts of contributions to various papers given in Mr. Carl Hering's digest in the *Electrical World* the following abstract of a paper contributed by Mr. Carlson to the *Zeitschrift fuer Elektrochemie*. The abstract deals with an electric furnace for producing calcium carbide, and reads as follows: By a thermo-dynamical method the author determines the difference of the outputs of furnaces operated continuously and of such with interrupted runs, and finds that the theoretical maximum output of a continuously-operated furnace cannot be above 75 per cent. of a furnace used with interrupted runs. In the latter it is possible to produce about 20 per cent. more carbide of 86 per cent. purity than of 76 per cent. purity in a continuously-operated furnace. In the latter, and in general in all furnaces, in which the carbide is to be brought into liquid form, it is quite impossible to reach approximately the maximum theoretical output. That the output of furnaces with interrupted runs is greater than that of continuously-operated ones has been proved also by practice. He concludes that the methods of producing calcium carbide are far from perfect. In the best designed furnaces the actual output is about 60 per cent. of the theoretical. The calcium carbide industry is, therefore, capable of improvements in both the design of furnaces and the method of smelting. The furnace to be used in future for producing calcium carbide will not be a resistance but an arc furnace, and will be operated with interrupted runs.

One-Minute Telephones.—We notice in the *American Electrician* an article by the general superintendent of the long-distance service of the Erie telephone system, describing a system of one-minute conversations on the telephone. The system is based on the supposition that the great majority of telephone messages can really be condensed into a minute's conversation when once the subscribers are connected up. The object of introducing this one-minute service was that the standard five minutes' service was too expensive, with long-distance telephones, to be at all popular. The one-minute service is, therefore, charged for at a rate of one-fifth of what it would have been for a five-minute service, with a minimum charge of 7½d. for one minute. Thus the rate for points between 100 and 200 miles from each other would be 10d. per minute. For a distance of 35 miles the charge would be 7½d. per minute and 2½d. for each additional minute. The author of the article states that in places where a three-minute service has been adopted business has largely increased, and from this he thinks that a still larger increase will be obtained by the one-minute system. Instead, also, of having aimless conversations after the business transaction in order to get the money's worth, the talk will, it is thought, be confined to business only. These rates having been a great success in Michigan, we note that they are to be introduced on the lines of the Wisconsin Telephone Company and the North-Western Telephone Company, both of which companies are controlled by the Erie Company. The change is expected to take place within about a year.

The Willard Third-Rail System.—We notice in the *Street Railway Journal* a description of the Willard third-rail system as equipped on a short length of railway at Brooklyn. In this system, the third rail, which is divided into sections, is placed down the centre of the track, and is so arranged that only the section under the tramcar is alive. The means by which this is ensured are purely mechanical, but it seems to us that even this mechanical device is open to objection. The sections of the conducting rail are made to move slightly in either direction, and when a force of from 300lb. to 400lb. is applied, a switch is closed and connection is made. This force has to be applied by the collecting shoes attached to the car. Thus it forms an additional load on the station, which is quite unnecessary. For instance, if it is assumed that the mean force applied to keep the third rail in contact is 330lb., and the car is going at 20 miles per hour, no less than 17½ h.p. will be required to operate the contacts. This, of course, is a very large power for such work, and it will involve a considerable additional outlay for electrical energy. In order to get the necessary force applied to the third rail, Mr. Willard uses a magnetic circuit between two portions of the contact used. In consequence of this we imagine that the eddy currents set up in the third rail, due to the passing of this magnetic circuit over it, will be very considerable, and this will, of course, be in addition to the loss above mentioned. It would seem to us, therefore, that the Willard method of securing a third-rail system which is insulated when a tramcar is not passing over it, will not find extensive patronage commercially.

Traction Motors.—Under the heading of "A Regenerative Controller," Mr. John C. Henry describes in the *Electrical World* a system of electric motors and controllers which he has devised for tramway working. The main object of the arrangement is to enable a large proportion of the braking energy on a car to be generated in the armatures of the motors and to be returned to the line. In order that this may be done, shunt-wound motors are used, which are grouped in a variety of ways. On the first step of the controller armature and field each motor is connected in series across the full voltage of supply. The connections are such, however, that a resistance is inserted between the two armatures so that the current through the armatures can be more than that through the field. This resistance is gradually withdrawn until the arrangement consists of two shunt-wound motors in series. The next step consists of leaving the armatures in series, and gradually bringing the shunt windings in parallel across the full voltage of the supply. In order to get the motors to return current into the line, the strength of the field is very much increased in this way. The author gives a series of test figures obtained by him, but we do not quite understand the fact that the voltage mentioned in these figures varies from 80 to 95 volts. He compares this with

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standard motors, but our impression was that all standard motors for traction work were now made for 500 volts. Still, on the trial figures on the experiments made he shows an average gain in efficiency by using these motors of about 30 per cent. It is interesting to compare the intermediate steps in the control of these motors, as in a number of cases the connections are such that the motors are neither in series nor shunt, but they are always so connected that there is no tendency for one armature to run faster than another.

Institution of Civil Engineers.—The council of this institution have made some modifications in the regulations for the admission of students and associate members. The regulations as amended for the admission of students are as follows: (1) In cases where the usual routine of pupilage is being, or has been, served under a corporate member, the pupil may be proposed as a student at any time after the commencement of such pupilage. (2) In cases where a course of training at any public institution approved by the council is being, or has been, pursued under a teacher who is a corporate member, the latter may propose a pupil for admission as a student after he has commenced a second year of training at such institution. (3) A corporate member may propose for studentship an assistant who has been in his office or works for a period of not less than three years. For the full election the following conditions apply: (1) In the case of a candidate who has only received the general education required for studentship of the institution, a pupilage or a training as an assistant of not less than three years' duration is required, and during this time the candidate shall have given his attention to various branches of work, partly in an engineer's office and partly in or upon engineering works; and (2) in the case of a candidate whose education has included a college course in scientific subjects, a pupilage or a training as an assistant of not less than two years' duration is required, and during this time the candidate shall have given his attention to various branches of work, partly in an engineer's office and partly in or upon engineering works. The amended application forms which are now issued enable those who sign to indicate what is their personal knowledge of the candidate's experience. This is distinctly a move in the right direction.

Electrical Tramway Accidents.—We have to protest against the headlines which frequently appear in the non-technical Press with reference to accidents in connection with electric tramways. In one case recently it was announced that a child had been electrocuted, and on reading the paragraph through it was clear that electricity had nothing whatever to do with the regrettable accident, which would have occurred whatever had been the means of propulsion. With the introduction in the public streets of an improved system of traction there is always a slight increase for a time in the number of accidents, and the provincial daily Press are only too eager in chronicling these accidents to lay the blame on the new system which has been adopted. If one takes the London streets, for instance, and compares the large number of fatal accidents which occur each year, as given in the police returns, with the number of paragraphs concerning these accidents in the daily Press, it will be found that hardly one accident in ten is mentioned. If this result is compared with any of the large towns now using electric traction, it will be seen that every accident which occurs is promptly put down to electricity, instead, as is often the case, to bad driving and people's own foolishness. If a driver of an ordinary cart neglects to use reasonable caution and collides with an electric tram, the tramway company or the corporation is always blamed, and we regret to say that heavy damages are often awarded against them. It must be remembered that these electric traction systems in the large towns are a great convenience to the public, and that in a large number of cases this convenience is seriously hampered by the obstinacy of the drivers of other vehicles along the route. These drivers only too often wilfully obstruct the tramcars, knowing that if an accident occurs they stand a good chance of obtaining damages. The solution of the whole matter lies in the hands of the magistrate, who when considering the case should remember that the tramcars are absolutely unable to leave a given track in order to avoid a collision, but that no such inability applies in the case of an ordinary vehicle.

Accumulator Traction.—Mr. Vollmer contributes an article to the *Centralblatt für Accumulatoren und Elementenkunde*, which discusses the relative merits of the Planté and Faure types of accumulator plate in their application to different conditions of traction work. The so-called Planté type of accumulator is assumed to consist of pure lead plates of large surface area, while the Faure type possesses an active material in the form of paste, supported by means of leaden grids or frames. Each type has its peculiar properties, which may become advantageous or disadvantageous according to the conditions involved. The Planté accumulator, for instance, admits of a high rate of discharge without considerable loss of economy, and at the same time it may be charged very rapidly. These advantages, coupled with that of somewhat greater durability, are, however, qualified by its more considerable weight, larger volume, and lesser capacity in comparison with the Faure type. In fact, the good qualities of the latter are of just the reverse order. Besides being lighter the Faure type possesses less volume and far greater capacity, but labours under the great disadvantage that its durability and capacity are very rapidly influenced by exceeding the normal permissible rate of discharge, which is not high. Repeated discharges at a high rate render the battery unserviceable in the course of a very few days. At the same time the rate of charging is low. After some further interesting comparisons, the writer comes to the following conclusions. The Planté type of accumulator may be employed with advantage when the conditions entail a heavy demand for current over short periods rather than a steady demand over long periods. On the other hand, the paste type of accumulator would justify its adoption when long distances and light, elegant construction of the cars were involved, and at the same time a lower degree of economy permissible. To ensure the lasting success of accumulators for traction work, the writer believes that far greater efficiency and durability are necessary, and these qualities are probably to be obtained only in a new scientific direction and on a new basis of research.

Induction Motors.—Mr. Emile Kolben, of Austria, has written a most interesting letter to the *Electrical World* of New York on the application of induction motors for electric railways. He expresses his opinion in his letter that the polyphase induction motor, and especially the three-phase motor, will eventually hold the field for inter-urban and trunk line service. The chief objection to this motor for tramway work is, in Mr. Kolben's opinion, the requirement of two or three trolleys, which necessitates overhead work, which will not be tolerated in the public streets. With the perfection of a good surface-contact system this objection would be done away with. With respect to the lagging between current and E.M.F. in the modern induction motors, Mr. Kolben holds that when

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properly designed this need not have any serious effect. He claims that induction motors with power factors of 0·9 at full and half load can be designed. With this power factor the reactions from the line are not serious. Naturally the alternators have to be carefully designed so as not to have much drop on induction loads, but this Mr. Kolben holds can be done. In consequence of this, it will not be worth while to get high-voltage condensers, which would cost a considerable amount and require a large space. As regards the small clearances in induction motors, Mr. Kolben points out that the air-gap in induction motors is much smaller than that in the direct-current railway motor. Thus, while he states that air-gap densities of about 4,500 are the rule for induction motors, those of direct-current motors are from 8,000 to 10,000. In consequence of this, side strains are to a large extent equalised in the induction type. As an example of what can be done, Mr. Kolben states that a 30-h.p. induction motor with a clearance of $\frac{1}{10}$in. gives good results, and we presume that he means that a 90 per cent. power factor can be obtained even with this gap. As regards speed regulation, the writer advocates the double winding of the armatures, so that there are two economical speeds, one double the other. Between these two main speeds, resistances may be used in the secondary circuit in order to obtain a gradual speed regulation, and the method then is nearly equivalent to the series-parallel system of control for direct-current motors. We wish, however, Mr. Kolben had seen his way to give some comparative figures as to the working efficiencies of the two systems.

Earth Connections.—With the underground trolley system of electric traction with both conductors insulated, the question of earth connections becomes more difficult than when one pole of the system is insulated overhead, as is the case in the trolley system. In New York City and Washington considerable experience has been gained with such underground systems, and the result of this experience is embodied in an editorial article in the *Street Railway Journal*. It is obvious that a number of earth connections would soon place such a conduit system in a hopeless condition, unless some ready means were found either to discover or remove the earthed connections or to nullify their action. The system already adopted consists of dividing up the tramway systems into sections of from one-half to one mile in length. Each section is separately equipped and supplied by a separate feeder. Throw-over switches are provided at either end of these sections, so that when one conductor is earthed the connections to it from the central station can be reversed, if need be, so that all the earthed conductors of the system are of the same polarity. This can conveniently be done at the switchboard. The indication as to which of these conductors is most nearly at earth potential is obtained in the usual way by incandescent lamps in series across the mains. Other faults which occur, and which are likely to cause an earthing of one conductor, are not quite so easy to eliminate. For instance, if an electric car has one pole of its equipment slightly earthed, its effect will vary on different sections of the track. If the line contacts of these sections are reversed for the small faults previously referred to, the switchboard attendant can then watch the intermittent connection due to the movement of this car along the track, and signal by telephone to the engineer-in-charge that a car with an earth connection is moving in a certain section of the line in a certain direction. An earth in the armature of the motor has a still more intermittent effect, as when the car is started up, and the armature is revolving slowly, it will cause the lamps to blink much in the same way as the lamps of a synchronising apparatus when alternators are being brought into step. Here again the position of the car with the faulty armature can be approximately fixed from the switchboard. The most valuable hint in the article in question is that the individual sections of the tramway worked on the trolley system should be independently supplied by feeders running back to the central station, rather than that a number of sections should be supplied by fuses from the one feeder. Care must, however, be taken to prevent short-circuits at the junctions of two sections where the polarity of the two conductors may be reversed.

The Electric Arc.—Mr. C. D. Child communicates a most interesting article to the *Physical Review* on "The Dissociation Theory of the Electric Arc." He starts his article with some photographs of the alternate-current arc, taken on a moving film, which were obtained by Mr. N. H. Brown. The records on these films were taken from the light obtained through a narrow slit, so that only a small section of the arc was photographed. Mr. Brown found that the light from the negative carbon started first, but that it moved with the slower velocity. This point was made clear by varying the speed of the film on which the record was taken. The negative carbon would, of course, be the hotter after one discharge had taken place, as it would have previously been the positive carbon. The positive light appears to move more rapidly than the negative, and the author takes up the consideration of how far this could be explained on the hypothesis that the current was partly carried by ions, and that the positive ions moved with the greater velocity. In the first place, it was pointed out that the resistance of the arc is not an ohmic resistance, and that the greater part of the fall of potential through the arc occurs at the point of contact between the contact gas and the positive carbon. Although it has been suggested that the phenomena known as the counter E.M.F. may be due to the Thomson and Peltier effects, the author shows that tests to confirm this assumption have failed to reveal their presence. On the ionic theory, the author assumes that the gases would be dissociated, and that the charges on the oppositely-charged ions are about equal. He also assumes that the positive ions move towards the negative pole, and the negative ions towards the positive pole. There would consequently be an excess of positive ions in the vicinity of the negative pole, and of negative ions in the vicinity of the positive pole. He then shows diagrammatically that this would partly account for the fall in potential found at the junction between the gases of the carbons. If, now, the negative ions moved much more rapidly than the negative ions, the bigger drop at the positive carbon will also be explained, because at any one time there will be more negative ions in the space between the carbons than positive, owing to the less rapid movement of the former. The author then refers to some experiments by Prof. A. P. Chattock on the velocity of ions in the gas discharged from the point of a plate. This experimenter found that the friction between air and the ions resulted in an increase of air pressure on the plate. This was measured by a sensitive manometer. Mr. Child adopted such a manometer to measure the air pressure at the surface of the positive and negative carbons of the arc. He introduced an exploring tube up the centres of these carbons, and was able to ascertain that the difference of pressure between the surface of the positive and the negative carbons was as much as ·00065 of an atmosphere. This difference was increased with an increase of current, and the author proved fairly conclusively that the effect was not due to the expansion of the gases on the surface. The full text of the article is worth careful reading by all interested in the physical problems connected with the electric arc.

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THE JOHNSON-LUNDELL ELECTRIC TRACTION COMPANY, LIMITED.

A company under the above title is to be brought before the public next week in order to acquire the numerous patents taken out by Messrs. Johnson and Lundell in connection with dynamos, motors, and apparatus for the generation and use of electricity for electric railways, etc. The directors of this company, of which Mr. Leonard W. Holmes is chairman, have adopted a new departure in bringing out the company which is to be highly commended. We refer to the fact that before bringing the prospectus of the company before the public, they invited the representatives of the technical Press to meet Mr. Johnson and Mr. Holmes in order that the technical details in connection with the formation of the company could be fully discussed. We have had repeatedly to complain in other cases that when new electrical companies have been formed, the prospectuses have been issued at such a time that the public have been deprived of any useful criticism by the technical Press. The course adopted by the directors of the Johnson-Lundell Electric Traction Company is, therefore, to be highly commended. At the meeting in question

Mr. L. W. HOLMES, in introducing Mr. Johnson, referred to the fact that the company is to be a parent company, and that it will own the patent rights above referred to in Great Britain, France, Germany, Austria, Italy, Spain, Belgium, and Switzerland. The company proposes to start manufacturing works in Great Britain, and to operate themselves the patents in this country. The Continental patents may afterwards be disposed of or worked as is deemed best by the company.

Mr. EDWARD E. JOHNSON commented on the practical work his colleague, Mr. Robt. Lundell, had done in the past in connection with electric motors and to the commercial quality which his inventions had shown. Mr. Johnson's first visit to this country was in 1882 in connection with the Edison patents, and he then became on intimate terms with the late Dr. John Hopkinson. Consequently he in this way had formed a friendship which had lasted until the untimely death of Dr. Hopkinson, and he was pleased to bring forward reports made by him in 1896 on the inventions with which the company had to deal. These reports will be found further on in this article. Referring particularly to the electrical generator which the company would manufacture, he pointed out that not only was the machine a most efficient one and a good regulator, but these results had been obtained with a very considerable economy of material. Thus Mr. Parshall stated in his report that he did not consider that the same results could be obtained by any other dynamo designed according to the usual methods. With respect to electric motors and their use in controlling on electric tramways, Mr. Johnson commented on the fact that practically no resistance was required in changing over from series to parallel with the system of connections designed by Mr. Lundell. It was also of great value to be able to use the electric motor as a brake, and with Mr. Lundell's device they were able to return current to the lines at any speed from the maximum speed of the car down to one-third of this. It was also much more safe to make the electric motor deliver the braking current against a counter E.M.F. than against a resistance. In this way it was ensured that their system with the output taken from the motors, when acting as a dynamic brake, could not exceed the normal output of the motors when driving the cars. The devices were also of special advantage when used in connection with accumulators for automobile work, as the return current either enabled the weight of the accumulators required to be considerably reduced, or else they could increase the range of the accumulator car with the same weight of battery. With respect to the surface-contact system over which the company would secure the rights, he and Mr. Lundell had expended some £40,000 in making experiments on a large scale with this system, and he considered that they had arrived at a practical system which could be used in practically every case. They used a magnetic means of operating the relay which put the surface contact in connection with the main feeders, and this magnetic relay was, of course, quite unaffected by the leakage currents. They also provided a low-voltage service for charging the relays, which gave much less trouble from sparking, etc., at the contact. Mr. Johnson went on to refer to the flexibility of the system when used somewhat on the lines of the Hanover system—*i.e.*, when a small battery of accumulators was carried on the car. It then became possible to dispense entirely with all the surface contacts on the down grades, as the small storage battery would give quite sufficient energy to start the car. The accumulator would then be recharged on the down grades, and also when running on that portion of the track which was electrically equipped. One great fault of all surface-contact systems was that at crossings the collecting skate, which was at 500 volts pressure above the rails, was obliged to be in close proximity to the tracks which it was crossing. The distance between the two could not be more than 1in., and it was quite likely that short-circuits would occur at such points, which would be apt to disorganise the system. Mr. Lundell had devised a means of overcoming this by placing in the switch boxes on either side of the crossing a resistance shunted by a fuse. In the event of a short-circuit this fuse immediately blew, and the resistance, which then was connected between the surface contact and the feeder, prevented more than 25 amperes being taken from the line. This current was quite sufficient to enable the car to traverse the crossing, but it prevented any further damage being done by a short-circuit, and it also prevented the whole traffic being disorganised by the car being stalled at the crossing. With respect to the influence of ice and water on this surface-contact system, they had in one instance flooded the track so equipped to the depth of 5in., and caused a horse to walk behind a moving car with its head over the dashboard. The horse received no shock, and the car worked equally well in the water. With respect to ice forming on the contacts, it was found that the moving skate cut through the ice exceedingly readily and kept good connection.

Mr. H. F. PARSHALL, who was asked to say a few words on the Lundell type of generator, referred to the history of dynamo design from the days of Hopkinson up to now. The late Dr. J. Hopkinson had been the first to recognise the armature reaction which took place, and he thought that Prof. S. P. Thompson was the first to suggest counteracting the same by placing magnetomotive force in the air-gap. Prof. Ryan had worked on the same lines by placing magnetomotive force in the pole-pieces, but the idea was not commercial. Mr. R. W. Sayers had also tried experiments with special coils, but he thought that the extra cost of the Sayers winding more than counteracted the slight increase in output. He considered Mr. Lundell's device a useful one, and when asked to report on the same, he had sent Mr. Hobart down to Newcastle-on-Tyne to find all the fault he could with it. Mr. Hobart had found this an exceedingly difficult task, and he reported that the machine was superior to any he had previously tested.

Mr. BROWETT, of Browett and Lindley, referred to the trial of one of these generators which had been made in his works, the generator being coupled to a Browett-Lindley engine. The machine ran sparklessly from no load to 25 per cent. overload, in spite of its small size and weight. It was a comparatively small machine, and the engine was a new one, but the efficiency obtained on the trial was slightly over 84 per cent. He might mention that the machine ran sparklessly without any shifting of the brushes on the commutator.

The representatives of the Press were then entertained to lunch, after which some more information as to the formation of the company and the details of the arrangements was given. It was made clear that the company intends to lay down works for manufacturing in quantity, but that, in order that there may be no delay, the machines will be at present manufactured by Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne, while the Sprague Electric Company, of New York, will supply the motors and controllers.

The following are some of the expert reports which the company has obtained with respect to its purchase.

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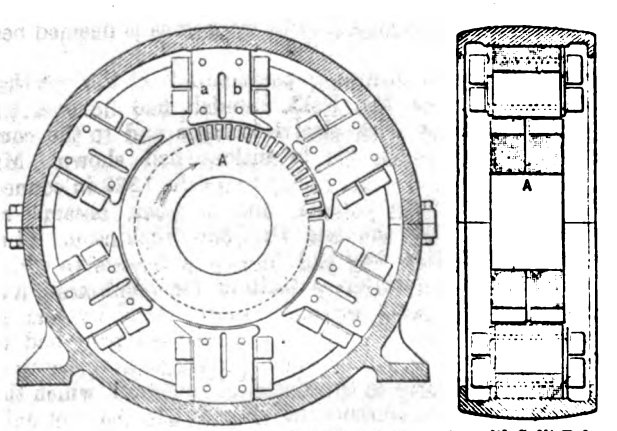
Thus, Mr. H. F. Parshall, writing on June 22, 1899, states: "In accordance with your request, I have had a series of tests conducted at your works with a view to corroborating the reports made by Messrs. Johnson and Lundell in respect to the merits of the form of design of their dynamo, as set forth in the prospectus of the Johnson-Lundell Electric Traction Company, Limited. These tests show that the dynamo has the qualities represented, and, in fact, the dynamo was tested under conditions more stringent than those made mention of by Mr. Lundell in his report to you, and was found to be highly satisfactory. I have conducted these tests at such length that I am prepared to state that the same results cannot be obtained on dynamos designed according to the usual methods. The tests were conducted under your own observations, and I attach herewith detailed logs of the run from which my deductions have been made.—(Signed) H. F. PARSHALL."

The report of the late Dr. John Hopkinson made in July, 1896, on the Lundell generator reads as follows: "I have read a description of the Lundell and Johnson improved machine prepared by Mr. Lundell. I have also examined the curves which show the E.M.F.'s at various parts of the field, and a drawing illustrating the proposed method of improving the machine. It has long been known that in ordinary compound-wound continuous-current machines, and also in shunt-wound continuous-current machines, the current in the armature of the machine has a distorting effect upon the character of the field in which the armature coil is moved. The amount of this effect is quite calculable, the method of calculation having been, I believe, first set forth by myself. The effect of this distortion is that the proper position of the brushes for commutation is changed, and that if this change is not made, sparking which may be injurious to the machine results. Various attempts have been made to so construct machines that the position of the commutation shall not be changed owing to the distorting effect of the current in the armature. It is to attain this end that the Lundell and Johnson improvement is addressed. The improvement is perfectly simple. The magnet is to be divided into two parts of about equal section wound with the same coils of wire for exciting. One of these parts has a large polar extension, so that the area of armature opposed to it is considerable. The other part has a smaller polar extension. The result is that a comparatively small current will fully magnetise the part with the larger polar extension, but will not fully magnetise the part with the smaller polar extension. On increasing the current, the part with the larger polar extension has its magnetism increased to a moderate extent only, while the part with the smaller polar extension has its magnetism much more largely increased; the result being that the distortion of the field is effectively diminished, and can be so arranged that the point of commutation is not materially altered. I am satisfied that this device would be practically successful in avoiding the necessity of shifting the brushes, and in my judgment it is by far the simplest expedient which has yet been proposed to attain this desirable end. It really adds nothing to the cost of the machine, and introduces into it no complication.—(Signed) J. HOPKINSON."

Mr. E. Manville's report on the motors and system of motor control states: "In accordance with your request, I proceeded to Newcastle, and there carried out a series of tests with a view of ascertaining to what extent the claims, as set forth in the prospectus of the Johnson-Lundell Traction Company, Limited, for the new motor and methods of motor control were justified. I have pleasure in stating that these claims have been fully established by the tests which I have made. The following are the particular merits of the motor and methods of motor control as observed by me: (1) These motors undoubtedly produce the starting torque and all the speed variations claimed without the loss of energy incidental to the use of the resistances ordinarily employed. (2) The method employed in series-paralleling the motor results in more uniform and fine graduations of speed than has hitherto been attained in electric traction. (3) This method enables the motors to be used most effectively as regenerative brakes from their maximum speed down to one-third thereof before resorting to the usual mechanical methods of braking. It is apparent that the electrical energy thus restored to the line will assist in propelling the other cars, thereby effecting an economy in the central power station. This characteristic of the system is extremely valuable in connection with the operation of automobiles. In such operation the energy recovered is restored to the accumulators, thereby not only producing greater longevity of the batteries, but materially increasing the mileage capacity of any given weight thereof. (4) My tests have demonstrated that the foregoing results are attained without any sacrifice of mechanical or electrical simplicity of apparatus. I have pleasure in handing you herewith the test logs from which these deductions have been made.—(Signed) E. MANVILLE"

Reports have also been obtained by the company on the surface-contact system from Lord Kelvin and the late Dr. J. Hopkinson, while Messrs. Cardew and Preece report that the price asked by the company for the patents is a reasonable one. This price, we may mention here, is £200,000, of which half is payable in cash, and the other half in shares in the company. The vendors, however, make the proviso that £80,000 worth of these shares are not to bear interest for the first four years unless a dividend of 10 per cent. is paid on the other shares of the company. Messrs. Lacey, Clirehugh, and Sillar also report favourably on the value of the rights which the company will secure. The following technical details of the generator and traction motor, etc., will be of interest to our readers in view of the above flotation.



FIGS. 1 AND 2.—Sections of the Lundell Electric Generator with Split Poles.

The Dynamos.—The great feature in the electric generators designed by Mr. Lundell is the split pole-piece, but the whole of the details have been carefully thought out and perfected. The object of the split poles (as shown in Figs. 1 and 2) was fully explained by us in an article in our issue for Feb. 26, 1897, but a brief *résumé* here may be serviceable. With a dynamo armature running in the direction indicated in Fig. 1, the armature currents tend to weaken the field strength under the edge of the pole-face which the conductors approach. This weakening results in a shifting of the neutral axis and also of the axis of commutation. Mr. Lundell prevents this weakening of the induction by imposing a reluctance in the path of the cross field. He also ensures by the design that the action of the compound winding shall tend to slightly increase the induction at the point where it is useful for commutation. Thus the half of the pole marked (*b*) in the figures has a large pole-shoe, which reduces the air-gap reluctance, and results in the iron of (*b*) being strongly saturated when the half of the pole marked (*a*) is still magnetised considerably below the saturation point. Any increase in the magnetising force consequently increases the induction through (*b*) but slightly, but greatly strengthens the induction through (*a*), and hence keeps up the commutating field. The split pole also halves at least the cross magnetising effect of the armature current.

The general appearance of one of these dynamos is shown in Fig. 3, which is of a 125-kw. generator running at 585 revolutions per minute. This machine weighs, with rails, about 7,000lb., or 56lb. per kilowatt. One of the poles of

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this machine as wound with both shunt and series coil is shown in Fig. 4. The details of the brush gear (Fig. 5) is also of special interest, as the same allows of the carbon brushes extending the full width of the commutator, and hence avoids the rutting of the same which is sometimes found with brushes which are spaced at intervals along the commutator. Fig. 6 shows the same brushes as mounted on the frame and connected together. The results of tests on a 100-kw. generator of the same type wound to give 125 volts at a speed of 254 revolutions per minute are incorporated in the curves given in Fig. 7 and 8. The division of the losses is of special interest. The shape of the efficiency curve is good, and the flatness of the same for overloads most remarkable.

The machine experimented on by Mr. H. M. Hobart was a 50-kw. one with six poles, and ran at 290 revolutions per minute. The voltage at the terminals was 125. The following details of this machine are of great interest for sake of comparison. The armature was 22in. diameter and 7¾in. long, and had 56 slots in it. The commutator had 112 parts. There were 44·5lb. of iron per kilowatt in the entire magnetic circuit, and 11·2lb. of copper per kilowatt in the windings. The shunt coil provided 3,372 ampere-turns per pole, and the series coil 2,600 ampere-turns. The total weight of the machine without base-plate was 3,517lb., while the armature alone weighed 1,131lb. The efficiency of the machine at different loads was as follows: one-quarter full load, 85·4 per cent.; one-half full load, 89·7 per cent.; three-quarter full load, 90·2 per cent.; full load, 90 per cent.; 1½ times full load, 88·1 per cent. Mr. Hobart also gives in his report most full details of the losses in the various parts of the machine, and comments on the perfect commutation at all loads. The figures in this respect are as follows:

Commutating Data.—One hundred and twelve commutator segments; 6·7 volts per segment; length of laminations along shaft = 7¾in. Assume 20 C.G.S. lines per ampere-turn and per inch of length of armature laminations. Four adjacent conductors are simultaneously undergoing commutation. 4 × 20 × 7·75 = 620 lines per ampere are linked with one turn by the magnetomotive force of the four. This turn has an inductance of ·0000062 henry with reference to the four. It reverses at the rate of 213 cycles per second. Hence reactance = 5·28 × 213 × ·0000062 = ·0083 ohm. Reactance voltage in short-circuited coil = 200 × ·0083 = 1·66 volts. This is a very low value, and taken in connection with carbon brushes would lead one to expect most excellent commutating results. Fifty-six armature slots and four conductors per slot; hence 18·7 turns per pole-piece on armature. There are two circuit windings; hence 200 amperes per turn. 200 × 18·7 = 3,740 ampere-turns per pole-piece on armature. Shunt ampere-turns per pole-piece, 540 × 7·05 = 3,800. Series ampere-turns per pole-piece = 6·5 × 400 = 2,600.

Coming, now, to the Lundell tramway motors, we regret that space at our disposal prevents more than a passing reference to their design and to the means of controlling the same for traction purposes. Fig. 9 shows a view, partly in section, of one of these motors. It will be noticed that the field-magnet system is built up entirely of laminated iron. Two commutators are provided on each motor. The method of control can be gathered from Fig. 10, in which O^1 represents the shunt winding, T^1 the series winding, C^1 C^2 the commutators for the armature windings of one motor. O^2 T^2 C^3 C^4 represent the corresponding windings and the commutators of the other motor. Each armature combination yields three different speeds by reason of a varied field-strength. The first three speed combinations, first, second, and third, give 125 volts per commutator (with a line voltage of 500), and the motors are practically working as shunt motors, owing to the very strong shunt and the weak series field winding. The next three speeds, fourth, fifth, and sixth, give 250 volts per commutator. The series fields have now become considerably stronger, owing to an increase of current through their windings, and the shunt fields have been somewhat weakened by the introduction of one or more resistances in series with the same. The three last speed combinations, seventh, eight, and ninth, give 500 volts per commutator, not counting the drop due to the series field winding. The series field at the seventh position is four times as strong as at the first position, and at the eighth and ninth positions it is furthermore strengthened, by reason of more

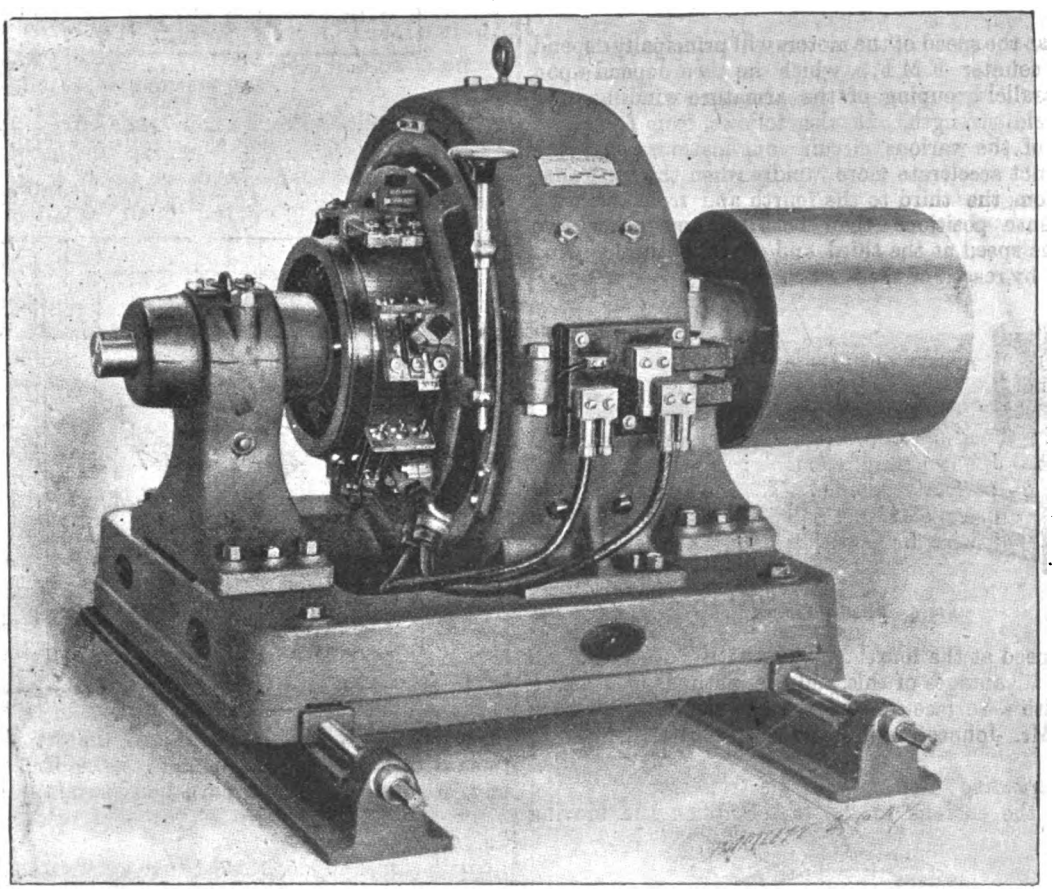

FIG. 3.—General View of a 125-kw. Lundell Dynamo, 585 revolutions.

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current flowing through the armature. The shunt field has been so reduced by reason of additional resistances in series with the same that the motors at the top speed are practically working as plain series-wound motors. As there is no external resistance in the armature circuits to cause a considerable drop of potential, and as the internal resistances of the motors themselves are comparatively small,

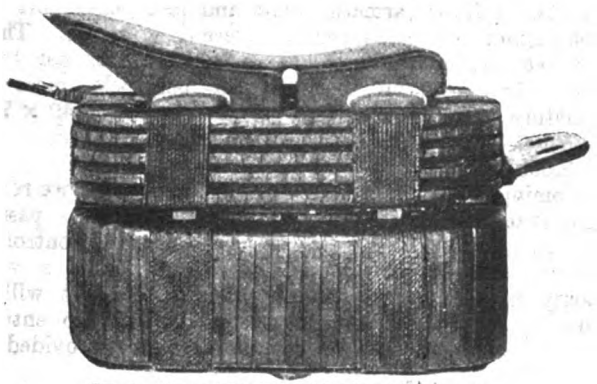

FIG. 4.—View of One Pole of the Lundell Dynamo.

it follows that the speed of the motors will principally depend upon their counter E.M.F.'s, which in turn depend upon the series-parallel grouping of the armature windings and upon the field strength. It also follows, from the above description of the various circuit combinations, that the motors will not accelerate more rapidly when the controller is moved from the third to the fourth and from the sixth to the seventh positions than between any other two positions (the speed at the third and sixth positions being so increased by reason of the weakened field that it approxi-

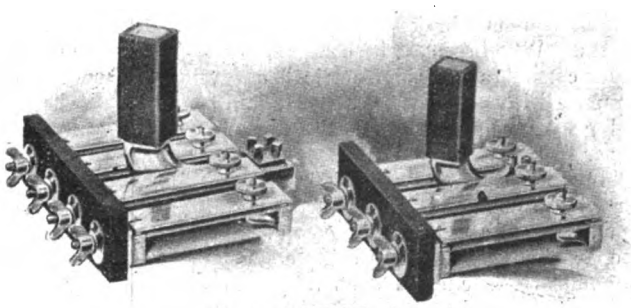

FIG. 5.—Detail of Brushes.

mates the speed at the fourth and seventh positions). As regards the advantages of this, and the methods of utilising the same with a surface-contact system, we have pleasure in quoting Mr. Johnson's views on the subject, which are as follows:

The Distributing System.—In electric tramways the delivery of the current to the motors upon the moving

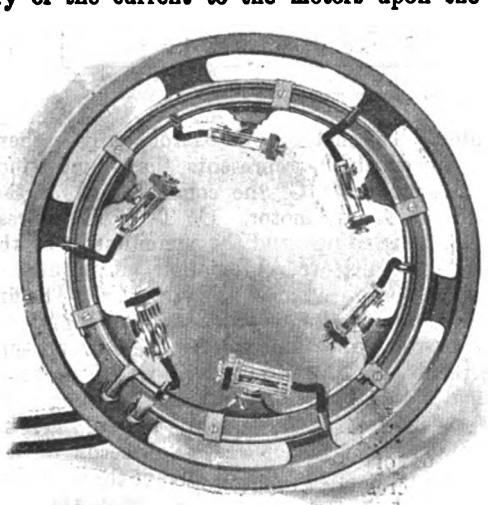

FIG. 6.—Brush Rocker and Connections.

car is effected by means of a continuous main conductor running parallel with the line, and from which conductor the current is collected by means of a rolling or sliding contact. The one great problem for which tramway managers, municipal authorities, and the public at large are still waiting a solution is that of collecting the current from this parallel conductor when in a hermetically-sealed conduit under the roadway. When placed overhead, the

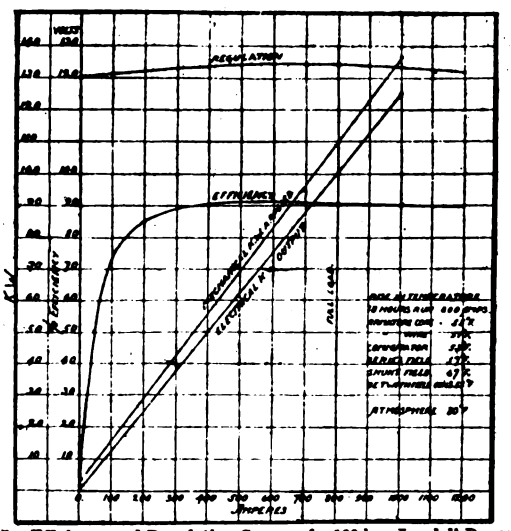

FIG. 7.—Efficiency and Regulation Curves of a 100-kw. Lundell Dynamo. Speed 254 revolutions.

current is collected by a small trolley fixed at the end of a flexible pole projected from the roof of the car. This method satisfies the demands of economy, is condoned by municipal authorities, and is acquiesced in by the public

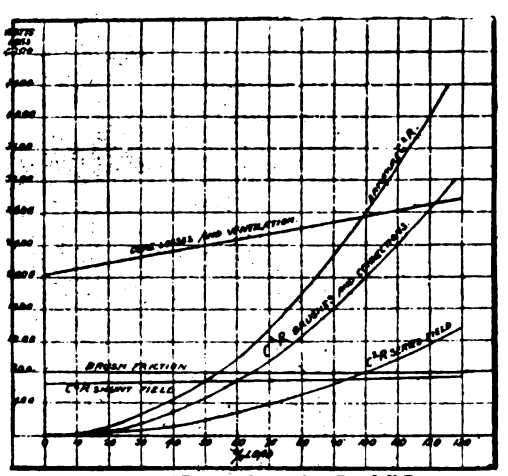

FIG. 8.—Curves of Losses of a 100-kw. Lundell Dynamo.

because they are made to believe that it is only by this means that they can employ electric traction at all. When this supply conductor is placed in an open conduit in the

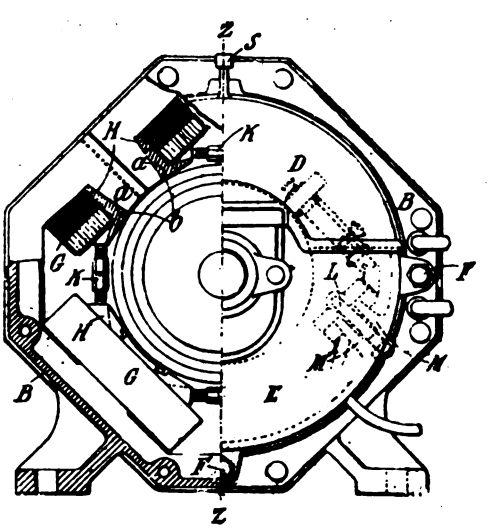

FIG. 9.—Detail of Tramway Motor.

roadway it fails to satisfy either economy, municipal authority, or the users of the street, who find it obstructive and dangerous. There remains, then, but one other place to locate it—viz., in a sealed conduit beneath the surface,

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but since it is, of course, physically impossible to effect contact with it when so located, it becomes necessary to supplement it by a non-continuous or sectionally divided conductor. This conductor is embedded in the street surface, and is of such length as to be safely covered by the car; each of these sections is in turn put into electrical connection with the continuously-charged subterranean conductor as the car moves along; no one of them must by any possibility be left in connection therewith after it shall have been uncovered by the progress of the car.

Many attempts have been made to evolve a system of this character, but they have lacked simplicity and certainty of operation, defects not necessarily inherent in the principle, but rather arising from a lack of comprehension of the essential requirements and of consequent thoroughness in perfecting the important details. While this system is not materially more expensive to instal than the overhead trolley, it affords by reason of the facility with which it may be combined with the storage battery a means for obtaining an economical and generally ideal system at a cost even less than that of the overhead trolley.

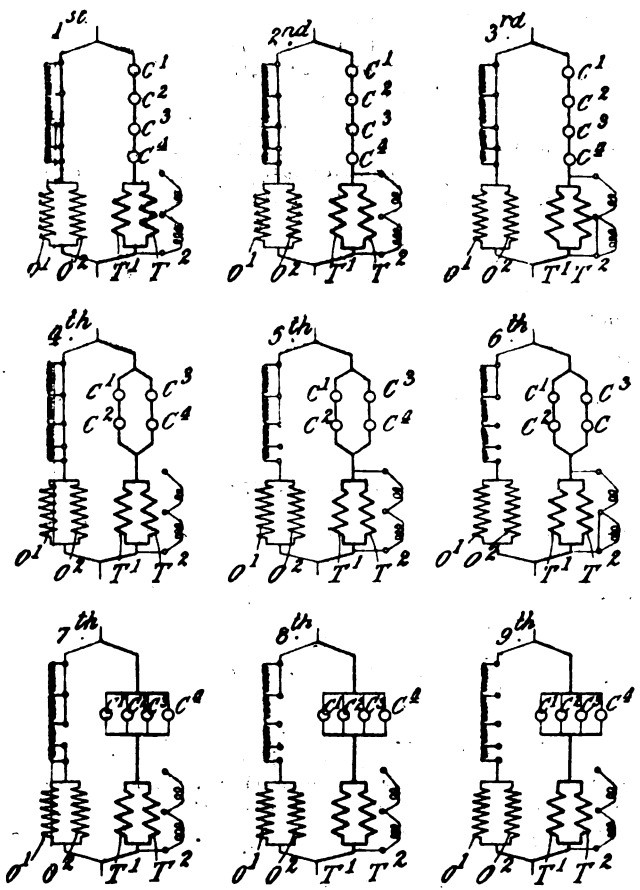

FIG. 10.—Diagram showing Motor Connections for Nine Successive Stops of a Controller on the Johnson-Lundell System.

In such a system the roadway is equipped with "feeders" and main and sectional conductors only upon the ascending side of its grades; the descending side, the levels, and all difficult situations, such as crossings, turnouts, and the roadway of another company are all left minus any electric equipment whatever. To propel the car over these unequipped sections of the road a small and light storage battery is employed. This battery need not exceed in weight 25 per cent. of that of the batteries ordinarily used. The operation of the system will then be as follows: The roadway is, say, 12 miles long. The power station is centrally located. The cars are equipped with battery capacity to carry them, say, eight miles on a level. The roadway is electrically equipped for a distance of, say, three miles either way from the central power-house. As the car passes over the equipped portions of the roadway its motor receives its energising force therefrom and the battery receives a renewal charge, thus putting it in condition to propel the car over the levels.

It is, of course, apparent that by reason of this method of charging the battery when doing duty, it is unnecessary to provide means in the power-house therefor, or even to remove a battery from the car at all. It may, in fact, be built into the structural frame of the car without other regard for accessibility than to afford means for its occasional inspection. The operation of the system is absolutely automatic. When the car passes over the equipped section, the master current from the power-house flows through both the motor and the battery. When the car leaves these equipped portions the current from the battery automatically flows through the motor; thus no manipulation is required of the driver.

As will be seen, the only feeders required in such a system are the short ones to supply the near-by mileage of the road, and since the amount of copper increases as the square of the distance, it follows that in omitting the long feeders a large proportion of the feeder cost is saved, particularly in view of the fact that the cost of conduits for the omitted feeders is also saved.

To realise the full benefit of this combination of battery and direct electrical supply, all grades of any consequence are electrically equipped on that side upon which the car ascends; thus, instead of such grades rapidly exhausting the battery by imposing upon it an abnormal draught, it is, as a matter of fact, not only not drawn upon at all, but is actually replenished. In this way the battery is saved from an extraordinary duty, and hence may be of very light weight and small capacity, and yet be capable of propelling the car over several miles of level, easy, or descending grades. In the event of the occurrence of grade equipment along the line remote from the power station, a proportionate amount of equipment may be omitted from the normal sections near by the station. The actual track equipment would thus not be much, if any, more, although there would be a somewhat increased "feeder" length.

As will appear from the description of the operation of the motor equipment presently to follow, the motors are used as dynamic brakes in stopping and in descending all grades. When so used in connection with the system now under consideration, the electrical energy thereby developed is pumped into the battery, thus again renewing its charge and greatly economising in the demands upon the central power station. In consequence of these several savings it is apparent that the cost of the necessary feeders, the partial equipment of the roadway, and the batteries combined will not aggregate the cost of an all-overhead trolley line, with its necessary complement of feeders. The economical efficiency of such a system is necessarily very high. The physical and æsthetic aspect is certainly ideal, since it presents the absolute minimum of obstructive and unsightly aspect of the street, as well as the minimum of street disturbance in laying down.

In conclusion, we wish to add a few remarks as to the company itself. The Board of the company consists entirely of business men, and could hardly be improved upon. The chairman, Mr. L. W. Holmes, is intimately connected with electrical work in this country, and hence will be able to direct the business of the company. Through his personal influence the underwriting of the capital of the company has been secured. The list of underwriters, which we have been allowed to see, shows that commercial support has been secured, and the large amount of capital taken firm by the underwriters is a guarantee of the company's stability. The working capital provided by the issue (£100,000 is sufficient, and we have pleasure in wishing the Johnson-Lundell Electric Traction Company a prosperous career, and hope that they will rank high amongst our English manufacturing concerns.

ELECTRICAL ENERGY FOR TRAMWAYS.

With the rapidly increasing use of electric traction and the combination of electric traction and electric lighting schemes, it is interesting to note the charge per unit which is being made in various towns for the energy supplied from such combined stations. We have therefore collected information from a certain number of towns which may serve to indicate the exceedingly low rate at which such power can be supplied when compared with the rates which have to be charged for energy for electric lighting. The

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lowest on record at the present time is Liverpool, where the charge per unit is only 0·9d. The number of units actually supplied to the tramways during 1899 was, however, 1,883,728, so that the electric lighting department had an income from the power supplied to the tramways of £7,064. At a recent meeting of the Liverpool City Council complaint was made that this power was being supplied at too low a rate, but this opinion is not shared by the Electric Lighting Committee. It was at that meeting brought forward that while the charge for electrical energy was £7,064, the total revenue of the tramways was over £77,000, from which it was argued that the charge was obviously too low. It was also pointed out that the cost of the horses, which had previously worked the tramways, came out at £144,000 per annum. This is a striking instance of the great saving through the use of electricity for the tramways.

The next town in order of cheapness of supply is Bradford, where the Electricity Committee charge the Tramway Committee at the rate of 1d. per unit for all current used in the tramway system. The Bradford tramways are being extended, and, while the total units used by the tramways in 1899 was 618,282, the average monthly consumption for the first three months of this year amounts to 63,309 units. When compared with the actual consumption, the Bradford rates are quite as favourable as those in Liverpool.

In Bolton the tramway department are now paying 1½d. per unit for their electrical energy, but this is only a temporary arrangement in view of a final basis being arrived at after three months' experience in order that the electricity department may determine the actual cost. It is believed by Mr. A. Ellis, the general manager of the tramways and electric lighting department, that 1d. per unit will be the ultimate figure.

In Halifax, where the trams are under the care of Mr. H. F. Street, the tramway current was charged at the rate of 2d. per unit up to March 31, when it was reduced to 1·88d. We have not any information from Halifax as to the actual consumption of energy.

At Aberdeen the present arrangement between the Tramway and Electricity Committees is that the energy supplied should be paid for at cost price, in which price all interest charges and sinking fund as well as working expenses are to be included. The price is to be fixed at the end of each financial year, when the actual cost has been ascertained. We presume, however, that Mr. J. A. Bell will not allow the Tramway Committee unlimited credit, but that the electric light department will receive payment regularly, the final balance of the accounts only being left over till the end of the year.

At St. Helens a sliding scale has been arranged, which Mr. J. H. Highfield, the electrical engineer, informs us is as follows: for any amount up to 200,000 units, 2d. per unit is charged; up to 400,000 units, 1½d.; up to 600,000 units, 1¼d.; and 800,000 units, 1d. The actual quantity used by the tramways for the first 8½ months' working—*i.e.*, from July 15, 1899, to March 31, 1900—amounts to 161,000 units. From this it will be seen that the charge at St. Helens is likely to be about 1½d. per unit.

At Plymouth Mr. J. H. Rider is at present obtaining more favourable prices from the Tramway Committee. Thus for all current up to 150,000 units per annum a charge of 3 5d. per unit is made. For the excess beyond this up to 500,000 units 2·3d. per unit is to be paid. In this case, however, the cost of the feeders to supply the trolley wire is borne by the Electric Lighting Committee, and the Tramway Committee is not charged for any portion of Mr. Rider's expenses and remuneration. In view of the fact that he superintends the tramway department this should obviously be taken into account. The tramways in Plymouth only commenced running in September last, but the present section is consuming some 10,000 units per month.

In all the above cases the electric tramways and lighting are owned by the municipal authorities, but in the case of Dover the electric lighting is in the hands of a company which supplies current to the municipal tramways. It is only to be expected, therefore, that at Dover somewhat higher rates are charged. In the agreement the Corporation undertake to purchase a minimum of 160,000 Board of Trade units per annum, the price to be 3d. per unit for all up to 240,000. If this amount is exceeded, and the total consumption is below 360,000 units, the price is reduced to 2·75d. per unit for the whole quantity. Again, if the quantity exceeds 360,000 units per annum, it is all charged at the rate of 2·5d. per unit. Mr. H. E. Stilgoe, the borough engineer, who has so ably equipped and managed these tramways, informs us that in 1899 he just succeeded in getting into the middle rate. Thus, the consumption of electricity per month was as follows: in January, 18,875 units; in February, 17,670 units; in March, 19,237 units; in April, 17,605 units; in May, 18,893 units; in June, 18,903 units; in July, 20,561 units; in August, 23,033 units; in September, 23,699 units; in October, 22,475 units; in November, 21,675 units; and in December, 21,652 units—making a grand total of 244,278 units. It is interesting to note that the using of one unit more than the 240,000 means an immediate reduction in the total of about £250—in fact, the total cost of electricity in 1899 amounted to £2,800, whereas, if the Corporation had only taken 239,999 units, the total would have been practically £3,000.

In order to show the difference between the charges for electrical energy for traction and lighting in the above towns we give the following table, which is as complete as we can make it from the balance-sheets issued up to the present. In those cases in which the 1899 figures are not obtainable, we have included the average cost per unit for 1898, and placed an asterisk before the figures:

Town.	Electric lighting. Units sold.	Electric lighting. Average price.	Electric traction. Units.	Electric traction. Average price.
Liverpool	*2,915,695	4·6d.	1,883,728	0·9d.
Bradford	*1,419,000	4·1d.	68,282	1d.
Bolton	416,635	4d.	—	1·5d.
Halifax	628,759	4·5d.	—	†2d.
Aberdeen	412,353	4·5d.	—	—
St. Helens	65,091	6d.	‡161,000	1·5d.
Dover	*423,057	5·75d.	244,278	2·75d.

† Price reduced to 1·88d. on March 31. ‡ 8½ months' working.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Electrical Equipment of Ships of War.

BY C. E. GROVE, MEMBER.

(Continued from page 521.)

Range-Finders.

These are sometimes electrical. That used by the United States navy, invented by Lieutenant Fiske, is based upon the Wheatstone bridge principle. Two telescopes (Fig. 23) are mounted so as to move over graduated arcs. In gear with the trains of movement are cylinders wound with resistance wire.

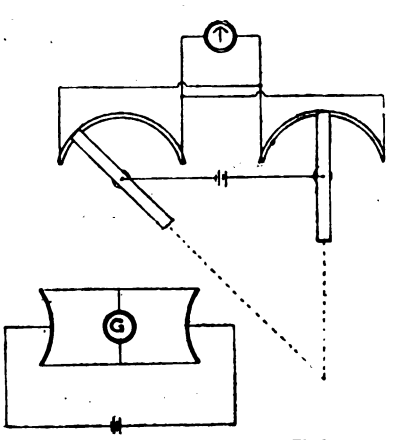

FIG. 23.—Diagram, Fiske Range Finder.

When the telescopes are parallel these resistances form balanced arms of a Wheatstone bridge. When the telescopes are trained so as to bring a distant object into the field of both simultaneously, the electrical balance is upset and current flows in the galvanometer to an extent depending upon the arc of training, which is a trigonometrical function of the distance of the object from the centre of the base line connecting the two telescopes. The base line should be as long as possible, whence one instrument is usually mounted on the

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forward bridge and one aft, the galvanometer being in the conning tower where the firing keys are placed. It is necessary to know this base line with great accuracy, or errors creep into the range. Further, three observers are necessary, who must be connected with each other by telephone. The method is a delicate one, and the difficulty of making the necessary adjustments, taken in conjunction with the difficulty of using the telephones during gun-firing, led, it is said, to the abandonment of the apparatus by the vessels engaged in the war with Spain, who found it easier to get the ranges by trial shots. The range-finder used in the British navy, and which has also been supplied to most foreign navies, is that of Barr and Stroud. It is designed for use by a single observer, but, being a purely optical instrument, does not call for detailed description here. The ranges having been found, the next step is to transmit them to the various gun stations. For this purpose Drs. Barr and Stroud have invented a system of range and order telegraphs for indicating simultaneously at any number of stations the range of a given object, together with information as to the guns which can be brought to bear upon it, and orders as to firing. The Japanese are adopting them generally, and the British Admiralty have them on trial. As fitted in the ship, a single transmitter near the range-finder position gives the range upon a receiver in the conning tower. Adjacent to this receiver are two double transmitters for sending orders and ranges to the several casemates or to the barbettes, the receivers at which stations are grouped upon two main circuits, with bells which ring at every fresh signal received. The transmitters and receivers consist of clockwork mechanisms actuating, under electrical control, the movements of pointers over dial faces, on which figures representing ranges and symbols indicating orders are inscribed. The transmitter has an outside handle moving about the centre of the instrument. To transmit an order, this handle is moved until its index pointer is over the required symbol. On moving it puts current, obtained by transformation from the lighting mains, into a small apparatus, which starts an inside pointer following the outside index pointer. While this is moving, currents are being transmitted to the receivers at the distant stations, and the whole of the pointers are set in motion. They all stop together over the symbol under the index pointer of the transmitter. Being clockwork, the instruments have, of course, to be wound up periodically.

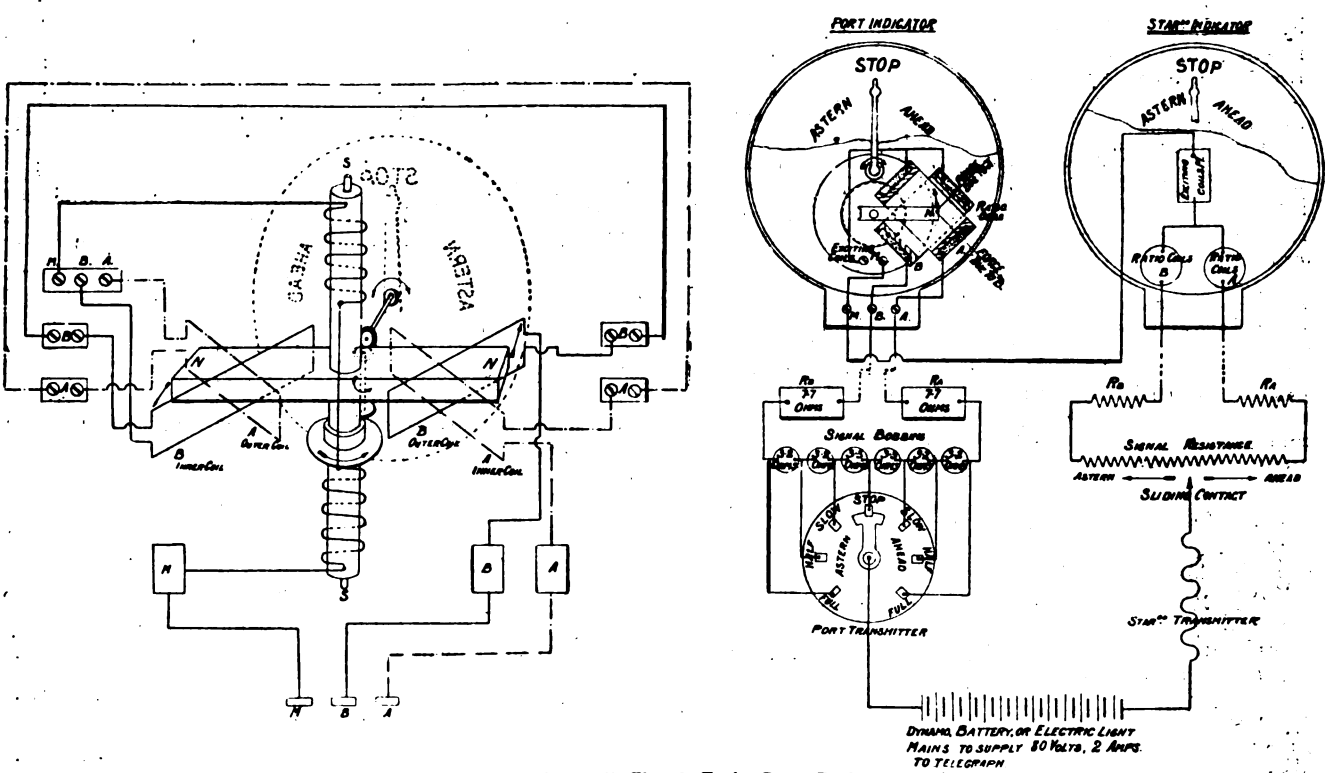

FIG. 26.—Richards and Evershed's Electric Engine-Room Reply Telegraphs.

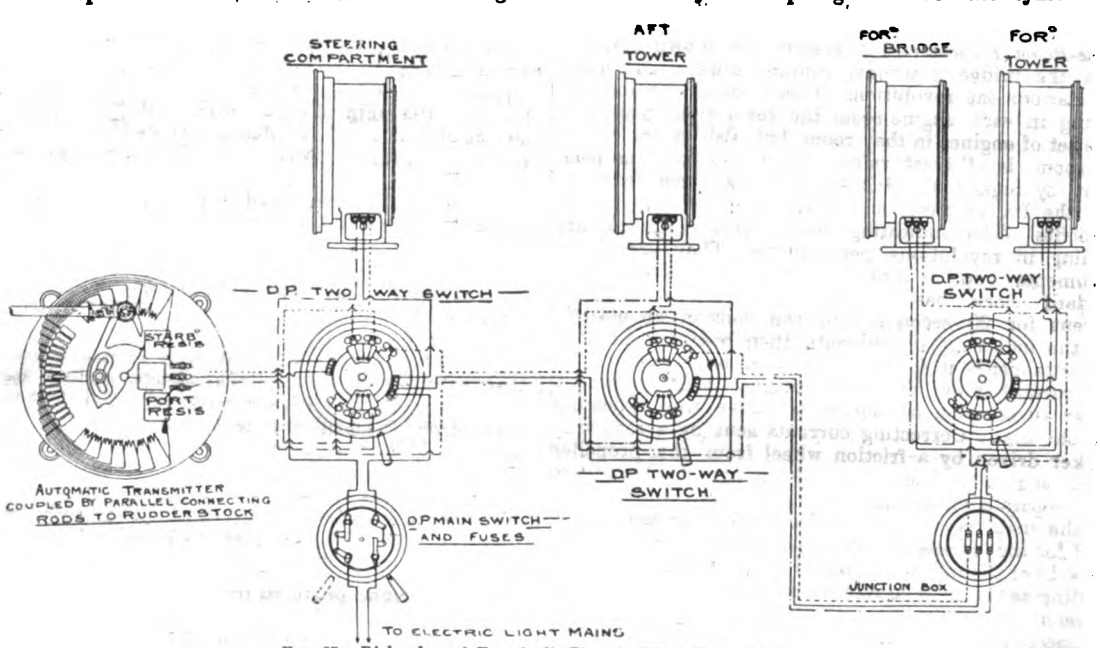

FIG. 27.—Richards and Evershed's Electric Tiller Transmitters.

Navigation Instruments.

1. *Engine-Room Telegraphs and Helm Indicators.*—An electric system of engine-room reply telegraphs worked out by Messrs. Richards and Evershed was fitted in H.M.S. "Howe" and "Narcissus" in 1893, to H.M.S. "Royal Sovereign" in 1896, and since then in other British war vessels. The

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indicating instruments have the appearance common to mechanical telegraphs, the dials being marked to show the usual direction orders, "Stop," "Slow," "Half" and "Full," "Ahead" or "Astern." The revolution of the indicating hand is effected by the combined operation of two electromagnets (see Fig. 26) placed at right angles to one another, and producing between them a cross magnetic field, within which lies a magnet with which the indicating needle is geared. The position of the needle depends solely on the relative strength of these two field components, and this depends on the ratio of the current in the two coils. This ratio is controlled by the "transmitter," which consists of a multiple contact switch, through which the ordinary 80-volt electric light circuit is connected to a pair of ratio arms included in the same circuit as the coils of the indicator; the movement of the transmitter switches resistance out of one arm into the other, thus altering the relative value of the current strength in them, and controlling the movements of the indicator. An important detail is that the action does not depend on the absolute value of the currents in the indicator coils, but only upon their relative value, so that a constant voltage is unnecessary. A similar indicating instrument, graduated in degrees, is used for showing, at the several navigating stations, the angle made by the rudder, the transmitter switch in this case being automatically worked from the rudder cross-head (Fig. 27). By means of switches these telegraphs can be arranged to signal from any of several working positions—bridges and conning towers, to wit. Transmitters send orders from any of these stations to a common receiving instrument in the steerage flat.

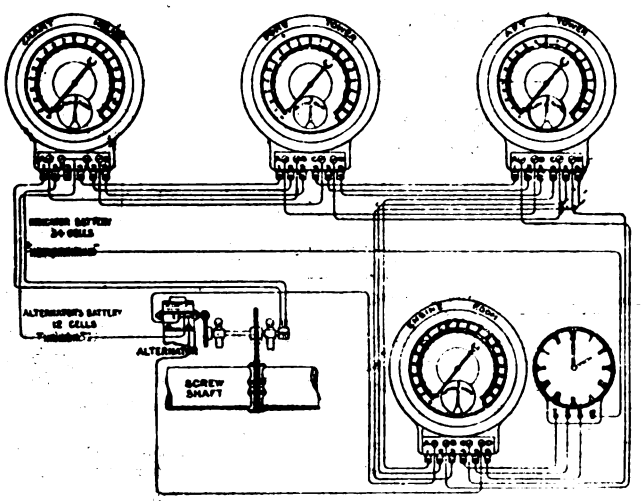

FIG. 28.—Molinari's Engine Revolution Indicators.

2. *Engine-Room Indicators.*—A system for showing simultaneously in the bridge positions, conning towers, and other navigating stations the revolutions of each set of engines, and for indicating in each engine-room the revolutions made not only by the set of engines in that room, but also by the set in the other room, is of great value. Such a system has been worked out by Signor P. Molinari, and has been adopted throughout the Italian navy, and is also used on warships of other countries. The indicating instruments (Fig. 28) are direct reading in revolutions per minute. They are clockwork instruments, kept in synchronism by a standard clock. This standard clock has a commutator within it which sends current for 20 seconds into the coils of an electromagnet in the indicating instruments, then breaks it for four seconds, re-establishes it for another 20 seconds, and so on. While this current is on, the electromagnet holds a detent which allows an escapement motion to drive the indicating hand over the dial. Correcting currents sent by a revolving contact-maker driven by a friction wheel from the propeller shaft of the engine at the rate of three per revolution are received in separate electromagnet coils in the instrument, and while the main current, controlled by the standard clock, is disturbed for the four-second interval mentioned, the correcting currents drive the indicating needle forward or pull it backward according as the average rate of revolution of the engines has been less or greater than that shown at the moment on the dial of the instrument. A galvanometer tell-tale for indicating "ahead" or "astern" is fixed in the bottom of the indicator case, and receives current from what is called by the inventor an "alternator," driven from the shaft in one direction or the other according as the ship is going ahead or astern. When no current passes at all, the needle takes the mid position and indicates "stop."

PART II.—Machinery and Power Distribution.

The machinery of a modern ship of war consists of:

(*a*) *Main Propelling Machinery*, consisting of high-speed steam-engines and high-pressure boilers. From the figures given by Sir William White at the 1899 meeting of the British Association at Dover as to the output and efficiency of this class of machinery for a given weight, and from calculations made by Mr. Alexander Siemens as to the weight of accumulators required to perform the same work, there is no difficulty in concluding that electricity will have no place for many a long day in the propulsion of large ships.*

(*b*) *Auxiliary Machinery.*—This general title covers a variety of machines whose functions fall into three principal classes: (1) Those which co-operate with the main engines and boilers in the propulsion of the ship—*e.g.*, boiler feed pumps, air and circulating pumps for condensers, fans for producing pressure in the stokeholds or furnace-blowing engines for working at "forced draught," steering engines, capstans for raising anchors, etc.; (2) functions relating to the operation of the ship as a fighting machine—*e.g.*, engines for moving turrets and for elevating and loading guns, hoists for raising ammunition, compressors for the supply of air under pressure to torpedoes, etc.; (3) domestic functions—*e.g.*, dynamos for lighting and fans for ventilating the ship, refrigerating plants for preserving food, pumping service for fire, bilge drainage, supplying fresh water and the like, hoisting machinery for lowering and picking up boats, etc.

In all, a first-class battleship carries nearly 100 sets of machinery, and a first-class cruiser 50 to 70 sets. Until a few years ago the whole of these auxiliaries were steam driven, with the exception of the gun-working machines, for which hydraulic power has long been preferred. By degrees electric driving has been applied to one and another, the most "advanced" examples being the U.S. battleship "Kearsarge" just completed, which carries 55 motors and a generating plant of 350 kw. capacity. More has been written and said, both in Europe and America, within the last two or three years on this section of the subject than perhaps on any other, some persons roundly asserting that the time has come for driving all auxiliaries by electricity, while others are sceptical as to the desirability of employing electricity at all except for lighting and bells. Between these two extreme views opinions exist of every intermediate grade.

Electricity as a motive power is now so commonly used on land that the charge against naval administrations in general, and the British Admiralty in particular, that they do not sufficiently avail themselves of this new mode of transmitting energy, is repeated with monotonous regularity by writers on the subject. It must, however, be remembered that it takes about three years to build and equip a large warship. If any novelty has been introduced in the design of the ship, it is not unreasonable to allow a year for trial of the novelty at sea, whence it follows that the experience available to naval designers to-day is that of the methods of four years ago. Now, in electrical development four years is a long time, and thus it is evident that, judged by the standards of present-day land practice, naval designers would appear to be several years more backward than they really are.

The conditions under which auxiliary machinery works on board a warship are of a very special kind, requiring motors of special design to meet them successfully. Thus, a glance at diagram No. 29 shows that auxiliary machines are located all over the ship. Boat hoists and ash hoists are located on the upper and boat decks, exposed to all conditions of sea and weather. Motors in barbettes and turrets, fans in ventilating trunks, and (sometimes) capstan engines are liable to be drenched with water by seas shipped, or at least to suffer from the effects of spray; the machines on the upper decks get covered with grit when coaling, while machines working in machinery compartments below decks have to endure high temperatures for prolonged periods. All, wherever situated, have to be able to withstand rough usage, and are liable to be left idle for long periods when the ship is out of commission. The mention of these difficulties suggests that, with very few exceptions, electric motors used on board ship should be of enclosed watertight and dust-tight type of extra strong mechanical construction to stand overloading, and arranged with long bearings and good automatic lubrication, so as to run for long periods with no attention at all; they should also be designed to work sparklessly with constant lead for all loads, so that the brushes are fixed; and, moreover, the brush gear must be so designed that the brushes do not jump off the

* "With modern twin-screw engines and high steam pressure each ton weight produced from 6 h.p. to 7 h.p."—Sir William White, *loc. cit.*, *Engineering*, lxviii., 341.

"A 6,000-ton ship propelled by 8,000 i.h p. will take about 150 hours to cross the ocean, equal to 1,200,000 horse-power hours. Fairly efficient accumulators give about 10 watt-hours per 1lb. of their weight, so that a horse-power hour can be obtained for 75lb. of accumulators. The ship in question would therefore have to load about 40,000 tons of accumulators for the trip across the Atlantic."—A. Siemens, *loc. cit.*, *Journal Soc. Arts*, xlvii., 820.

In other words, for 150 hours' steaming, 1 h.p. is produced from five tons of accumulators; hence, neglecting weight of electric motors and accessories, electric propulsion is inferior to steam propulsion on the score of weight in the ratio of at least 1:30,—Author.

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commutator if the machine is exposed to external vibration; the motors should run for normal periods with moderate temperature rise (the rise permissible depends on what is called the "normal period" of running, and will be different in such cases, for example, as electric ventilating fans, which ought to be able to run for two or three weeks on end, and capstan motors or boat-hoist motors, which in normal circumstances would work less than an hour at a time). The switchgear should be of massive construction, and should be an engineering apparatus, as substantial as a stop-valve or a starting lever.

It cannot be said that all these requirements could have been met by the general run of electric motors produced four or five years ago, but they can all be met to-day. Cases, unfortunately, have occurred in which motors fulfilling none of the above conditions have been put on board ship. The cheap stock motor, suitable only for dry situations on land with good foundations, and requiring careful attention, has been installed and sent to sea. When, as is inevitable, such motors fail, the report sent in is less likely to be to the effect that "this particular motor is unsuitable," as that "electricity is not adapted to this class of work." The modern traction type of motor best meets, on the whole, the requirements laid down as necessary for shipwork, and the conditions under which it actually works on land are as bad, if not worse; yet the accumulating experience of the world that such motors will endure the very roughest usage, makes it unnecessary to argue further that enclosed motors can be built of moderate weight and cost in relation to output that will leave nothing to be desired on the ground of reliability. Reliability being the first consideration, the next in importance is simplicity in operation, combined with ease of inspection and repair. An electromotor is a simpler machine to operate than a steam or hydraulic engine. It has fewer working parts requiring attention. Indeed, if only attention is given to supplying the bearings with oil and to cleaning the commutators periodically, there is nothing else for an attendant to do. Also a motor is cleaner in operation; it is not necessary to drain out a pipe full of water before it will start, and not only is the mess due to the absence of drainage water saved, but there is the advantage that the motor can be started instantly. Cables for motors may, in like manner, be held to be a simpler means of transmission than steam or hydraulic pipes; they are more easily led about, weigh less, and take up less room than pipes capable of conveying an equivalent power, and they interfere less with the structure and disposition of space in the ship. It has been objected against them that faults in cables are not so easily found as in the case of steam-pipes, but if the cables are originally watertight and are led about the ship from point-to-point junction or fuse boxes, it is not difficult to isolate the sections one at a time and locate the fault rapidly. If a fault exists, when it is found it can be repaired much more expeditiously than a leaky joint or other fault in pipes can be, especially steam-pipes, which have to be allowed a long time to get cool before they can be handled. Further, if it is not convenient to repair a cable fault immediately, a temporary length of cable, not necessarily of the same size, can be run in and the faulty section disconnected; this cannot be done with pipe systems of distribution.

American writers point out two other disadvantages attending the use of steam-pipe systems of distribution: (*a*) that the steam-pipes heat the living spaces to an uncomfortable extent; (*b*) that pipes exposed to the effects of shot and shell are likely to be injured in action, and to lead to the demoralisation of the guns' crews. Neither of these considerations apply to modern British ships. Steam-pipes do not pass through living quarters. Pipes to the steering and capstan engines pass through certain storerooms below the protective deck, but these are so chosen that the heat is unobjectionable. As regards the pipes to the deck hoists, which are exposed, they are usually led up the stokehold fidleys amidships, and are provided with valves below by which they can be shut off from the steam-main in time of action.

Efficiency.

The mechanical efficiency of an electric motor is, as a rule, a few per cent. higher than that of a steam-engine of corresponding power. The efficiency of the system as a whole involves the consideration of the generating and distributing arrangements, and here electricity has a marked advantage over either steam, compressed air, or hydraulics, the power taken being strictly proportional to load and the overhead efficiency from indicated horse-power of generators to brake horse-power on motor shafts averaging about 65 per cent. at full load. Efficiency, however, cannot be considered alone. The naval architect wants the relative advantages of competing systems expressed in terms of weight and space. In a given ship of war the correct adjustment of weights and dimensions is correlated with the maximum offensive and defensive qualities involved in armour and armament, speed, and coal endurance. Hence, unscientific as it may appear in itself, an electric power distribution system of high mechanical efficiency may be a positive disadvantage to a warship if the weights involved conduce to an unfavourable design in the offensive and defensive qualities of the ship. Whether the change from steam to electric driving of auxiliaries involves the sacrifice of greater weight than is compensated for by the advantages gained is precisely the question on which authorities differ—the differences being chiefly due to the use of general terms for the sake of the argument instead of precise calculation. The main sources of loss in operating steam-driven auxiliaries are three: (*a*) the use of too great a range of temperature and pressure in the cylinders; (*b*) leakages past pistons and valves due to wear; (*c*) steam-pipe condensation.

(*a*) As illustrating the uneconomical use of steam under the first condition, consider the case of winches and capstans. These must exert a powerful effort in starting, and hence must have very little lead and lap to their valves. If, therefore, steam at or near boiler pressure, say 250lb., be taken with cut-off at, say, three-quarter stroke, and discharged into the condenser at the end of the stroke, it is obvious that the steam consumption per indicated horse-power must be very high. Steam engineers are well aware of this, and the increase

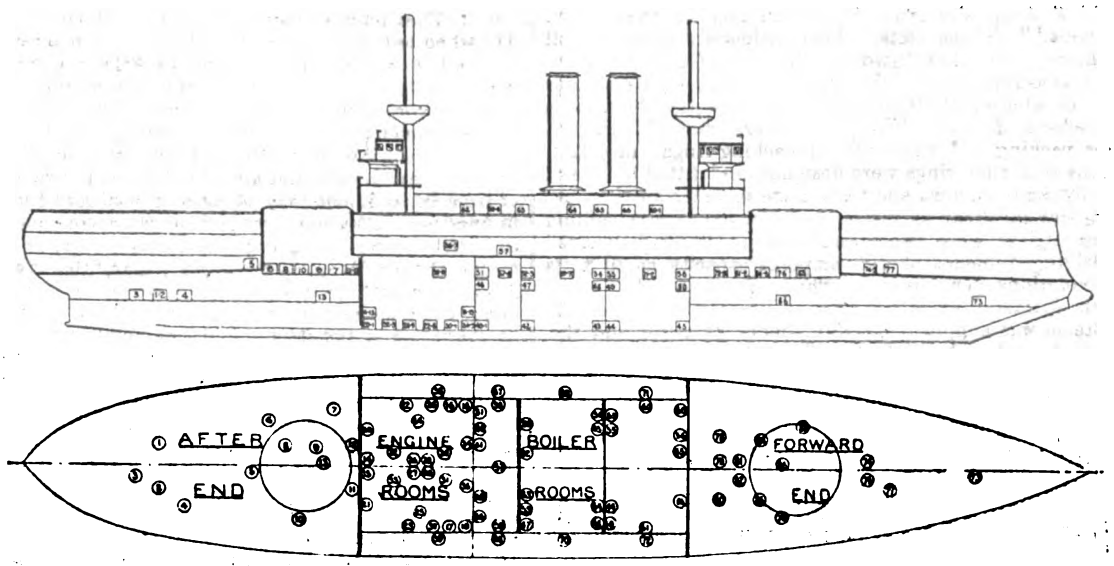

FIG. 29.—Location of Auxiliary Machinery on a Typical Battleship.

1-2.	Steering Engines ..	2 sets	14-15.	Steam Dynamos	2 sets	40-45.	Boiler Feed Pumps ..	6 sets
3.	After Capstan.		16-19.	Main Circulating Pumps	4 sets	46-50.	Furnace Air-Blowing Engines	5 sets
4-7.	Ventilating Fans ..	4 sets	20-21.	Auxiliary ,, ,,	2 sets	51-56.	Ventilating Fans ..	6 sets
8-9.	Air Compressors ..	2 sets	22-25.	Air (*i.e.*, Hotwell) Pumps	4 sets	57.	Steam Dynamo	
10.	Main Hydraulic Engine.		26-29.	Fire and Bilge Pumps ..	4 sets	58-59.	Boat Hoists	2 sets
11-12.	Turret-Turning Engines	2 sets	30-31.	Starting Engines ..	2 sets	60-61.	Coal ,, ...	2 sets
13.	Turret Auxiliaries— Shot Hoists. Rammers, etc		32-33.	Turning Engines ..	2 sets	62-66.	Ash ,, ...	5 sets
			34-35.	Distiller Pumps	2 sets	67-72.	Ammunition Hoists ..	6 sets
			36-37.	Ventilating Fans ..	2 sets			
			38-39.	Ammunition Hoists ..	2 sets			

73.	Capstan Engine	
74-75.	Refrigerators	2 sets
76	Workshop Engine	
77-80.	Ventilating Fans ..	4 sets
81-82.	Air Compressors	2 sets
83.	Main Hydraulic Engine	
84-85.	Turret-Turning Engines	2 sets
86.	Turret Auxiliaries— Shot Hoists. Rammers, etc.	

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in boiler pressures of the last few years has led to the introduction of several methods of utilising steam in auxiliary machinery to better advantage. One obvious but not too commonly employed method is the use of reducing valves in the steam supply pipes of auxiliary engines. The favourite practice at present in the American navy is to turn the exhaust from the auxiliaries into a feed-water heater, in which the latent heat is abstracted and the feed raised from about 80deg. or 85deg. F. to approximately boiling point; and when the power being developed in the main engines is too low for the feed to condense all the auxiliary exhaust steam, the surplus has been turned into a low-pressure evaporator. Notwithstanding the increase of back pressure on the auxiliaries by this arrangement, a saving of about 99 per cent. of coal used for auxiliaries is said to have resulted. In our navy, auxiliary feed heaters are being introduced for the same purpose. Other devices for economising steam are: the employment of compounding devices for using the steam in stages, as, for example, operating some auxiliaries by the exhaust from others, supplying auxiliaries at full pressure and exhausting into the intermediate receiver of the main engines, or drawing supply for the auxiliaries from the intermediate or low-pressure receiver and exhausting into condenser. All these systems have serious attendant disadvantages. Finally, some pressure is being put upon manufacturers of steam plant to improve the performance of the smaller engines by compounding, improving cylinder ratio, and so on.

(*b*) The losses that may occur in steam-engines due to the effects of wear are most strikingly brought out by Mr. W. W. White in his well-known paper on the "Steam Consumption of the Main and Auxiliary Machinery of the U.S.S. 'Minneapolis.'" These tests, which ultimately embraced all the machinery, were instituted in the first place to measure the steam consumption of the dynamo engines, which was known to be abnormally large due to leakage past the pistons from the effects of wear. The pistons were originally grooved for water packing and were without packing rings; new cast-iron pistons with snap rings were designed and fitted to one of the three dynamo engines, and tests made to ascertain whether the saving was sufficient to warrant the change in the remaining two. The engines were two-cylinder simple vertical inverted engines driving dynamos of 300 amperes capacity at 80 volts at 400 revolutions per minute. The engine cylinders were each 10¼in. diameter by 5in. stroke, and were large for their work. Steam was supplied at 142lb. boiler pressure and the exhaust condensed and weighed. The following results were noted:

Set.	Load I.H.P.	Steam lbs. per I.H.P. per hour.	Remarks.
No. 1	21·873	123 27	Pistons water-packed and bad fit to cylinders; cylinder bores rough and pitted.
"	19·598	88·64	New pistons with two cubic inch packings rings in each; in use about 10 days.
"	33·601	68·25	
"	29·184	69·33	New piston with packing rings in cylinders.
No. 2	19·012	108·71	Water-packed pistons, cylinder bores rough.
	30·354	84·03	
"	16·791	102·73	" " "
	26·553	84·74	
"	22·923	65 12	New pistons with packing rings; in use about nine days.
	35·287	56·45	
No. 3	17 324	97·75	Water-packed pistons; fit cylinders closely. Cylinders in good condition.
	26 234	79 48	
"	18 241	81·62	New pistons with packing rings; in use about four days.
	27·815	72 14	
"	20·40	97·92	Water-packed pistons.

The chief source of loss is evident enough here, but even the improved results leave much to be desired. How much loss was attributable to similar causes in the case of the other auxiliaries was not investigated, but the results were in all cases extremely bad. There is no corresponding loss due to the effects of wear in the case of electromotors.

(*c*) Condensation in the steam-pipes is probably the most serious of all the sources of loss. If we allowed that in the progress of design, the average steam consumption in pounds of dry steam per indicated horse-power of all the auxiliaries were brought down to the level of that of the dynamo engine—the most efficient auxiliary in the ship—the margin of loss from condensation to be got rid of by the extended use of electromotors would go a long way to furnish the required set-off in coal saving to balance the necessary increase in weight of the electric system. For it is to be remembered that this loss occurs not merely when the auxiliaries are exerting power, but goes on the whole time the ship carries steam, whether the engines are working or not. To illustrate this point, an instance may be mentioned that has recently come under the author's observation. The new first-class battleship "Shikishima" carries 25 Belleville boilers, capable under full steam of developing over 15,000 i.h.p. in the main engines, besides working the auxiliaries necessary for steaming at full power, driving dynamos, etc. Thus each boiler at full power is equal to the supply of steam for over 600 i.h.p. When at anchor, one boiler under easy steam—*i.e.*, evaporating from 9lb. to 10lb. of water from and at 212deg. F. per pound of coal—was just able to work one 48-kw. steam dynamo at about half power, together with one feed pump and the air and circulating pumps connected with the auxiliary condenser into which the dynamo engine exhausted, besides working a fire and bilge pump occasionally. If a capstan engine or boat hoist had to be worked in addition, a second boiler was necessary. The dynamo was about 160ft. of pipe length away from the boiler, the total range of steam-pipe connected being 500ft. to 600ft. Performing the first-mentioned service with only one boiler alight, the coal burnt varied from 3½ tons to 5 tons per day of 18 hours, for about 65 i.h.p., or about 7lb. per indicated horse-power hour at the best to 10lb. at the worst, the average being over 8lb., which shows that more than half the fuel must have been expended in keeping the pipes warm. All pipes were well covered and below decks, and all machinery new and in first-class condition. Sir John Durston has published particulars of the coal consumption of certain auxiliaries of H.M.S. "Diadem," obtained when the ship was at rest in the basin, which bear on the same point. He discovered that to run one main feed pump, one blowing engine, one auxiliary circulator, one electric light engine, and two distiller pumps, consumed coal at the rate of 6·1 tons per day when two extreme forward boilers were employed, or 3·88 tons when two extreme after boilers were employed; the same machines, with the addition of two evaporators, working compound, consumed 8·8 tons per day when supplied from the forward boilers, and 7·09 tons when supplied from the after boilers—*i.e.*, the elimination of the lengths of steam-piping between the forward and after boilers alone resulted in a saving of from 20 to 30 per cent. of the total coal used for the machines in question. The same proportion of waste may be concluded to exist under sea-going conditions; for, although more machinery would be at work, and, therefore, the steam would in some measure be used to better advantage, yet, on the other hand, the long lengths of pipes fore and aft of the ship would be connected to the steam-mains, as well as branches going into colder regions above the protective deck. Hence it is clear that with short direct connections to steam dynamos, and electric distribution to all the other auxiliaries for which electric driving is suitable, a considerable saving of coal—probably at least five tons per day—would be effected under this head. The total coal consumption for auxiliary purposes may be thus computed: steaming at "economical" speed—about 12 knots—involving, say, one-fifth power, it is known that the coal consumption of a good modern first-class battleship or cruiser with Belleville boilers fitted with economisers is about 2lb. of coal per indicated horse-power, which for 3,000 h.p. represents about 65 tons per day of 24 hours, of which the minimum number of auxiliaries employed under these conditions—*i.e.*, steering engine, pumps, distiller, and one dynamo—consume on an average about 25 per cent. = 16 tons. Supposing the engine-room pumps continue to be steam-driven, the principal auxiliaries used when the ship is cruising under ordinary sea-going conditions will be, besides those mentioned, ventilation fans, ash-hoist engines, and refrigerating machinery, together with air-compressors and turret machinery for drill purposes. These machines work intermittently, and hence average coal consumptions are to some extent a matter of speculation; but it will probably be below the actual consumption of many ships to take the average total coal consumption of all the auxiliaries employed in an ordinary commission at 20 tons a day, or, neglecting the dynamo, 15 tons. The "Powerful" is said to have burnt on her voyage to China last year 40 tons a day for auxiliaries. The "Diadem" cruisers and the "Canopus" battleships are, however, much more economical.

Turning to the broad question of the mechanical efficiency of electrically-driven auxiliaries, notice must be taken of a couple of recent papers by Lieutenant Robinson, U.S.N. For purposes of comparison, Lieutenant Robinson takes the average steam consumption of the best steam auxiliaries now produced at just below 70lb. per indicated horse-power hour. He puts the best steam consumption of an electrical generator at 26lb. per indicated horse-power hour, the exhaust being taken into a feed heater. He takes the efficiency of the engine at 93 per cent., dynamo 86 per cent., line 95 per cent., and motor 78 per cent. = overall efficiency 59 per cent.; and on this basis shows that the steam consumption per brake horse-power on the motor shaft is 44lb. per hour, representing a reduction of 35 per cent. of the steam used by the best steam-driven auxiliaries. He then goes on to argue that if electric motors are used to drive the auxiliaries, it will be necessary in order to get the requisite torque at the highest speeds, to instal motors of 1·5 times the rated horse-power that would be required if steam auxiliaries

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were used ; and hence that as against a total of 1,500 i.h.p. of steam auxiliaries weighing (at 100lb. to the indicated horse-power) 70 tons, a total motor capacity is required of 2,250 h.p., weighing on the same basis 105 tons.

The author ventures to join issue with this conclusion, which appears to be incorrect in several particulars : (i.) The indicated horse-power of steam-driven auxiliaries is compared with the brake horse-power of motor-driven auxiliaries, which is unfair. It would probably be liberal to allow an average mechanical efficiency for steam-engines of the class used for auxiliary machinery of 70 per cent., so that if they consume 70lb. steam per indicated horse-power this represents 100lb. per brake horse-power. Hence the saving of coal due to electric driving is 56 per cent. instead of 35 per cent. (ii.) The only auxiliaries requiring maximum torque at highest speeds are pumps and fans, and it does not at all matter whether the torque exerted by motors on such machinery is equal to that exerted by steam-engines, or not, provided the useful work done per minute is the same ; on the contrary, services of this kind are excellently adapted to the capabilities of motors of comparatively small torque but high speed, the high speed allowing of a smaller and more compact machine than the slower-running engine. (iii.) Winches, capstans, turret, and steering engines, and, in fact, all in which inertia effects come in, require maximum torque at starting. Here the electric motor is distinctly on its own ground, for it is quite easy to build and control motors in such a way as to obtain from them a starting torque equal to two or three times that corresponding to their rated full power, which is not the case with steam-engines, besides which the motor has the further advantage of exerting a continuous rotary effort in lieu of the fluctuating turning moment of the reciprocating engine. (iv.) The argument as to the higher power rating of the motor drive appears to be drawn from the analogy of electrically-driven as compared with steam-driven machine shops, which is inapplicable to the case under discussion. The conclusion appears to follow from the foregoing arguments that any appreciable increase in the horse-power rating of electric as against steam driven auxiliaries is unnecessary, and that if the whole of the auxiliaries of a 15,000-h.p. ship were electrically driven a saving of about five tons of coal used in generating the auxiliary steam would result from the suppression of pipe condensation, and (on the rather low basis of 59 per cent. overhead efficiency) a further saving of 56 per cent. of the balance of 10 tons = 5½ tons, due to superior mechanical efficiency—a total of 10½ out of the 20 tons of coal per day used by a good steam auxiliary equipment. The total bunker capacity of a ship of the power mentioned would be about 2,000 tons, representing the ability to keep the sea for about 25 days at economical speed. The saving in coal consumption in these 25 days represents 262 tons on the basis shown—an amount sufficient to more than counterbalance the necessary additional weight of generators and motors carried.

The questions next arising are : to what purposes is it practicable, having regard to all considerations, to adapt electric driving, what would be the changes in weight, space, etc., involved, and what should be the arrangement of the installation for supplying the power ? There is a broad difference at once to be recognised between machines directly co-operating with the main propelling machinery and those performing other duties. On the whole, present engineering opinion is, from considerations of reliability, decidedly in favour of continued steam driving for boiler feed pumps, circulating and hot-well pumps, fire and bilge and distiller pumps. It happens that these pumps are the worst steam-eaters in the ship. In the "Minneapolis," for example, the consumption ranged from 75·74lb. in a circulating pump doing 4·1 i.h.p., one cylinder alone taking steam, to 318·68lb. for a small pump developing ·78 h.p., which was used for flushing purposes, the average for the 12 pump tests included in Mr. White's tables being 161·61lb. per indicated horse-power hour. Experience with electric auxiliaries in other situations may eventually lead to the use of electricity for these services, but this contingency may be left out of account for the present. Starting and turning engines may be regarded as parts of the main engines themselves, and, of course, will be driven by the same power. The only auxiliary services within the engine and boiler rooms for which the use of electricity may be considered at present are ventilation and furnace blowing.

Fans for Engine and Boiler Room Ventilation.

In the "Canopus" class of battleships each engine-room is ventilated by a 7ft. 6in. fan driven by a direct-acting steam-engine, while the boiler-rooms are supplied with air from four 8ft. fans at 240 revolutions, and two 6ft. fans at 320 revolutions per minute. These represent in the aggregate about 150 i.h.p., with a weight of between three and four tons. The "Duncans" will carry two engine-room fans, each 6ft. 6in. in diameter, with two 8ft. 3in. and eight 6ft. 6in. fans in boiler-rooms, the speed being about 300 revolutions. Fan-driving, being a purely rotary movement, is a duty which electric motors have shown themselves excellently able to perform ; they can run at least twice the speed of reciprocating engines for the same power without noise or vibration, and can give the required deliveries with smaller fans, with higher efficiencies in both motors and fans, and therefore with less total power. It would probably be reasonable to take the total power of motors to perform the engine and boiler room ventilation of the most powerful ships at about 80 b.h.p. on the fan shaft, say 100 e.h.p. input, which could be provided in enclosed type motors built for continuous work at 750 revolutions per minute for about three tons ; or, allowing for the weight of the fans, an increase of not more than one ton of the above total weight.

Furnace Air-Blowing Engines.

These are high-pressure air-pumps adapted for delivering air at 15lb. to 30lb. pressure above the fires and into the combustion chambers of the boilers. A set of five such engines in the "Shikishima" weigh 5 tons 2cwt., and develop an aggregate of 220 i.h.p. Pumping services of this kind are very efficiently performed electrically, but the substitution of geared motors for engines would result in this case in an increase of the total weight, probably to the extent of about three tons for 200 e.h.p. Furnace air-engines are generally placed in the boiler-rooms, but if electrical they could more conveniently be placed outside or above the boiler-rooms, air-pipes only being led into the firing compartments.

Considering next the auxiliary machinery outside the engine and boiler rooms we find these include steering engines, capstan engines, boat, coal, and ash hoists, ventilating fans, air-compressors, refrigerators, workshop engine, turret-working machinery, and ammunition hoists.

Steering Engines.

It is convenient to consider these machines in this section, as they are usually placed in the after steerage flat adjacent to the tiller compartment. In some of the latest British ships they are placed in the engine-rooms and connected by long lines of shafting to the tiller mechanism. This arrangement saves carrying steam-pipes aft, but seems to have nothing else to recommend it. Next to the main engines these are the most important in the ship, and before every question of weight or efficiency the most reliable machine must be used here. Electric steering engines have, the author understands, been made, and there seems no reasons, so far as the motors are concerned, why equally positive results should not be obtained with these and with steam-engines. The controlling of their motion is the principal difficulty. The motors would be everlastingly starting, stopping, reversing, and altering speed ; or, if the motors ran continuously, then such movements would be always being made by the gears and clutches. And whereas the steering engine is deep down in the ship, the control has to be operated from distant stations, of which there are usually five, interconnected, the forward bridge and conning tower being the most important and the most generally used. Simple rheostatic control from a distance is not good enough ; to secure the necessary sensitiveness, a large number of switch contacts and connections would be necessary, and an extensive system of cables interconnecting all the steering stations is inadmissible. A maker of steering engines once told the author he had invented an electric steering engine which he was sure met every requirement, but it required 79 wires ! The reply was, of course, that 79 wires would kill any such project. Recourse must be had either to a pilot motor worked by a small switch and two or three wires, operating in its turn the controller of the steering motor proper (indeed, it would probably be possible to employ the hydraulic telemotor, now so largely used, for working electric controlling switches alongside the steering motors, in similar fashion to that in which it reverses the valves of the steam steering engine), or to the interaction of two machines, as in the Ward Leonard system of controlling turrets. If the difficulty of control be satisfactorily overcome, the gain in efficiency of electric steering mechanism ought to be very substantial, owing to its long periods of work. From its irregularity of working it is impossible to define the average horse-power of a steering engine. The motor to replace it must be a substantial affair, heavily geared, the torque required on the rudder post of a big battleship being as much as 500 ton-feet. To move the rudder from hard-a-port to hard-a-starboard in 30 seconds, which is the usual requirement, a steering engine will make about 300 revolutions, and working at this maximum rate the indicated horse-power will lie between 300 and 400, and the useful work done on the rudder post will be at the rate of about 75 h.p. net, an overall efficiency of 20 to 25 per cent. Each steering engine with its gear weighs 5½ to 6 tons ; two sets are carried. If each steering engine were replaced by one motor capable of exerting the same starting torque, the full load rating of each motor on continuous work might be taken at 150 h.p., though the starting current allowed would correspond to twice this power. With electric driving, an improvement in efficiency might be expected. The extra weight involved, using open-type machines, would be about two tons per set.

Capstans.

The principal capstan is, of course, the forward one, which has to operate the heaviest anchors. Besides other stipulations, its engines (usually duplex) are required by our Admiralty to

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lift a weight of 35 tons at the rate of 25ft. per minute = 60 actual horse-power. The maximum indicated horse-power may be taken at 200, and the weight of the complete capstan with engines and gears is about 47 tons. If electric motors were substituted for the steam-engines with the same gears this weight would be increased by about two tons. But with better-designed worm gears the work could be done electrically on the same total weight. The after capstan performs similar but lighter work, lifting 15 tons at 25ft. per minute = 25 actual horse-power, say 75 i.h.p. In our latest ships, while the forward capstan is still steam-operated, the after capstan is specified to be driven by two reversible watertight motors, performing the above specified work at speeds not exceeding 750 revolutions per minute, and so designed that the rise in temperature after one hour's run at full load does not exceed 80deg. F. This change involves an increase of total weight in capstan, motors, and gear of from one to two tons. In lieu of two motors, the Admiralty have accepted for the "Duncans"

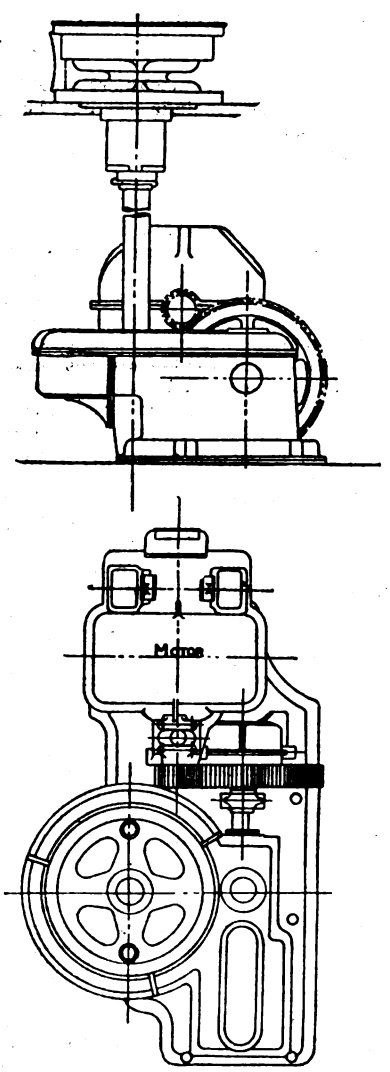

FIG. 30.—Electric Capstan, H.M.S. "Irresistible."

and other ships an electric capstan driven by one 50-h.p. motor at 350 revolutions per minute, the weight of the complete capstan motor and gear being approximately the same as that of the steam after capstan of H.M.S. "Albion." Fig. 30 shows the general arrangement of the electric capstan of H.M.S. "Irresistible" by Messrs. Clarke, Chapman, and Co. It will require a somewhat protracted experience to determine whether, on the whole, the use of electric motors for capstans proves advantageous. To be quite safe, motors should be used with a large margin of power, notwithstanding the increase of weight involved, for the stresses involved in such work are apt to rise with great suddenness to many times their average value, and capstan chains have a habit of jamming in the stops. If steam-driven the engine will pull up, and is able to stand under the load; a motor cannot do this, yet it can neither be allowed to burn up nor to relinquish its work by cutting itself permanently out of circuit. Special devices are necessary to meet such a condition. Mr. Siemens dealt somewhat fully with this matter at Dover, so it is unnecessary to dwell further upon it here. Neither in this case, nor in that of the steering engines, do there appear to be difficulties incapable of satisfactory solution electrically, and in these cases the longest steam-pipes in the ship are concerned.

(To be continued.)

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE ELECTRICAL EQUIPMENT OF SHIPS OF WAR.

SIR,—In Mr. C. E. Groves's interesting summary of the uses of electricity on ships of war since its first introduction in the Royal Navy in 1875, published in your last issues, I notice under the head of "Dynamos" a statement that the dynamo installed in H.M.S. "Minotaur" in 1876 was a "magneto machine."

Faraday, in his first series of experimental researches (*Phil. Trans.*, 1832, p. 138), defined the exact meaning to be given to the term magneto-electricity in the following paragraph: "58. The similarity of action, almost amounting to identity between common magnets and either electro-magnets or volta-electric currents, is strikingly in accordance with and confirmatory of Ampère's theory, and furnishes powerful reasons for believing that the action is the same in both cases; but as a distinction in language is still necessary, I propose to call the agency thus exerted by ordinary magnets, *magneto-electric* or *magnelectric* induction (26)."

All machines, therefore, that generate electricity from ordinary steel magnets are, according to Faraday's definition, magneto-electric machines. Now, the machines established under my direction on the "Minotaur" and on other battleships in 1875-1880 were self-exciting multipolar dynamos constructed in accordance with the specification of my patent of March, 1867, in which permanent steel magnets were dispensed with. Further descriptions of these dynamos for lighting and for the electro-deposition of metals were published in the *Philosophical Magazine*, 1873, and in other journals. I have elsewhere directed attention to the fact that the term "dynamo-electric machine" was invented by Charles Brooke, F.R.S., who applied it expressly to my electromagnetic generator (*Proceedings*, Royal Society, vol. xv., 1867, p. 409). I may also mention that the general method of searchlight signalling with the vertical beam, by means of a reflecting disc mounted horizontally on a spindle in front of the projector and vibrating the disc by means of a lever handle, was invented and applied by me on the "Minotaur" in 1876.—Yours, etc.,

HENRY WILDE.

Alderley Edge, April 18, 1900.

REFUSE DESTRUCTORS.

SIR,—We notice in your issue of April 13 a note with reference to the refuse destructors at Darwen of our type, which are providing all the steam required for the electric lighting. The note concludes by saying, "It will be interesting to know the exact point at which the refuse at Darwen will be insufficient to meet the demand for electric lighting."

In this connection you will doubtless be interested to learn that at present not a quarter of the power which could be developed, if necessary, at Darwen from the refuse destructors is at present being used, so that there is a very ample reserve of power to meet the increased demand which may be expected to arise as time goes on.—Trusting that this will be of interest, yours, etc.,

MELDRUM BROS.

Manchester, April 18, 1900.

Our Volunteers.—In view of the arrival of the first section and the departure of the second of the Electrical Engineers Volunteers, the following, which appears in the *London Gazette* amongst the War Office appointments, will be interesting: Major R. E. B. Crompton, the Electrical Engineers, R.E. (Volunteers), is granted the temporary rank of major in the army while serving with the Volunteer Section in South Africa; and the undermentioned officers are granted the temporary rank of second lieutenant in the army while serving with the Volunteer Section in South Africa: Second Lieutenant H. F. Bigge, the Electrical Engineers, Royal Engineers (Volunteers); Second Lieutenant F. P. Williams, the Electrical Engineers, Royal Engineers (Volunteers).

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ELECTRIC LIGHT COMPETITION.

The inhabitants of the parish of St. Marylebone have now more hope of a really good electric supply at reasonable rates than at any period in recent years. This is because the Board of Trade have recommended that an electric lighting provisional order shall be granted to the St. Marylebone Electric Supply Company, Limited. If this order is confirmed by Parliament—and we see no reason why it should not be—it will be another example of the consideration shown by the Board of Trade to the real interests of the public. The history of the electric lighting in the above district shows that for several years the character of the supply given has been far from creditable to the Metropolitan Electric Supply Company, and that the price charged has been inversely proportional to the reliability of the supply. The Vestry has made several attempts to remedy the matter in the past, but since the prime mover in electrical matters has been made chairman of the Vestry no very definite policy has been followed. The application for a provisional order in 1898 was rejected, because the Vestry could not arrange terms for the immediate purchase of that portion of the works and mains of the Metropolitan Company within the parish. An attempt was accordingly made to arrange terms mutually acceptable, but a difference of nearly £300,000 was found between the valuation of the undertaking by the experts on each side. The company asked £933,211 for its works and goodwill, and of this amount only a small portion could be considered of actual value to the Vestry. The consequences of a purchase at such a high price would have seriously handicapped a municipal scheme of supply. Coming now to the third party in the triangular fight, the St. Marylebone Electric Supply Company would not be hampered by this heavy weight of dead capital, and would in consequence be able profitably to give a supply at low rates. In fact, the company has already undertaken to charge the same rates as are in force in the area supplied by the St. James and Pall Mall Company, with which it is closely allied by having practically the same board of directors. The results of the competition so given would be of great value to the inhabitants of the district, and, in spite of our objection to the double set of mains in all streets, we think the granting of the order would be the best solution of the present difficulty. Naturally, this will be strongly opposed by the Metropolitan Company in Parliament, but this opposition is too much interested to have much weight. The Vestry's opposition, on the other hand, may be of service to the electric lighting consumers, in that protective clauses may be inserted in the Bill, coupled with favourable repurchase clauses. Clauses should also be arranged to ensure real competition between the rival lighting companies. If this is done, the better supply will speedily be obtained by the bulk of the consumers, and the result will be almost, if not quite, as favourable to them as if the Vestry had the supply in its own hands. This decision of the Board of Trade again emphasises the fact that the granting of an electric lighting provisional order does not confer a monopoly. Yet it is equally true that in no case

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has a competing order been granted unless there has been evidence that the undertakers under the first order have been lax in fulfilling their obligations.

FORTHCOMING EVENTS.

FRIDAY, APRIL 20.

North-East Coast Institution of Engineers and Shipbuilders.—At 7.30 p.m., at Sunderland, ordinary meeting.

SATURDAY, APRIL 21.

North-East Coast Institution of Engineers and Shipbuilders.—At Newcastle-on-Tyne, graduates' meeting.

MONDAY, APRIL 23.

Institution of Civil Engineers.—At 8 p.m., special meeting; James Forrest lecture, "On the Relations between Electricity and Engineering," by Sir W. Preece, K.C.B.

Royal Institution of British Architects.—Paper on the "Protection of Public Buildings from Lightning," by Mr. Killingworth Hedges.

TUESDAY, APRIL 24.

Institution of Civil Engineers.—At 8 p.m., annual general meeting of corporate members.

WEDNESDAY, APRIL 25.

Institution of Electrical Engineers.—At 7.30 p.m., students' meeting. Paper by Mr. Humphreys on "Meters and Magnets."

Tramways and Light Railways Association.—At 7 p.m., at Hotel Cecil, inaugural dinner.

THURSDAY, APRIL 26.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting. Paper on "The Electric Transmission of Power," by Prof. G. Forbes, F.R.S.

Institution of Mechanical Engineers.—At 8 p.m., ordinary meeting. Paper on "Road Locomotion," by Prof. H. S. Hele-Shaw, LL.D.

FRIDAY, APRIL 27.

Physical Society.—At 8 p.m., ordinary meeting, at Solar Physics Observatory, Exhibition-road, South Kensington. A short account of the Physical Problems now being investigated at the Solar Physics Observatory, and their Astronomical Applications, by Sir Norman Lockyer. Weather permitting, the 36in., 10in., and 9in. telescopes will be used for the observation and photography of celestial objects and their spectra. The Apps-Spottiswood coil and 21ft. Rowland grating will also be in operation.

EXPERIMENTS WITH ACCUMULATOR PLATES.

The following is a digest of an article by Mr. Franz Peters which appeared in a recent number of the *Centralblatt für Accumulatoren und Elementenkunde* describing some experiments with positive accumulator plates which had become soft. In connection with accumulator plates composed of peroxide of lead whose active material is in the form of paste, it has been observed, remarks the writer, that after a certain number of discharges, the active substance, which was previously of normal consistency, becomes soft and greasy on the surface. This softening spreads gradually towards the centre of the paste after continued use of the accumulator, and finally attains such a degree that the active material falls out of its supporting frame or grid. Being unable to find anything in the literature of the subject which explained the cause of this softening, it occurred to the writer to undertake a series of experiments on his own account. The question presented itself to him whether positive plates of normal hardness and constructed on the same method differed in the chemical composition of their active material from electrodes formed at the same time, but whose substance had become too soft for a slight depth below the surface. Samples from both the surface and centre of the experimental plate were taken and thoroughly freed from sulphuric acid by washing in distilled water. In the dry tests the oxide and peroxide of lead were determined by reduction with oxalic acid and reincorporation of the non-oxidised portion of the latter with permanganate of potassium. The total quantity of lead, after dissolving the mass in nitric acid with the addition of hydrogen peroxide, and destroying a superabundance of the latter by means of electrolysis, entered into the solution. The volume of oxide of lead present in the mixture was then determined by distillation with nitric acid of 1·2 specific gravity, the residuum being digested in hot water impregnated with nitric acid, and the combined filtrate afterwards subjected to electrolysis. The results of the analyses are given in tabular form. Comparing the richness of the positive active substance, taken from below the surface of the plate, in active oxide and peroxide of lead with the corresponding richness of that taken from the surface, it is found to be approximately equal in the case of the plates of normal hardness, while in the case of the soft plates this richness in active oxide and peroxide of lead is considerably greater under the surface than at the surface. The writer does not think this difference can be attributed to lack of uniformity in forming the plates, but that some had remained comparatively hard after their formation because called upon to do very little work. The formation of peroxide of lead in the centre, where the frame possessed a smaller current-carrying capacity than on the surface, had taken place to approximately the same extent as on the surface. On the other hand, a disintegration had set up in the plates, which had become soft through the frequent charging and discharging to which they were subjected as a result of the constant expansion and contraction of the paste thereby entailed. But towards the centre of the plate the loosened particles were prevented from falling away, and at the same time kept in good contact with the leaden frame, by the outer layers and the construction of the grids. The increased porosity of the paste enabled the transformation of further quantities of oxide of lead into peroxide. At the surface, however, the particles of paste were even during the first charges and discharges loosened relative to each other and to the lead grids, chiefly on account of the mechanical disturbance caused by the formation of oxygen gas on the surface of the positive plates. In consequence of the faulty contact thereby entailed the transformation of the oxide of lead into peroxide could not make much progress, but was forced to lag behind the transformation which occurred under the surface of the paste to no inconsiderable degree. The loosened particles of paste were much more easily saturated by the sulphuric acid than the firm paste, so that they finally formed a greasy mass on the surfaces of the plates. As this soft layer offered little more resistance to the change in form of the layer immediately below than that initially incurred, the softening of the active material of the positive plates consequently continued to penetrate towards the centre of the plates as the charging and discharging processes were continued. Assuming the correctness of this theory, it should be possible to re-harden plates which have become soft to the same degree of hardness which they originally possessed. To test this point the writer undertook some further experiments, which fully established his theory. If an accumulator whose plates have become soft be discharged and then charged in an opposite direction, a contraction of what was the positive plates takes place. Through this contraction the particles are forced into intimate contact with each other, and with the grids—that is to say, the plates become hard, but remain porous. When the charging current is again reversed, so that the plates assume their original polarity, the active paste of the plates retains the hardness so produced. Further experiments showed that the resistance of the hard active mass of the positive plates did not differ materially from that of the soft.

THE CENTRAL ELECTRIC SUPPLY COMPANY, LIMITED.

The above company is authorised by Parliament to establish works to supply electrical energy on a wholesale scale, its primary object being to provide the Westminster Electric Supply Company and the St. James's and Pall Mall Electric Supply Company with power, as their present stations prove too small. The works of the Central Electric Supply Company are to be erected under the supervision of Prof. A. B. W. Kennedy, by whose courtesy we are able to give the following details of plant now advertised for. It will be noticed that the generators will be placed in the

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Eccleston-place station, but the equipment at the other station is such that the supply from Willesden can be utilised as soon as the large works are ready to supply. This plant also enables one station to assist the other to a larger extent than at present possible.

It is proposed to instal two 1,200-h.p. engines, direct-coupled to 6,000-volt three-phase generators of about 780 kw. output each; six 6,000-volt three-phase induction motors, coupled direct to 450-volt continuous-current generators of about 260 kw. capacity each; two switchboard panels for the three-phase generators and their exciters; two switchboard panels, each for a 6,000-volt three-conductor feeder; three switchboards, each for one feeder and two three-phase motors; and three switchboards, each for two continuous-current generators. The high-tension generators, and two of the motor-generators, together with their respective switchboards and two feeder switchboard panels, are to be erected at the Eccleston-place station of the Westminster Electric Supply Company, Limited. Of the remaining motor-generators and switchboards, two of each will be erected at the Davies-street station and two at the Millbank-street station of the same company. One three-conductor high-tension feeder is to be laid from the Eccleston-place station to the Davies-street station, and another from the Eccleston-place station to the Millbank-street station, the approximate distances being 3,100 yards and 1,900 yards respectively. These feeders will be laid under a separate contract. The three-phase high-tension generators at Eccleston-place will generate power, which will be transformed by the motor-generators mentioned above into continuous current of from 400 to 450 volts pressure, so that it can be distributed from the existing continuous-current low-tension switchboards at the several stations to the Westminster Electric Supply Company's distributing system. The continuous-current generator will therefore be connected in parallel with the existing steam-driven continuous-current generators at the different stations, and must be suitable in every way for working and supplying power when so connected.

Tenders for the plant and apparatus will be let in three sections: (1) engines and three-phase high-tension generators; (2) motor-generators—high-tension induction motors driving low-tension continuous-current generators; (3) switchboards.

The engines are to be of the vertical inverted triple-expansion three-crank type by Messrs. Willans and Robinson, Limited, and known as their "Three V" size. Each is to be capable of indicating continuously about 1,200 h.p. when running at its normal speed of about 230 revolutions per minute, with a steam pressure at the engine stop valve of 190lb. per square inch when running condensing. But the engines are required to run at first with a steam pressure of only 150lb. and non-condensing.

With regard to the generators, these are required to deliver three-phase currents with an angle of 120deg. between each phase. They are to be excited by continuous current at a pressure varying between 400 and 450 volts, supplied either by their own exciters or from the main low-tension switchboards at the stations. Tenders will be considered only from those firms which have already manufactured three-phase generators of large size which have been in successful use for at least 12 months. The armature coils are to be embedded in the iron core and securely fixed in place by mechanical fastenings. The field magnets are to be of the multipolar type with separate coils for each pole, the field coils to be protected from contact with the main armature coil by a metallic shield connected to earth. Each generator is to have an output of 780 kw. when running at its normal speed (about 230 revolutions per minute). The normal full load in each phase to be 260 kw., which is equivalent to 75 amperes at 6,000 volts between the conductors, or 3,460 volts between any one of the three conductors and earth when working on non-inductive load. It must be further capable of running steadily at any E.M.F. from 5,800 to 6,100 volts between the conductors without variation of the engine speed, the generator to be wound so that the full output of 780 kw. can be obtained at any voltage between the above limits—viz., 5,800 to 6,100 volts—on non-inductive load or on an inductive load with a power factor of 0·85, the speed of the engine remaining constant. The generators must also be capable of giving an output 20 per cent. above the normal full load for one hour continuously. The periodicity of the machines is to be between 40 and 60 alternations per second, this to be such as is most suitable both for the satisfactory working of the generators and of the three-phase induction motors, each of about 250 kw. capacity. Each generator is required to work in parallel with the second generator and with similar machines of about double their capacity. The motors will be worked direct from the three-phase feeders at about 5,800 volts pressure and 400 to 450 revolutions per minute. The temperature of no part of the generator armatures or fields must exceed 70deg. F. above the surrounding air after a run of six hours continuously under a normal full load of 780 kw. The contractors for the plant are requested to state how far it would be possible to provide an induction winding on the field magnets sufficient to drive the generator as a motor should its field circuit fail when working in parallel with the other generator; also how far such an additional winding would affect the efficiency of the combined sets. It is stipulated that the insulation resistance between the whole of the conductors and the frame of the machine, after a continuous test at full load for six hours, shall not be less than two megohms. The insulation is to be capable of resisting the application of a test pressure of 10,000 volts alternating for one hour continuously. The efficiency of each of the steam generators—that is, the ratio of the electrical horse-power at the generator terminals upon a non-inductive circuit to the indicated horse-power at full output and speed—is not to be less than 84 per cent. when driving its own exciter. The exciting current of each generator is provided by a direct-driven continuous-current shunt-wound dynamo coupled to the end of the generator shaft. This dynamo is to supply current at a pressure of either 200 or 400 volts. The total electrical energy absorbed in exciting and field magnets of each generator at full load is not to exceed 2 per cent. of the normal full load output. Each generator is to be tested, driven by its own engine, on a non-inductive circuit at 20 per cent. overload, at normal full load, at three-quarter load, half load, excited, and also at normal full load, with a current of 88 amperes in each circuit for six hours continuously.

The induction motors are to work with three-phase current delivered by the three-phase generators at a pressure of 6,000 volts between the conductors. The armatures of these machines are to be star-connected, with the centre connection earthed. The low-tension generators which they drive are to be of the shunt-wound continuous-current type, with drum armatures and preferably multipolar fields, and to be capable of generating at a voltage of 400 to 450 volts. Each of the motor armatures is to be stationary, and slot or tunnel wound. The field magnets are to be multipolar, with separate coils for each pole. It is intended that the generators should work in parallel among themselves, and also in parallel with the continuous-current steam-driven generators already connected at the Westminster stations. Each motor is to be capable of taking a normal full-load input of 260 kw. when running at normal speed (400 to 450 revolutions per minute), the normal full-load input in each phase to be 86·7 kw., which is equivalent to 27 amperes at 6,000 volts between the conductors, or 3,460 volts between any one of the three conductors and earth when working with a power factor of 0·93. The motors must be wound so that the full-load input of 260 kw. can be taken at any voltage between the limits 5,800 to 6,100 volts without the power factor dropping below 0·93, the speed of the motor remaining as nearly as possible the same with the same periodicity. Each of the low-tension generators is to have a normal full-load output of 230 kw. when running at its normal speed (400 to 450 revolutions per minute)—that is to say, 511 amperes at 450 volts pressure—the motors to work with a periodicity of between 40 and 60 alternations per second, as deemed most suitable, and to be capable of working in parallel with each other. These motors are

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to be further capable of running for one hour continuously with 25 per cent. overload, the temperature of their armatures not to exceed 70deg. F. above the surrounding air under these conditions. The efficiency of each motor-generator—that is, the ratio of the true input of the motor, measured at its terminals, to the output of the generator—at full load and normal speed is not to be less than 88·5 per cent. The commutators of the low-tension generators are to be of ample size to admit of the use of carbon brushes, should it be decided to adopt these, without undue increase of temperature.

From the high-tension generator switchboard the 'bus bars are to be carried to the high-tension feeder switchboard, on which provision for two feeders is to be made, the general arrangement and interconnections between the several boards to be adapted to the method of working indicated above.

STANSSTAD-ENGELBERG RAILWAY.

(Concluded from page 526.)

From Gherst, situated at the top of this steep section of the line, the track wends its way with easier gradients to the Engelberg Station. The necessary clearance for the track over the latter portion of its course had in many places to be won by blasting away the rock. Curves up to 160ft. radius had also to be made and the construction of some 330ft. of supporting and lining walls was found necessary. The details relating to the length and gradients of the line are given by Fig. 4. The entire length of the line amounts to 14 miles, of which the rack section occupies 9½ miles, as previously mentioned. With regard to the permanent way, it may be mentioned that the

S. KHOLB, ESQ., MANAGER OF THE STANSSTAD-ENGELBERG RAILWAY.

Vignoles type of rail was employed, weighing 44lb. per yard, the rails having an individual length of 34ft. They rest upon iron sleepers weighing 66lb. each, and of these 11 are provided for every rail-length of track over the adhesion portion of the line, while 12 are provided for an equivalent length of the steep stretch. Fig. 5 includes a profile of the rack section of the permanent way. The rack itself is of the ladder type with trapez-shaped teeth of cast steel riveted to the side flanges. The weight of the rack amounts to 104lb. per yard run; it is constructed in 11½ft. lengths. The entrance to the rack is movable, and mounted on springs.

A few words may be said with regard to the station buildings, which are substantially constructed of brick and wood, containing offices, cloakroom, waiting rooms, etc. They are electrically lighted, small transformers being installed to supply the necessary current. The energising current for these is taken from the trolley wires and transformed down to 100 volts. In Stansstad a car shed, capable of accommodating eight motorcars, is erected, together with the necessary repairing shops and stores.

With regard to the power-house, the existing conditions enabled it to be situated in a place favourable to the distribution of energy for the purposes of the line—namely, at the foot of the steep section—hence close to the point of maximum demand. The necessary water power is obtained from a covered reservoir of 35,000 cubic feet capacity, which is fed by several springs. From this reservoir the water is conducted to the turbine-house through a line of pipes one mile in length. The pipe line is of cast-iron pipes of 9ft. 10in. internal diameter and from $\frac{5}{8}$in. to $\frac{3}{4}$in. thick for 750ft. of its length, while the remaining and longer portion consists of wrought-iron pipes of the same internal diameter, but from $\frac{5}{16}$in. to $\frac{3}{8}$in. in thickness. The effective fall amounts to 1,360ft. The power-house (see Figs. 6 and 7), to which a repairing shop and a locomotive shed are attached, is situated in Obermatt. It provides accommodation for three generators and two exciters, all of which are direct-coupled to their respective turbines. The latter are of the high-pressure type, with horizontal shafts. The output of each of the rotary-current sets, of which two were originally installed, amounts to 180 h.p. at 650 revolutions per minute, while the exciting dynamos each have an output of about 12 h.p. Patent hydraulic regulators are fitted to the large turbines, but not to the exciter turbines. However, the load on the exciter dynamos is maintained constant by regulating the resistance in the field circuit of the generators. The switchboard, which is mounted against one of the end walls of the dynamo-room, consists of four panels of white marble supported by an iron framework. Of these panels, one contains the instrument and switches belonging to the exciters, while the others serve each for one generator, the board being so arranged that new units may be provided for in the future by lengthening it without disturbing the existing portions. The exciters, and also the rotary-current generators, run in parallel, the latter being connected up to common 'bus bars, one of these being connected with the railway metals, which are used as a return conductor. The trolley wire and feeders are connected with the 'bus bars through switch fuses and double-pole cut-outs. Behind the switchboard are situated the fuses for the transformer sub-station and the high-tension leads. A special device is also provided, which in case of mishap to a high-tension cable switches off the exciting current, thereby interrupting the whole supply. Since, as above mentioned, the maximum demand for current occurs in the neighbourhood of the generating station, and the latter, moreover, adjoins the railway track, the generators are, practically speaking, connected up direct with the trolley wires and feeders, and a portion only of the energy generated in the station is transformed up for the purpose of economical transmission to a distance. For the latter purpose three 30-kw. single-phase transformers are installed at the generating station in a room behind the switchboard. These are connected up on the star system, and transform the pressure in the trolley wire (750 volts) up to 5,300 volts. About four miles away, in the immediate proximity of the Dallenwyl Station, is situated a second transformer sub-station containing a like number of units, which in this case, however, transform the high-tension current again down to the line pressure of 750 volts. At first feeders were employed only for the stretch of line between Grafenort and Grünenwald, but the rapid increase of traffic over the railway between Stansstad and Stans soon necessitated a further transformer sub-station in Stans, from which a feeder is run to Stansstad. The two trolley wires consist of hard-drawn copper wire 7·5mm. in diameter. They are suspended from span wires 15ft. above the rail level, the posts supporting the span wires being of wood, 20ft. in height (see Fig. 8). By means of line insulators the whole system of trolley wires is divided into five sections, which may be independently fed with current. The main feeders are connected up to the trolley wires at the various feeding points through switch fuses placed in iron boxes attached to the span-wire poles. These feeders are composed of two semi-hard-drawn copper wires, each of 7·5mm. diameter, and the Grünenwald feeder has an extreme length of 2½ miles. It is attached by means of porcelain insulators to the span-wire poles, which thus serve a double purpose. On the other hand, the high-tension cable serving the Grafenort-Grünenwald section, which has a length of seven miles, consists of two 3·5mm. diameter copper wires, and is supported throughout by independent posts. These posts are 26ft. in height, and for the greater part are erected along the permanent way at a distance of 3ft. from the trolley or span-wire posts; they are all suitably

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anchored. Both at the crossings of the high-tension cable with the streets and the crossing of telephone and telegraph wires over the track, the cable has been carefully protected from accidental contact by means of a network of guard wires. On the tops of the trolley poles a telephone wire is attached. This consists of a silicium-bronze 2mm. in diameter. It may also be mentioned here that the high-tension cables and trolley wires are protected by means of lightning arresters; the former by so-called fork arresters, and the latter on the Westinghouse system.

In the neighbourhood of Stans the track intersects the Stansstad-Stans Electric Tramway, which, as previously mentioned, is worked by means of continuous current. The difference between the respective arrangements for the collection of the current on the two systems, together with the system of current supply itself, rendered the employment of a special device necessary at this point.

At the time of opening the line the rolling-stock comprised two locomotives and five motorcars. The latter are of the four-axle type, divided into compartments, with two-axle bogie trucks. The length of each car is 46ft., and its weight 14 tons. The compartments, which comprise two classes, second and third, afford accommodation for 46 passengers, there being also a luggage compartment on the car. The front bogie is equipped with two three-phase motors wound for 750 volts, of 35 h.p. at 480 revolutions per minute, and each weighing a ton. These motors are suspended from the bogie truck by means of spiral springs, and are sleeved to the driving axles. A single reduction with cast-steel cogwheels has been adopted, the wheels running in an oil-bath. The rear bogie truck is equipped with a cogwheel brake, which is actuated from the rear platform. A powerful hand-brake is also provided, which acts upon all eight wheels of the car. The driving current is collected by two collector bows (see Fig. 13), which are attached to the car roof by means of spring contacts. The wires from these contacts are carried along the roof to the controllers. Each end platform is provided with controlling apparatus, consisting of a double-pole reversing switch, and the requisite measuring instruments, besides a controller for the starting and regulating resistances. The maximum permissible speed is 12½ miles per hour, but the resistances provided admit of any intermediate speed which circumstances may dictate. Starting is therefore accomplished very gently and uniformly. The cars are both lighted and heated electrically. For the lighting of the car a small transformer is installed in the luggage compartment, which reduces the pressure in the trolley wires down to 100 volts. Fourteen electric radiators serve for the heating, these being divided into two series of seven each and connected between the trolley wires and the rails.

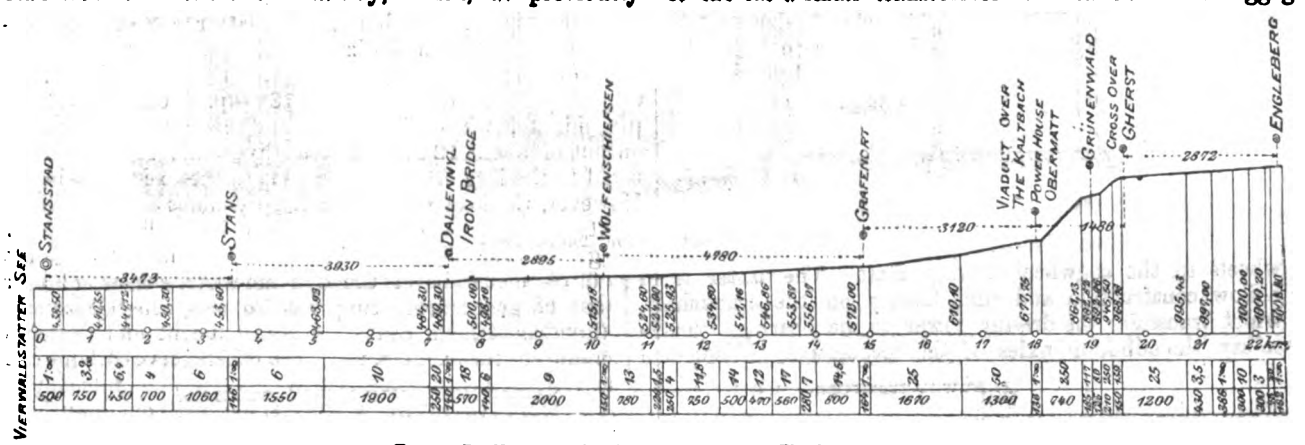

FIG. 4.—Profile of Track. Lengths 1 : 120,000. Heights 1 : 30,000.

The electric locomotives employed on the Stansstad-Engelberg Railway are designed to haul the loaded motorcars of 15 tons weight at a speed of three miles per hour over the steep section of the line previously mentioned, which has a maximum gradient of 25 per cent., or to act as brakes to the same on the return journey, and, further, to convey the goods traffic over the adhesion section of the line between Grafenort and Obermatt, over which the maximum gradient amounts to 5 per cent. In the latter capacity this type of locomotive is capable of hauling two goods trucks, of a total weight of some 20 tons, at a speed of seven miles per hour. Having regard, then, to the work for which this particular type of locomotive is intended, its construction naturally differs very considerably from the electric locomotives employed on the Jungfrau Railway and elsewhere. The two electric motors with which each locomotive is equipped develop about 75 h.p. each at 650 revolutions per minute.

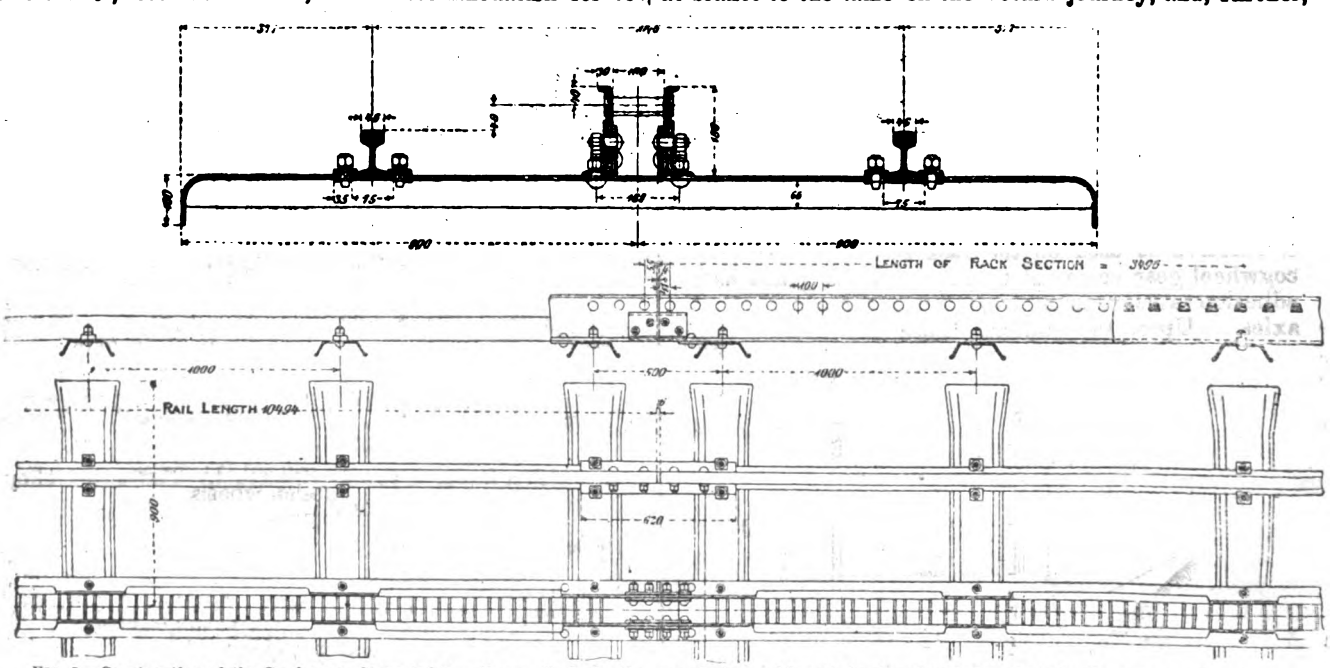

FIG. 5.—Construction of the Rack-way—Stansstad-Engelberg. Scale for the ground plan and longitudinal section 1 : 30. Scale for the cross-section 1 : 15.

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These motors each engage by means of cogwheels, possessing V-shaped teeth, in a common spur-wheel and through this with the connecting gear. From the latter the power is transmitted through two symmetrically disposed spur

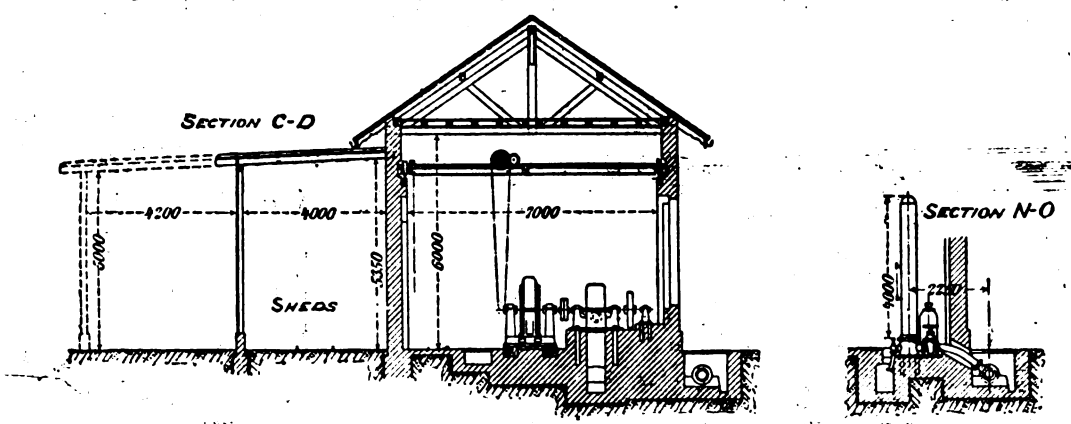

FIG. 6.—Cross-Section Power House. Scale 1 : 200.

wheels to the cogwheel driving shaft. The latter is of hollow construction and runs loosely on the crankshaft, which transmits the driving power to the bearing—that is to say, the adhesion axles of the locomotive. When the

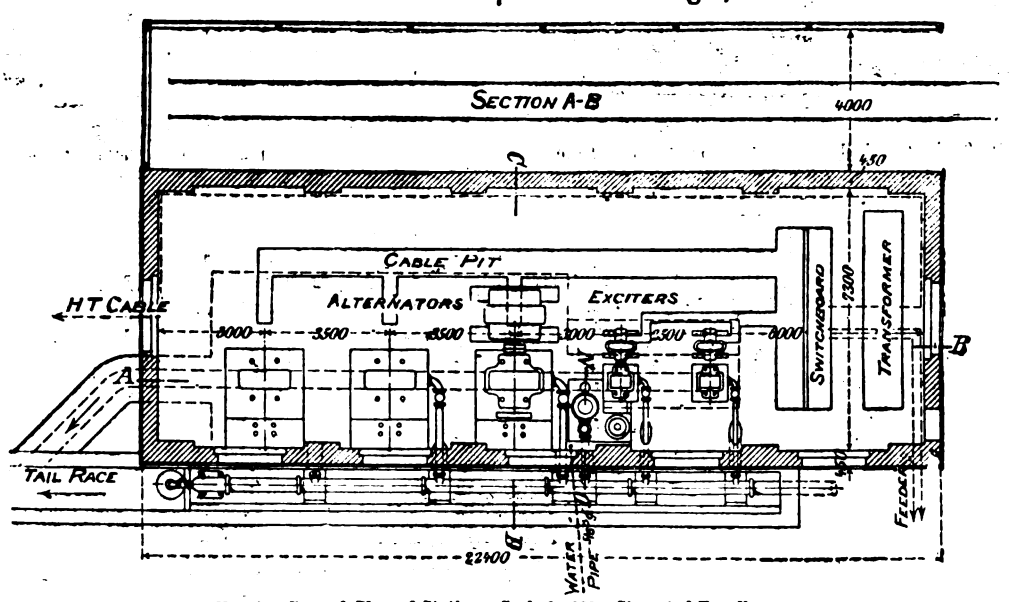

FIG. 7.—Ground Plan of Station. Scale 1 : 200. Stanstad-Engelberg.

locomotive is used on the rack section of the line the cogwheel gear comes alone into play, the crankshaft and adhesion axle running loose being then merely bearing axles. Upon the adhesion track the friction coupling

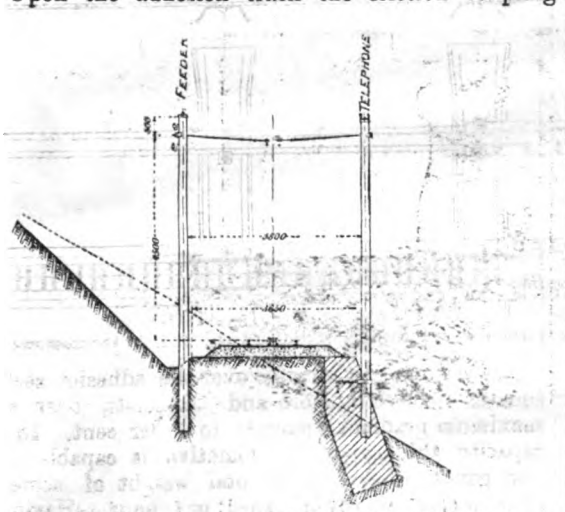

FIG. 8.—Cross-Section of Rack-way, Stanstad-Engelberg. Scale 1 : 150.

mounted on the countershaft, together, therefore, with the outer cogwheel gear, is brought into action, the crankshaft being transformed into a driving shaft which communicates the power by means of coupling rods to the adhesion axles, the cogwheel mechanism moving without load. For downhill work a cogwheel brake is provided on the front driving axle, which runs loose when not in action.

On the downward journey the motors act automatically as brakes, since an excess of about 4 per cent. over the normal speed has the effect of converting their action into that of generators; but, besides this, the locomotive is provided with the following brake equipment: (1) a hand-brake to the right, which acts simultaneously upon the brake discs of the cogwheel driving shaft and the emergency cogwheel brake; (2) a hand-brake to the left, which acts independently of the first-mentioned upon the two axles; (3) an automatic cogwheel brake—that is to say, a device which actuates one or both of the screw brakes mechanically directly the electric current is interrupted for any reason, or if the normal speed is exceeded during the downhill journey—this brake may also be actuated by hand, either by the locomotive driver or the car conductor; (4) a screw brake acting upon both adhesion wheels.

The cogs of the first reduction gear are of nickel steel, those of the large spur wheels being composed of Siemens-Marten forged steel, while the wheels of the second reduction gear are of cast steel, and the toothed driving wheels of crucible steel, all the teeth being made to fit exact. The necessary driving current is collected from the overhead trolley wires by a similar arrangement of collector bows to that adopted in the case of the tramcars. The locomotives may be driven either backwards or forwards by adjusting the reversing switch, previously mentioned, according to the desired direction of travel, while the starting torque may be regulated through a resistance common to both motors. Electrical illumination is also provided for the locomotives. The following dimensions may be collated to ensure ease of reference:

Gauge of track	1m. (39½in.)
Maximum gradient	25 per cent.
Diameter of the driving (cog) wheel	27½in.
,, ,, bearing wheels	26½in.
Speed attained on the mountain section	3 miles per hour.
,, ,, ,, level	7 ,, ,,

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Output of the motors	150 h.p.
Revolutions of the motor	650 per minute.
Pressure of driving current	750 volts.
Weight of locomotive	12 tons.
Tractive effort on the adhesion section	4,400lb.
,, ,, ,, rack ,,	16,500lb.

of 12½ miles per hour over gradients up to a maximum of 25 per cent. It is therefore possible, with the assistance of trailers, to satisfy the demands of the heavy traffic which naturally occur in the lower portion of the Engelberg Valley, especially between Stans and the Vierwaldstätter-See,

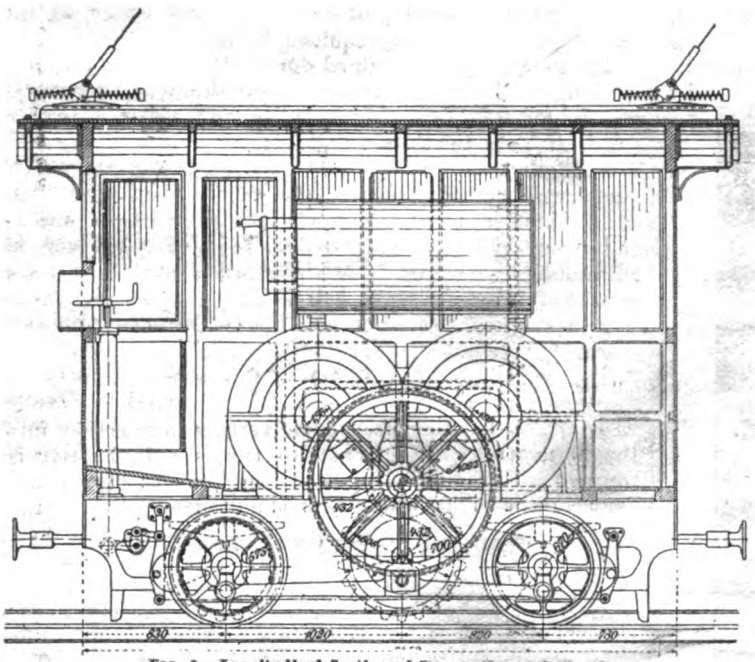

FIG. 9.—Longitudinal Section of Locomotive scale 1 : 40—Stansstad-Engelberg.

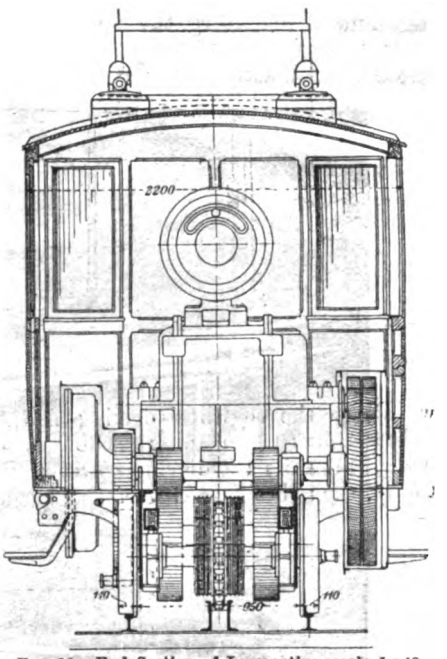

FIG. 10.—End Section of Locomotive, scale 1 : 40—Stansstad-Engelberg.

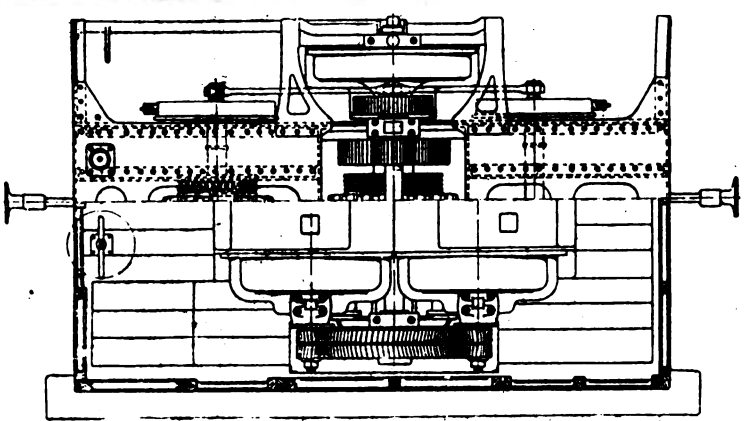

FIG. 11.—Plan of Locomotive, scale 1 : 40—Stansstad-Engelberg.

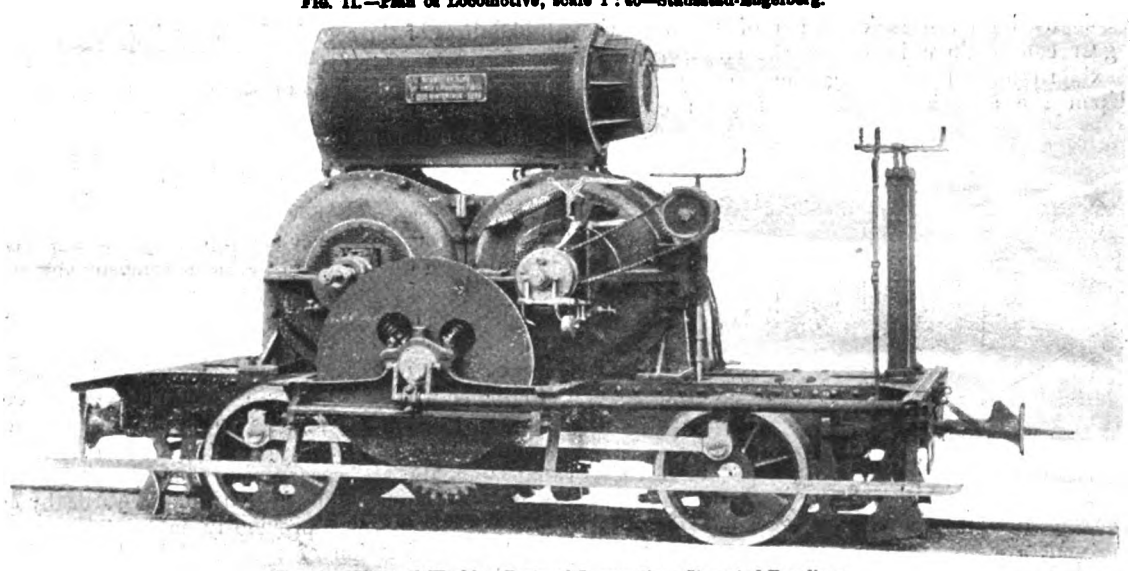

FIG. 12.—View of Working Parts of Locomotive—Stansstad-Engelberg.

Figs. 9 to 11, inclusive, show a plan and section of this type of engine, while Figs. 12 and 13 give a photographic view of its working parts and an exterior view of the locomotive respectively.

The conditions of the service are as follows: A motorcar is capable of hauling after it a trailer weighing 10 tons, thus making a combined weight of 26 tons, at a speed up to the Grafenort Station. But from the latter point to the approach of the rack section—that is to say, over a gradient varying between 1 and 5 per cent.—the motor-car runs freely at a speed of 30 miles per hour. Its consumption of energy with a load of 16 tons and a gradient of 5 per cent. amount to from 80 h.p. to 90 h.p. From Obermatt the car is pushed by one of the locomotives

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(Fig. 14) over the rack section, during which operation the locomotive is not coupled to the motorcar, whereby independent braking is enabled should they by any chance become separated. The power absorbed on the rack section, with a gradient of 25 per cent., a train weight of 26 tons, and a speed of three miles per hour, amounts approximately to 150 h.p. From Gherat, the summit of the ascent, to the terminus at Engelberg, the motorcar is again self-propelled.

In order to prevent the excess current generated by the motors, when acting as brakes on the downward journey,

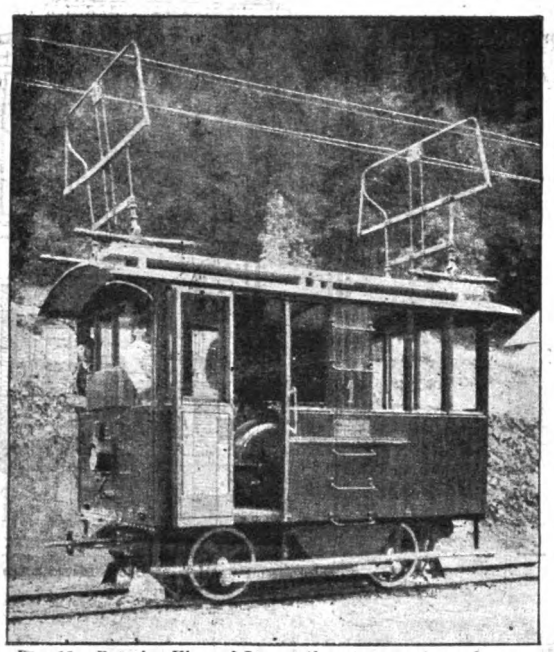

FIG. 13.—Exterior View of Locomotive—Stansstad-Engelberg.

from flowing back through the trolley wires to the generating machines, thus tending to increase the speed of the same, provision is made whereby the generators work on an artificial resistance—namely, a water resistance—situated in the tail race from the turbines. Experiments have shown that a train weighing 28 tons travelling at the normal speed down the rack section reduces the load on the station generating plant by about 75 h.p. This energy must, therefore (assuming it is not absorbed by trains moving over other portions of the line), be expended on

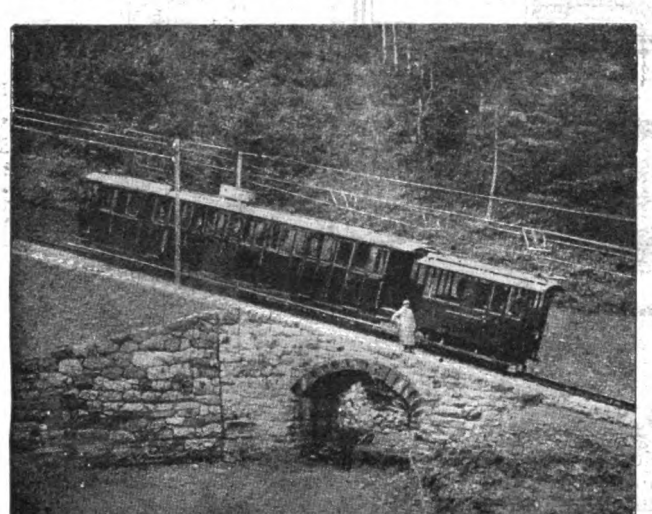

FIG. 14.—Locomotive Pushing Car Over the Rackway—Stansstad-Engelberg.

the water resistance, in addition to a slight excess demanded from the generators for safety's sake. When the station was opened the plant installed proved more than equal to the demand on it, wherefore no automatic arrangement for switching this resistance in or out of circuit was provided, the same remaining constantly in circuit.

The efficiency of the original plant may be gathered from the following list of rolling material which could be propelled simultaneously by it:

1. A train consisting of a passenger car and locomotive, with a total weight of 28 tons, up the rackway ascent, having a gradient of 25 per cent. (150 h.p.).

2. A passenger car on the Grafenort-Obermatt section, requiring a maximum propelling power of 80 h.p. to 90 h.p.

3. A train consisting of a passenger car and trailer on the Grafenort-Stans section, having an aggregate weight of 26 tons (maximum power required about 60 h.p.).

4. A train consisting of a motorcar and trailer on the Stansstad Stans section, requiring 25 h.p.

The great success attained during the first few months' working of the line made it appear desirable to increase the rolling-stock and efficiency of the system. In the spring of 1899 the third generating set of 180 h.p. capacity was therefore added to the plant, together with the second transformer sub-station in Stans with the involved high-tension and feeder cables, while the rolling-stock was at the same time supplemented by two motorcars and an additional locomotive. These extensions enabled a quick service of trains between Engelberg and Stansstad to be inaugurated and two trains to make the ascent of the rack section of the line simultaneously.

The extensions of the electrical plant, it may be mentioned in conclusion, were also entrusted to Messrs. Brown, Boveri, and Co., whose work in connection with the undertaking has throughout shown very satisfactory results.

HORNSEY ELECTRIC LIGHTING.

In his report to the Hornsey Urban District Council Mr. Robert Hammond, M.I.C.E., pointed out that the provisional order was granted to the Hornsey District Council on July 1, 1898, which conferred powers to supply electrical energy for public and private purposes in certain parts of the parish, including practically the whole of the shopping area. The provision was made that within six months of July next a supply must be given, and though at one time the Board of Trade gave great latitude to local authorities, the municipal trading debates in the House of Commons had made them much more strict, and they now either revoked the orders or threatened to do so unless proof was given that the work was about to be started. If the Council wished to keep the matter in their own hands, they must take early steps in the matter. On Dec. 31 last 309 local authorities had provisional orders and 122 companies. In November notices had been given in Parliament by 50 companies and 63 local authorities for orders and 13 and 5 respectively for Bills. The local authorities had invested and authorised expenditure for electrical work to the amount of £11,214,750, and companies to the extent of £8,678,000. The proportion of money invested by companies, compared with the number of works, was greater than that of local authorities, because the former had secured some of the best areas in the Metropolis. Mr. Hammond advised that if the order was leased to a company the Council should advertise for tenders, which should come freely. To allow the order to lapse and a company to come in would be unwise, and the Board of Trade would not treat the Council's opposition with much consideration if they opposed a company applying for an order. If, then, they did not work the order themselves, they should either arrange with a company to supply them with energy or transfer to a company on the best terms possible. The first course he opposed, and though not in favour of the second, thought it better than the first. So far as he could ascertain no local authority who had laid down its own works had regretted doing so. In nine cases where a company obtained an order, and the authority afterwards bought, the result was that the capital invested in the companies was £1,003,184, and the amount paid by the authorities for the undertakings £1,693,787.

A site near the Hornsey railway station, adjoining that of the proposed public baths, had been chosen for a generating station. In his preliminary report in November, 1897, he recommended the high-pressure alternating system, but he now thought the low-pressure system best suited for Hornsey. This would be more economical under the new conditions, and he had fixed the delivery current at the feeding points at an average E.M.F. of 480 volts, thus necessitating the use of 240-volt lamps. The cost of laying mains would be about £6,104, being £2,704 for distributors, £1,937 for feeders, and the balance for trenching. This provided for 5,692 yards of distributors, etc., and he suggested another £3,750 for mains and extensions. He estimated that 6,000 equivalent 8-c.p. lamps would be required, but suggested that 15,000 should be provided for. The generating plant for this, with pipes, etc., would cost £20,250, but this did not include cost of site. The engines would be arranged for an output of 300 kw. As to the question of public lighting, Mr. Hammond thought 45 arc lamps would

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be needed, the cost of which, with connections, etc., would be £2,250. A further £3,050 would be needed for meters, fuse boxes, and house connections. He allowed £500 for engineer's fees, and for incidental contingencies £3,096. The whole reached a total of £38,500, which was £3,500 more than his estimate of 1897, but the increase was due to the higher price of materials. An alternative scheme for 21,000 lamps alight at one time, or from 30,000 to 40,000 on consumers' premises, he estimated would cost £73,500, which included public lighting. The probable financial results with a maximum charge of 7d. per unit for 100 hours per quarter, and then 2d. per unit, which he thought would average about 5d. per unit, would be an increase of £6,119, and for the complete scheme £11,512. The cost of generation and distribution in the two schemes he set down at £3,329 and £5,990 respectively. If the interest and repayment of capital were added, sums of £2,630 and £4,226 must be added to each, and thus in the first a net profit, after the public lighting had been charged for, would be made of £160, and in the second £1,764.

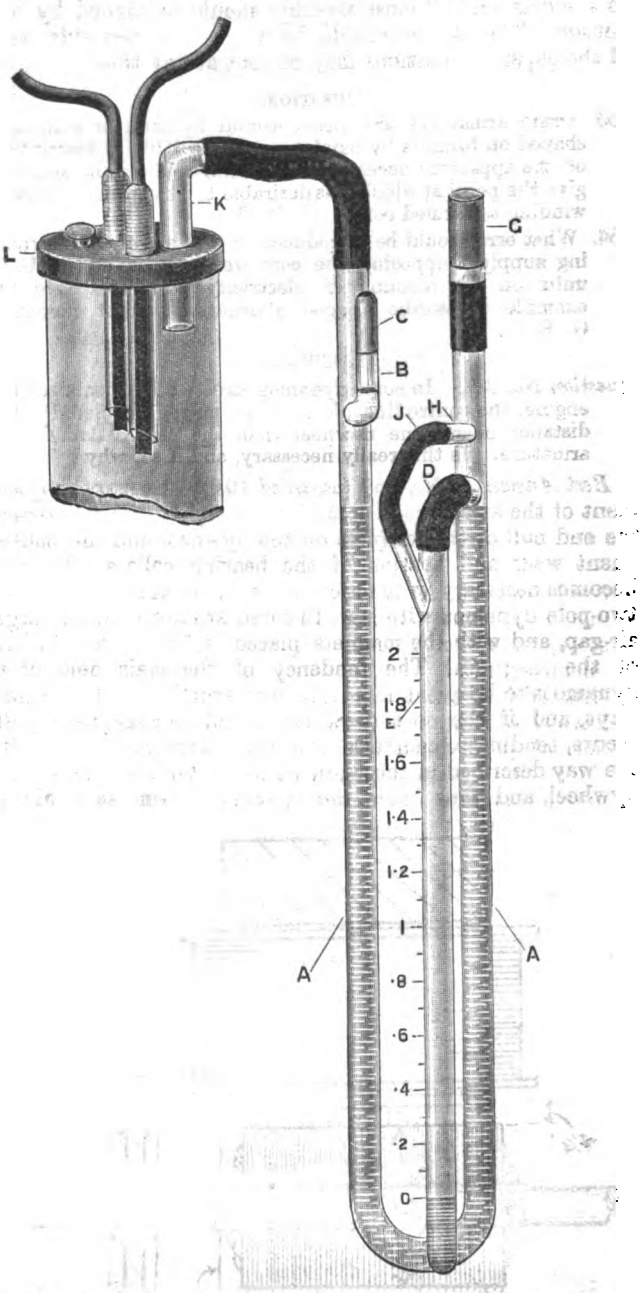
GLASGOW TELEPHONES.

At the meeting of the Police Department on the 17th inst. a minute was adopted in which the Joint Sub-Committee on Applications by the Post Office reported that a deputation had met a sub-committee of the Association of Municipal Corporations. We quote from the *Scotsman* as follows: "That sub-committee had been appointed to co-operate with Glasgow Corporation in their efforts to secure from Parliament the protection of their streets from any compulsory interference on the part of the Post Office for the purpose of affording facilities to any company trading for private gain. After discussion at that meeting it was agreed 'that Mr. Pritchard, the secretary of the association, be requested in conference with the representatives of the Glasgow Corporation to prepare a statement to be issued to the town clerks of all the municipalities of the United Kingdom, so that the same may be forwarded to all their members of Parliament; that Mr. Pritchard be requested to obtain the services of Mr. A. R. Bennett as an expert to report upon the question of municipal telephony provided a sufficient number of towns join in a guarantee of the cost; that Mr. Pritchard be instructed to prepare a report embodying information as to the legal position of municipalities in relation to this subject, and as to the terms of the license, especially dealing with the period of the duration of the license and its effect; and that a further meeting of the sub-committee be held to consider the draft report of Mr. Bennett and Mr. Pritchard, and also, if found necessary, to confer with the Post Office authorities.' Mr. M'Farlane remarked that an agitation had been started which would have a very material effect in the future.

"In another minute the committee reported having had under consideration notices by the Post Office authorities that they intended to break open certain streets to lay down telegraph wires. The Corporation made the stipulation that the wires should be used only for Post Office purposes, and not handed over to the National Telephone Company. The superintending engineer replied that, without prejudice to the Postmaster-General's legal rights, there is no present intention of using the pipes for the purposes of the National Telephone Company. The Corporation Joint Sub-Committee agreed to recommend that, accepting the undertaking already given by the Post Office authorities, that any damage which might be done to carriageways in the execution of the works would be made good by the Post Office, and also accepting the explanation that there is no present intention of using the pipes for the purposes of the National Telephone Company, permission be granted on the Post Office authorities further undertaking that the pipes in question would not be used for the purposes of the National Telephone Company without the Post Office authorities first communicating with the Corporation and affording them full opportunity of reconsidering the whole matter, with a view to it being then arranged between the Postmaster-General and the Corporation, or, in the event of difference between them, being determined as provided for in the Telegraph Acts."

THE RIMINGTON MAXIMUM DEMAND INDICATOR.

We illustrate herewith a new maximum demand indicator which is being placed on the market by the Bastian Meter Company. As will be seen from the illustration, the construction of the meter is very simple. The meter and demand indicator are fixed on the same backboard. The arrangement of the instrument is shown in the illustration, and is as follows: The stopper, L, of the Bastian meter is made absolutely gas-tight, and a tube, K, passing through this stopper, connects the interior of the meter with the demand indicator, so that the gases resulting from the decomposition of the electrolyte in the meter are led into the U-tube, marked A A′ in the drawing, the tube being filled with coloured liquid up to the level shown. The branch tube, B, has its end closed by a specially-prepared porous plug, C, so that the only possible exit for the gas generated in the meter is through this porous plug, the rate at which gas can escape through this plug being proportional to the pressure under which it is confined. When the current passes through the meter, the rate at which gas is evolved is proportional to that current, and consequently the pressure of this gas will increase until it reaches such a value that the rate of its escape through the plug, C, is equal to its rate of production by the current. It then follows that for every definite current passing through the meter a definite pressure is produced which is absolutely proportional to the current. This pressure will cause the liquid in A to move down and that in A′ to rise correspondingly and overflow through D into the



down tube, E, the height of the liquid in this tube indicating permanently on the scale behind the maximum current which has passed through the meter. The free end of A′ is closed with a porous plug, G. To reset the instrument the rubber tube, J, is taken from the nozzle, H. The tube E is released from its spring clip, and raised so that the liquid runs back into A A′ The tube is then put back in the reverse manner, and the indicator is again ready for use. It will be seen that the accuracy of this maximum demand indicator is wholly dependent on the porosity of the plug through which the gas from the electrolysis has to pass, and also on the tightness of the various joints in the apparatus. No doubt the makers have undertaken experiments to prove the reliability of the porous plug which they employ, but we should fancy that it is bound to be somewhat affected by atmospheric conditions. Otherwise the apparatus is an exceedingly simple one, and should be easily manipulated. Naturally, the indicator is only applicable to a meter of the Bastian type.

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

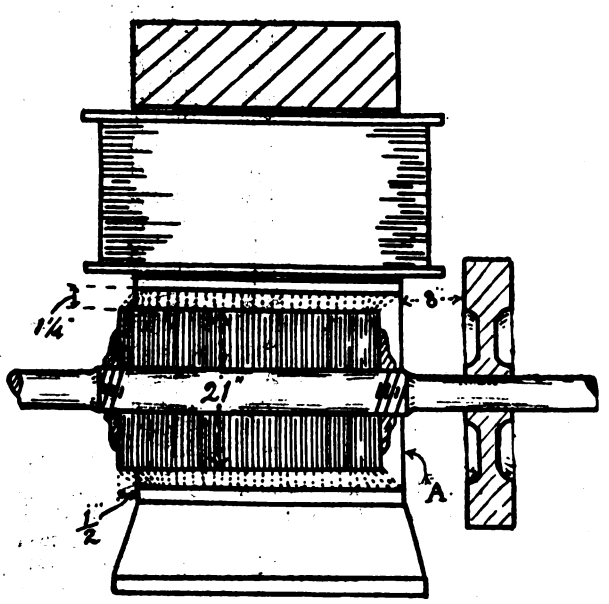
263. Drum armatures are either wound by hand or with coils shaped on formers by hand or machine. Give a description of the apparatus necessary for making these coils, and also give the point at which it is desirable to change from a hand winding to formed coils.—H. O. C.

264. What error could be introduced in the case of an alternating supply, supposing the cost were calculated in B.T. units on the amount of electricity passed? Give an example. Describe a good alternating-current meter.—G. R. B.

ANSWERS.

Question No. 257.—In some dynamos direct-coupled to a steam-engine, the centre line of the field magnet is placed some distance nearer the flywheel than the centre line of the armature. Is this really necessary, and if so, why?

Best Answer to No. 257 (*awarded* 10*s.*).—Such an adjustment of the armature is occasionally employed to counteract the end pull of the magnets on the flywheel and the consequent wear and heating of the bearing collars. It only becomes necessary in practice, however, in the case of large two-pole dynamos with smooth-cored armatures and a large air-gap, and with the magnets placed within a few inches of the magnets. The tendency of the main field of a dynamo is to keep the armature core exactly central lengthways, and if the core is set out of centre a magnetic pull occurs, tending to centralise it again. This pull is used in the way described in the question to oppose the pull on the flywheel, and thus leave the rotating system as a whole



without any tendency one way or the other. The forces involved cannot be calculated with any great accuracy, but a fair idea of them can be obtained as shown in the following example. The machine shown in the diagram is a 130-kw. two-pole smooth-cored dynamo; diameter of armature core = 21in.; diameter of magnet bore, 23½in.; length (peripherally) of each polar arc = 25in.; induction density in the air-gap = 5,500 C.G.S. lines per square centimetre; distance of magnet poles from flywheel face = 8in.; area of each magnet face at A facing the flywheel = 220 square inches; total number of ampere-turns on the field magnet = 30,000 (15,000 on each limb).

The induction density of the flux passing from one pole to the flywheel and then out of the flywheel into the other pole is found by the ordinary air-gap formula:

$$\cdot 8 \times \text{density} \times \text{length of air-path in centimetres} = \text{total ampere-turns acting};$$

or $$\cdot 8 \times \text{density} \times 16\text{in.} \times 2.54 = 30{,}000;$$

$$\therefore \text{density} = 930 \text{ C.G.S. lines per square inch,}$$

and the pull corresponding to this flux is obtained by the magnetic pull formula:

$$\text{Pull in dynes per square centimetre} = \frac{(\text{density})^2}{8\pi};$$

$$\text{or total pull in pounds} = \frac{(\text{density})^2 \times \text{area in square inches}}{1{\cdot}73 \times 10^6} = \frac{(930)^2 \times 220 \times 2}{1{\cdot}73 \times 10^6} = 220\text{lb.}$$

This large force of 220lb. drawing the flywheel towards the magnets would in the ordinary course (unless a special thrust bearing were introduced) fall on two or three small collars on the spindle, and be quite enough to appreciably reduce the efficiency of the machine, besides causing continual trouble at the bearings. Suppose, now, that the magnets are set ½in. out of centre, as shown. The greater part of the main flux of the machine will continue to pass radially into the armature, and will produce no end pull whatever. There will, however, be a small portion of flux at each end of the magnet, which passes obliquely into the armature, and produces a certain end pull depending on its density and the average angle at which it lies to the axis. In this case the average angle will be, approximately, such that its tangent = 1½in. ÷ ½in.—*i.e.*, it will be about ·68deg. The length of this slanting path from magnet to core will be, approximately, $\frac{1\frac{1}{2}\text{in.}}{\sin 68\text{deg.}} = 1{\cdot}35\text{in.}$, and consequently the density of this slanting field will be $5{,}500 \times \frac{1{\cdot}25}{1{\cdot}35} = 5{,}050$.

The area at each end of the armature occupied by the slanting field may be taken as ½in. × 25in. × 2 = 25 square inches, or 50 square inches for the two ends.

$$\text{The pull in the direction of the slanting field} = \frac{(5{,}050)^2 \times 50}{1{\cdot}73 \times 10^6} = 735\text{lb.},$$

using the same pull formula as above. This pull reduced into the horizontal direction will be 735 × cos 68deg. = 277lb., or rather more than the amount required to counterbalance the pull on the flywheel, as calculated above.—Q.

Answer to No. 257 (*awarded* 5*s.*).—The reason why the centre line of the field magnets in some direct-driven sets

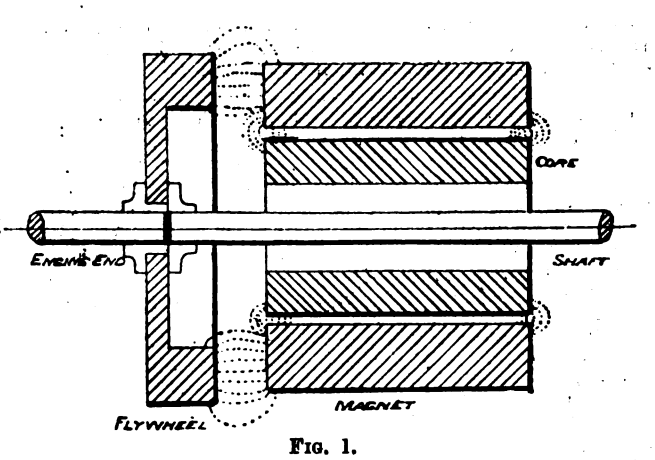


FIG. 1.

is not in the same as that of the armature is due to the influence of the flywheel, which, if in this position, owing to magnetic leakage through it, causes the shaft of the engine and dynamo to be pulled towards the dynamo end (Fig. 1). This is corrected by the apparently paradoxical method of setting the magnets nearer to the flywheel (Fig. 2). By this means the pull on the flywheel is slightly increased, but the armature having a very much larger induction through it, is pulled in the reverse direction sufficiently strongly to equal the effect of the fly-

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wheel, by a small movement of the magnets. This is known in engine works as "balancing" the armature. To obtain this position the crank and armature are placed in their bearings, and the field magnets also fixed approximately correctly. The fields are separately excited, and the armature and shaft rotated to enable them to take up a position of equilibrium. It will be found that one of the crank webs is hard up against its brass. The magnets are then moved till the shaft is free from end stress.

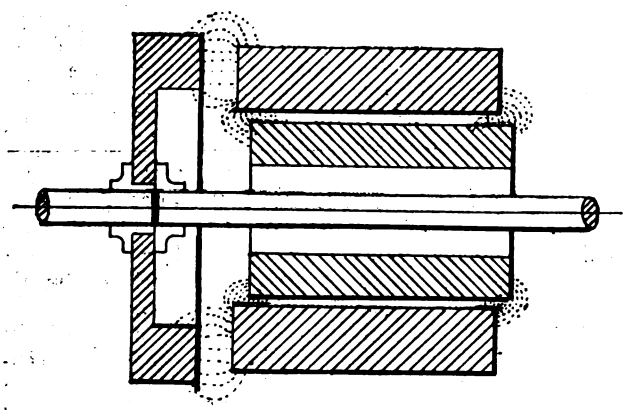

FIG. 2.

It is sometimes advantageous to have a slight pressure in one direction if it is desirable to avoid end play in running. That this force is of importance is shown by the fact that in the case of a six-pole machine it may be over 100lb. if the magnets are ½in. out of the balancing position. If only a small barring wheel is used with a large multipolar armature, the effect is very small. It is of most importance in the case of two-pole machines with relatively large flywheel. In the case of large armatures of several tons weight the neatest method of balancing is to run it as a motor by sending a current of about 50 amperes through it by a pair of brushes, using a switch in circuit for breaking the current. Full excitation should be used, as the increased magnetic leakage when fully excited will cause a larger proportion of the field to pass through the flywheel than when a less exciting current is used.—E. H. R.

Question No. 258.—State the advantages of rail welding in tramway work compared with the usual methods of bonding; also state how the strain on rails due to variation of temperature may be ascertained.

Best Answer to No. 258 (*awarded* 10*s.*).—The usual method of bonding is to connect the lengths of rail by means of short copper conductors, such as the Chicago "crown" or Columbia bonds, bridging the joints. The two parallel rails are, in addition, cross bonded every 80 or 100 yards. By this means, provided that the joints between the copper and steel are good, a continuous return is provided, the two rails acting in parallel as one conductor. The principal defects of this system are the following:

(*a*) A badly-made bond sensibly diminishes the conductivity of the circuit, and as there are very many joints in series in the return circuit its resistance may easily be made such as to increase the voltage drop above the Board of Trade limits (seven volts). The bond may be imperfect owing either (1) to dirty contact surface, due to oxidation of the metals or to foreign matter; or (2) to insufficient care being taken to bring the surfaces closely into contact while bonding.

(*b*) These bonds, even though perfect when newly made, are subject to strains due to alteration of temperature and consequent movement of the rails, and to vibration due to passage of cars. These strains gradually loosen the bonds at the joints, raising the resistance of the return, and also involving an increased cost of maintenance. The Columbia and old Chicago types of bond are more liable to injury from these causes, as they are made of solid copper rod. The Chicago "crown," or the Neptune type, being made of stranded wires, gives more easily and does not transmit the strains to the joints.

(*c*) The bonds do not assist the mechanical strength of the rails against vertical displacement at the ends due to the passing of cars. All strains due to the continued hammering action as the car-wheel rolls from one section of rail to the next, are borne by the fishplates and the permanent track. As regards the fishplates, it is well known that in railway work the alternate expansion and contraction of the rails loosens the grip of the plates, while it must be remembered that a tramway track is of much lighter construction than the permanent way of a railroad, and cannot stand so much shock. The ends of the rails therefore get worn in a rather short time.

It is to overcome these objections that rail-welding has been introduced. Two methods are in vogue—(1) direct electrical welding of the rail sections; (2) the Falk system of casting a sleeve of cast iron round the adjacent ends of the rails. The first may very briefly be described as passing a large alternating current of low voltage through the brightened ends of the rails, thus heating them, and by hydraulic pressure forcing the ends together while soft. Each weld takes about 15 minutes, the electrical power (about 15 kw.) being on for about three minutes of this time. The equipment for this purpose is expensive, and this probably prevents the more extended use of the method. In the Falk system an iron mould is placed round the butting ends of the rails, and molten iron at a high temperature run in. The iron in contact with the mould cools first, exerting a tremendous pressure on the portion still molten, and forcing it into the interstices of the steel web (which is raised to a white heat). Pieces of carbon are laid on the top of the rails to prevent the steel from softening during the welding process. These cast-welded joints are generally about 14in. long, and of such a section that the joint has at least the same tensile strength as that possessed by the rail. The weight of cast iron varies from 70lb. to 140lb. per joint, according to the weight of the rail. Although, strictly speaking, a weld cannot be produced between cast iron and steel, an equivalent result is obtained with this method, as if the cast iron be torn away from the web of the rail it always brings some of the rail away with it; also, if a welded joint be sawn across and examined, it is impossible to say where the cast iron ceases and the web of the rail begins. It will be seen that all the objections to the "bonding" system enumerated above are avoided by the solid-weld system, though the equipment necessary in both cases is somewhat expensive, and in the first method a large supply of electrical power is required.

Two objections were formerly urged against these systems; the first (applying only to the Falk joint) being that water was likely to get into the joint, causing rust and destroying mechanical strength and electrical conductivity. The second was that in any solid welded rail joint the effect of variation of temperature along a good length of rail would be to induce enormous stresses which would concentrate at the weakest point and cause rupture, or, alternatively, would buckle the rails or damage the paving. Both these objections have been found to have no warrant in practice, the second one being met by the ascertained fact that the fastenings of the rail to the permanent way prevent the strain from concentrating at any one point. It is, however, difficult to cut out a faulty section in case repairs are necessary, as the metal has to be sawn across. The strain on a rail due to variation of temperature is determined from the following considerations:

Let L be the length of the rail at the time of welding;
c, the coefficient of expansion of the material of which the rail is made (steel);
t_1, mean temperature of the rail at the time of welding;
t_2, temperature of rail at the time at which the strain is determined;
then if the rail were free to expand, the variation of length under a temperature of t_2 degrees would be

$$L\,c\,(t_2 - t_1),$$

and elongation (under a rise of temperature) per unit length would be

$$c\,(t_2 - t_1).$$

If the quantity $(t_2 - t_1)$ were negative in sign, contraction has taken place.

Now, let K = modulus of elasticity of the material of the rail—*i.e.*, the force in pounds per square inch which would

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produce an elongation equal to original length, supposing the body to be perfectly elastic—then the equivalent mechanical force producing the same elongation per unit length as is produced by the given rise in temperature will be

$$K\,c\,(t_2 - t_1)$$ pounds per square inch;

and if cross-sectional area of rail is R, total mechanical force which would have to be opposed to the force of expansion or contraction due to rise or fall of temperature, in order to keep rail length constant, would be

$$R\,K\,c\,(t_2 - t_1)$$ pounds,

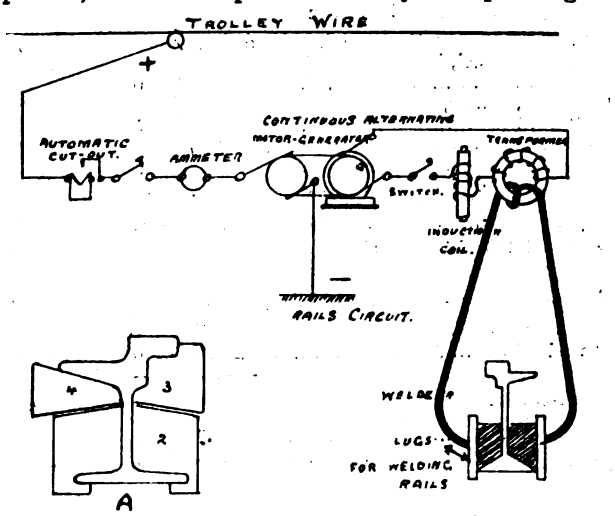
and this would be the strain on the rails due to variation of temperature.

Now, the coefficient of expansion of steel is ·0000065 per degree F. The modulus of elasticity of steel is 29,000,000lb. per square inch. The maximum variation of temperature at any time from the temperature at which the rails were welded, can be safely taken as 70deg. F. The cross-sectional area of a particular rail is easily ascertained.

It is worth noting that the average ultimate tenacity of manganese steel is 38 to 40 tons per square inch, a figure exceeding any strain likely to be produced by variations of temperature from summer to winter.—J. A. S.

Answer to No. 258 (*awarded* 5*s.*).—The continuous rail without fishplates, bolts, and bonds is the ideal, as all troubles, mechanical and electrical, are due to poor joints. Two methods of attaining this end have so far actually been tried. The first consists in electrically welding the ends of the rails together; the second in casting a sleeve of cast iron round the adjacent ends of the rails. This latter is known under the name of the "Falk cast weld." There is a prejudice against the continuous rail, the chief reason being that standard railway practice makes special allowances for contraction and expansion at joints. It was thought that if a continuous track were laid, and the paving on the length of road removed, the track would buckle, or that the paving might be damaged, owing to contraction and expansion of rails; but experience has demonstrated that, in continuous track, joints are all held so firmly that rails are practically immovable, and differences of temperature simply change the molecular condition and the stresses in the rail. In tramway work variations of temperature do not affect the rails much, owing to their being entirely covered in pavement of some kind which is a non-conductor of heat. It is easy to ascertain the strain on rails due to variations of temperature. Assuming a coefficient of expansion for steel of 0·0000065 × 75, which is a liberal figure, for the number of degrees of maximum deviation from the temperature at which the welding is done, we get 0·000487, which is that part of its length which a rail would expand when exposed to a rise of 75deg., or contract when exposed to a fall of 75deg. in temperature. A steel bar will expand 0·00003 of its length due to a load of 1,090lb. per square inch. Divide the estimated expansion by this figure, we get for the strain 16,200lb. per square inch. As 40,000lb. per square inch is a safe value for the elastic limit of steel, it can be seen that the elastic limit will never be reached, so expansion and contraction may go on indefinitely, and as long as the joints remain unbroken no harm will be done to the rail. Assuming 80,000lb. per square inch as the ultimate strength of steel, there is still, as far as the strength of the rails themselves is concerned, a factor of safety of 5.

A sketch is given herewith showing the process of rail welding. The current passes through an automatic circuit-breaker switch, ammeter, and starting rheostat to a motor-generator, where it is transformed into an alternating one at 300 volts with a periodicity of 74. The alternating current passes through a switch, a regulating induction coil with movable iron core to a transformer, where it is transformed to a pressure of from three to four volts. The secondary winding of the transformer consists of a single turn of heavy copper strips leading to the copper contacts between which the welding is done. The distance between these contact pieces is regulated by the jaws of a hydraulic press, by which great pressure can be brought to bear upon the weld. A small motor is used to handle the hydraulic press, and a continual current of cold water is forced through the arms of the welding press by a hydraulic motor. Another electric motor, fitted with a flexible shaft and emery wheel, is used to polish the ends of the rails before welding. A shows method of welding. The ends of the rails are butted; where this is not possible a thin section is driven in between the ends of the rails. The webs of the rail are polished for 2in. to 4in. on either side of the joint. The joint is then clamped in a gunmetal casting on and partly surrounding the foot of the rail, into which the first two steel lugs, 1 and 2, are put. These are from 4in. to 7in. long. The current being gradually put on through the lugs and the web of the rail when at welding heat, they are pressed together by the hydraulic press and the weld made. The top lugs, 3 and 4, in the diagram are treated the same. To prevent the tread of the rail from softening, pieces of carbon are placed on the top of the rail. After welding, the top of the rail is smoothed by hammering, the hammer being contained in the welding apparatus. The average time required to make a weld is from 12 to 15 minutes, current being on for about three minutes of this time. The power required is from 12 kw. to 15 kw. The tools and plant required for electric welding are very expensive, and this has prevented the system spreading.



The "Falk cast-weld" system consists in casting an iron sleeve round the sides and bottom of the rail joints, these being first placed firmly together. In cases where they do not absolutely touch, thin plates of steel are driven in between the heads of the rails before casting. Before fixing the moulds, which are of cast iron, the sides and bottom of the rail are cleaned with an emery wheel. The cast iron, which is of special chemical composition, running into the iron moulds, cools rapidly on the outside surface, thus causing great pressure to be exerted on the metal whilst in its molten state in contact with the web and foot of the rail. As the metal is poured in from one side and comes in contact with the web at its greatest heat, this part is brought to a white heat, and, owing to the tremendous pressure exerted on the molten cast iron, this is practically forced into the interstices of the steel, making a good mechanical and electrical joint. On sawing a welded joint through, it is impossible to say where the cast iron ceases and the web of the rails commences. The cast-welded joints used are about 14in. long, the weight varying from 70lb. to 140lb. per joint.—A. B.

ST. PANCRAS ELECTRICITY ACCOUNTS.

The following is the report of Mr. Albert E. Pycraft, chief clerk to the St. Pancras Vestry, on the working of the electricity and public lighting department during the past year. The revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are also appended:

During the year loans amounting to £51,850 have been received, making the total amount borrowed at Dec. 31, 1899, £286,780. Of this amount a sum of £17 246. 14s. 7d. has been repaid. The expenditure incurred during the year on account of capital amounts to

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£47,915. 8s. 9d., making a total capital expenditure of £288,146. 12s. It will be noticed under the heading "Public Lamps" the expenditure is reduced from £8,893. 19s. 10d. to £4,311. 1s. 2d.; this alteration is in consequence of the London County Council having now decided that loans for public street lamps and columns must be borrowed under the Metropolis Management Acts and not the Electric Lighting Acts, and the account has been adjusted accordingly. The gross revenue for the year amounts to £44,880. 7s., an increase over the year 1898 of £6 624 6s. 8d. After paying all charges in connection with instalments of loans and interest charges, the net profit for the year amounts to £6 841. 19s. 11d. The increase in revenue is over 17 per cent., and in units sold over 24 per cent., on the previous year. The rebate allowed off accounts to consumers charged by the maximum-demand indicator system amounted to £6,536. 16s. 6d. The following table shows the progress of the electricity undertaking since the commencement:

Year ending Dec.	No. of consumers.	Current sold to consumers (not including public street-lighting). 3d. per unit. £ s. d.	4d., 5d, and 6d. per unit. £ s. d.	No. of lamps etc., applied for. Incandescent. 16 c.p.	Arc.	Motors.
1892	172	—	8 167 7 8	9,990	82	11
1893	238	384 11 6	9,161 6 0	12 851	110	19
1894	349	1 236 13 9	10 819 15 9	15,542	129	22
1895	447	2,142 9 6	12,682 6 0	19,195	139	37
1896	672	2,946 14 9	19,430 8 8	26,423	187	47
1897	808	4,081 10 0	25,220 11 5	32 250	256	78
1898	984	8,415 0 0	23 446 5 2	38,124	292	91
1899	1,184	11,699 12 3	25,992 17 6	46,172	315	126

Revenue Account.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including carriage, etc.	£9,498	10	0			
Oil, waste, water, and engine-room stores	976	16	5			
Proportion of salaries of engineers	478	9	0			
Wages at generating stations	2,907	16	2			
Sundry petty expenses	94	18	10			
Repairs and maintenance: buildings, £188. 11s. 10d.; engines, boilers, etc., £1,416. 16s. 2d.; dynamos, exciters, accumulators, etc., £903. 8s. 9d.; other machinery, instruments, and tools, £142. 16s. 4d.; less received for old materials, £41. 7s. 1d.	2,610	6	0			
				16,566	16	5
Distribution of Electricity.						
Proportion of salaries of engineers, etc.	227	4	7			
Wages of outdoor staff	943	6	7			
Repairs, maintenance, and renewals of mains of all classes, including materials, labour, and tools	1,566	10	9			
Rearranging public arc lighting mains	746	5	9			
Alterations in connection with changing pressure on mains, etc., to 220 volts	1,348	5	10			
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	410	7	6			
Water, etc., at sub-stations	7	12	3			
				5,249	13	3
Public Lamps.						
Carbons	253	13	11			
Repairs	316	11	1			
Attending	545	10	3			
				1,115	15	3
Licenses and wayleaves				28	10	6
Rents, Rates, and Taxes.						
Rents payable	148	12	10			
Rates and taxes	1,015	11	8			
				1,164	4	6
Management Expenses.						
Salaries—viz., engineer's department and clerical staff	1,720	10	11			
Stationery and printing	238	5	6			
General establishment charges	260	17	11			
				2,219	14	4
Law expenses				24	8	0
Special Charges.						
Insurances, etc.	246	17	3			
Fees, testing meters	2	0	0			
Expenses obtaining loans	114	18	6			
Compensation claims	96	18	0			
Hire and erection of temporary plant	126	7	4			
Dismounting and removing plant	39	1	11			
London County Council, items disallowed on capital account	220	6	0			
Map of mains	18	0	0			
				861	9	0
Total expenditure				27,230	11	3
Balance carried to net revenue account				17,649	15	9
				£44,880	7	0

Cr.				£	s.	d.
Sale of current per meter at 6d. per B.T.U.				23,674	12	6
,, ,,	5d.	,,		360	11	8
,, ,,	4d.	,,		1,957	13	4
,, ,,	3d.	,,		11 699	12	3
				37,692	9	9
Public lighting (sale of current and all maintenance charges)				6,639	17	8
Indicator rentals				97	9	0
Sundry chargeable works				106	18	7
Fees for testing installations				8	0	0
Rents receivable, £181. 4s. 6d.; less repairs, rates, and taxes, £144. 11s. 2d.				36	13	4
Proportion of office expenses chargeable to the lighting (gas) department				298	18	8
				£44,880	7	0

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	236,780	0	0
Amount received on loan from bankers	17.876	14	6
Sundry creditors	8 057	11	3
Amounts due under contracts	33 679	9	7
Interest accrued on loans	2 135	16	6
Net revenue account	8,734	9	6
Reserve fund	8,000	0	0
	£315,264	1	4

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	288,146	12	0
Stores in hand: coal, £74. 5s. 8d.; oils, waste, etc., £135. 17s. 2d.; carbons, £130. 3s. 9d.; general, £4,817. 6s. 11d	5 157	13	6
Debtors for current supplied, £15,911. 19s. 7d.; less deposit account, £307	15,604	19	7
Sundry debtors	326	1	10
Amounts due on account of public street lamps and installations in public buildings	5,355	9	5
Suspense account	658	18	10
Cash in hand	14	12	2
	£315,264	1	4

Statement of Electricity Generated, Sold, etc.

Regent's Park Station.

Quantity generated (in Board of Trade units)		1,954 062
Quantity sold: Public lamps	237,239	1,766,283
Quantity sold: Private consumers (by meter)	1,529,044	
Quantity used on works and testing-room		39 102
Total quantity accounted for		1,805 385
Quantity not accounted for		336,927
Total maximum supply demanded (kilowatts)		1,047

King's-road Station.

Quantity generated (in Board of Trade units)		1,115,415
Quantity sold: Public lamps	222,547	711,225
Quantity sold: Private consumers (by meter)	488,678	
Quantity used on works and testing-room		122 921
Total quantity accounted for		834 146
Quantity not accounted for		93,013
Total maximum supply demanded (kilowatts)		742

No. of public lamps, 228.

COMPANIES' MEETINGS AND REPORTS.

WESTMINSTER ELECTRIC SUPPLY.

An extraordinary general meeting was held at Eccleston-place last week, Lord Suffield presiding. The resolution to be considered was that the capital of the Corporation be increased from £399,500 to £550,000 by the creation of 30,100 ordinary shares of £5 each, and that the board of directors be authorised to issue 20,100 of the shares at £10 per share. After considerable discussion, an amendment providing that the shares be issued at par to the shareholders was adopted. A poll will take place on May 11.

WINCHESTER ELECTRIC LIGHT.

The annual general meeting of the Winchester Electric Light and Power Company was held at the offices, St. Peter-street, Winchester, on Tuesday afternoon, Mr. T. F. Kirby (chairman) presiding.

The report stated that as the contract with Messrs. Edmundsons for the running of the works terminated on July 1 last, the accounts submitted did not represent exactly the working of the undertaking for the past year. The directors were satisfied with the reception the electric light had obtained in Winchester. Ten thousand 8 c.p. lamps were connected by the end of last year, and further applications continued to be received. The accounts show a balance to net revenue account, after paying all expenses (including interest on debentures), amounting to £323 12s. 2d., of which it is proposed to apply £202. 6s 6d. in payment of a dividend at the rate of 2½ per cent. per annum for the year, and to write off £121. 5s. 8d., the balance, in reduction of £197. 17s. 4d., the preliminary expenses. During the year another large engine and dynamo set and a third boiler had been added at the works, and large extensions of the mains had been laid, to meet the public demand. The Company continued to do a fair share of

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the wiring work in the city, and introduced last autumn a system of free wiring, ½d. per unit used being charged as rental.

The Chairman said when people understood the system he was certain they would have a good many applications on those terms. In conclusion, he hoped the shareholders would be as satisfied with the progress of the Company as the directors were. They had now 10,858 lamps connected, 800 having been applied for since the New Year.

The report and balance-sheet were adopted, and the dividend agreed to. Mr. F. E. Gripper, the retiring director, was re-elected, and the auditor appointed by the Board of Trade was elected auditor to the Company.

A vote of thanks to the chairman closed the meeting.

BRITISH COLUMBIA ELECTRIC RAILWAY.

An extraordinary general meeting of this Company was held on Wednesday. Mr. R. M. H. Payne presided, and resolutions to increase the capital of the Company from £370,000 to £450,000 by the creation of 8,000 new preference shares of the nominal value of £10 each, in addition to the 12,000 preference shares of the like nominal value already issued, were agreed to.

The Chairman said the need for the new capital was the great prosperity which the Company had met with. The directors contemplated at an early date the further enlargement of their plant by the addition of an electrical unit both in Vancouver and Victoria, and by the purchase of a considerable amount of additional rolling-stock. The increase in the Company's business had been very profitable At the time they made the last extension of premises and plant they made ample room for increasing steam and water power. There could be no doubt that the expenditure now contemplated would be very beneficial.

INDO-EUROPEAN TELEGRAPH.

The report to be presented at the meeting on 30th inst. states that the directors have been successful in obtaining an extension of the Russian and Persian concessions for a period of 20 years from January, 1905. Also that they have come to an agreement with the German Telegraph Department, and are now in negotiations with the German Government for a similar extension. The revenue amounted to £142,343, as compared with £134,642 for 1898, an increase of £7,700. The expenses were on commercial and general account £36,148, maintenance account £38,509—total £74,657 (£74,346), an increase of £311; £25 000 has been placed to reserve. A dividend for the six months ended Dec. 31 of 17s. 6d. per share is recommended, making, with the dividend already paid, 6 per cent., and a bonus of 20s. per share, making in all 10 per cent. for the year, carrying forward £7,692.

ORIENTAL TELEPHONE.

The report to be presented at the meeting on the 25th inst. shows a balance of £11 739, including £1,344 brought forward. After deduction of £2,858 paid as interim dividend on Oct. 31, there remains £10,225. The directors recommend a final dividend of 8d. per share, free of tax, making 5 per cent., leaving £3,000 to transfer to reserve, and to carry forward £1,508. A small but increased profit has been made by the electric lighting branch. The Indian subsidiary companies have paid 6 per cent. for the year, and have carried forward substantial sums. The Telephone Company of Egypt has declared a 6 per cent. dividend, and has transferred a considerable amount to reserve. The China and Japan Telephone Company has paid its debenture interest, but the accounts for the past year have not yet been closed. Highly satisfactory progress is recorded as far as the Hong Kong exchange is concerned. A branch exchange will probably be opened this year at Kowloon.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Birkenhead.—The Corporation invite tenders for various plant. Tenders by April 23.

Plymouth.—The Corporation invite tenders for overhead line construction, etc. Tenders by May 2.

Glasgow.—The Corporation invite tenders for a supply of electricity meters. Tenders by May 5. Details in our advertisement columns.

Barrow-in-Furness. — The Corporation invite tenders for erection of extensions to the existing electricity works in Buccleuch-street. Tenders by 23rd inst.

Whitechapel, E.—The District Board of Works invite tenders for the construction of an electricity supply station at Osborn-street, Whitechapel, E. Tenders by 3 p.m. on 24th inst.

London, E.C.—The Directors of the Great Eastern Railway Company invite tenders for the supply of stores and materials. Tenders by May 8. Details in our advertisement columns.

Sunderland.—The Corporation invite tenders for the supply of two additional switchboard panels, with instruments, etc., complete. Tenders by April 27. Details in our advertisement columns.

Wimbledon.—The Council invite tenders for an installation of electric wiring and fittings at their new isolation hospital. Tenders by 24th inst. Full particulars in our advertisement columns.

Dundee.—The Town Council invite tenders for the supply and erection at the electric station, Dundee, of a traction switchboard and equipments. Tenders by April 25. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the opening of trenches and the supplying and laying of underground conduits for telephone cables therein, etc. Tenders by April 30. Details in our advertisement columns.

Villa del Rio (Spain).—The Municipality invite tenders for the electric lighting of the town for 20 years. Tenders by April 30. Particulars may be obtained from the Municipality at Villa del Rio, province of Cordoba. Specification may be inspected at this office.

Ilford.—The Urban District Council invite tenders for the construction and erection of (1) shaft, height 180ft.; (2) electric light station, comprising engine and boiler, battery-room, and the necessary offices for an electric lighting station. Tenders by 23rd inst.

Southampton.—The Corporation invite tenders for the supply and erection of one 300-kw. continuous-current generator, coupled direct to a medium-speed vertical compound steam-engine. Tenders by May 1. Full particulars in our advertisement columns.

London, S.E.—The Bermondsey Vestry invite tenders for erection of a chimney shaft, about 150ft. high, of brickwork, on the site of their new electric generating station in "Neckinger," Spa-road, at the rear of the public baths and wash-houses. Tenders by May 4.

London.—The Streets Committee of the Corporation of London invite proposals from firms or persons experienced in the manufacture and use of electric motorcars for the hire of an electrically-driven dustcart. Tenders by June 1. Full particulars in our advertisement columns.

Liverpool.—The Select Vestry invite tenders for an installation of about 100 lights in connection with the nurses' home of the workhouse, Brownlow-hill. Specification may be seen at the office of Mr. H. J. Hagger, vestry clerk, Parish Offices, Brownlow-hill, Liverpool. Tenders by 25th inst.

Dublin.—The Electric Lighting Committee of the Corporation invite tenders for the supply and erection of the following: boilers and accessories—viz, six Lancashire and four water-tube boilers and two economisers; polyphase generators—viz., two 1,000 kw. and two 500-kw. low-speed generators. Tenders by April 26. Details in our advertisement columns.

Rhyl.—The Urban District Council invite tenders for the supply and erection of—boiler-house plant: water-tube boiler, fittings, steam and exhaust pipes, etc.; engine-house plant: steam dynamos, pumps, etc.; switchboard, etc.; underground mains lamp-posts, etc.; accumulators, meters, crane, etc. Tenders by May 14. Details in our advertisement columns.

London, W.—The Central Electric Supply Company, Limited, invite tenders for the supply, delivery, and erection of two 1,200-i.h.p. Willans engines, each direct coupled to a three-phase H.T. generator; six three-phase H.T. motors, each direct coupled to a L.T. continuous-current generator; and switchboards and connections for above plant. Tenders by May 22. Details in our advertisement columns.

Mariupol.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Taganrog stating that tenders are invited by the Municipality of Mariupol not later than May 16 (29) for the construction and exploitation of an electric tramway and the installation of electric light in that town. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Barking. — The Urban District Council invite tenders as follows: (Contract No. 1) for the supply, construction, and erection of about 365 tons of cast iron and 235 tons of steel in an opening bridge over Barking Creek, 45ft. in clear opening, and to carry a double line of railway, together with two shore spans of 45ft. each, and the embanked approaches, and with all the electrical and other machinery and appliances incidental thereto and required for opening and closing the bridge by electrical power supplied from the generating station of the Council; (No. 2.) the construction of 73 chains of 3ft. 6in. gauge single-line railway (83lb. tramway rails) and 38 chains of double-line railway, with granite sett paving on concrete, electrical rail bonding, etc. Tenders before 12 noon on May 7.

Inverness.—The Highland Railway Company invite tenders for the Wick and Lybster light railway, extending from Wick Station, Highland Railway, to the village of Lybster, a distance of about 13½ miles, divided into two contracts—viz.: (No. 1, or Wick, contract) 7 miles, or thereby; and (No. 2, or Lybster, contract) 6½ miles, or thereby. Plans may be seen with and specifications and schedule of quantities obtained from Mr. William Roberts, the company's engineer-in-chief, Inverness, on payment of 10s. 6d. for each contract. An assistant engineer will meet intending tenderers at Wick on 27th inst., at 9 a.m., and accompany them over the route of the new line. Tenders, addressed to Mr. Wm. Gowenlock, secretary, Inverness, and marked on outside "Tender for Wick and Lybster Railway," will be received on or before May 8.

RESULTS OF TENDERS.

Rochdale.—Mr. Barton has placed his order for dynamos with Messrs. Holmes and Co., one of the makers specified in the contract.

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Bury St. Edmunds.—The tender of Messrs. Macfarlane to supply 20 single and six double pillars, at £87. 5s., exclusive of tail pieces, has been accepted.

Liverpool.—The City Council have accepted the tender of Messrs. Stern Bros., 57, Gracechurch-street, E.C., for the supply of tram and motor sternolines, at £23. 10s. per ton.

Salford.—The Electric Light Committee have confirmed the contract made by the Tramways Committee with Messrs. Russell and Co. for 500 steel tramway poles, subject to any slight modifications of the ornamental parts which might hereafter be decided upon.

Rainhill.—With reference to our note on these contracts in our last issue, we learn that Messrs. Lowdon Bros. have placed the order for engines for this installation with Messrs. Broweth, Lindley, and Co. (1899), Limited, Sandon Engine Works, Patricroft, Manchester.

Lowestoft.—The Council have received the following tenders: Messrs. T. O. Callender (No. 1) for cement-jointed pipes, 3in. laid with draw-wire, including additional excavation to standard trench, 1s. 7d per yard; (No. 2) the same, but the pipes to be Stanford jointed, 1s 10d. per yard (accepted).

Southend.—The tender of the Brush Electrical Engineering Company, of Loughborough, has been recommended for acceptance for the supply of 10 car bodies, to carry 43 passengers, at £235 each; two car bodies, to carry 67 passengers, at £315 each; and two car bodies, to carry 20 passengers, at £198 each.

BUSINESS NOTES.

LIGHTING AND GENERAL.

Coventry.—The mains are to be extended in Spon-street and Cox-street.

Leith.—It is proposed to light the coal hoists and cranes in the docks by electricity.

Bangor.—Mr. P. F. White has been appointed electrical engineer to the Corporation.

Colne.—The electrical engineer is preparing estimates for an electric generating station.

Morecambe.—Several new cables are to be laid to meet various applicants for electric light.

Salford.—One hundred arc lamps will be employed in the lighting of the new tramway routes.

Bristol.—Mr. K. O. Hale has been appointed draughtsman in the electrical engineer's department.

Taunton.—During the past quarter a total equivalent of 615 8-c.p. lamps has been connected to the mains.

Hanley.—Mr. J. M. Blair, from Messrs. Crompton and Co., Limited, has been appointed junior assistant engineer.

Walsall.—The total number of consumers supplied by the Electric Lighting Committee on March 31 last was 159.

Monmouth.—The Council are asking for a loan of over £20,000 in connection with their electric lighting and sewage scheme.

Great Harwood.—The Urban District Council will not offer any opposition to the Lancashire Electric Power Company's Bill.

Edinburgh.—During the past week applications have been made for 4,500 new lamps, or their equivalent, including 14 motors.

Willington Quay.—The Tyneside Electric Supply Company are asking the Council to support their Bill now before Parliament.

Barnstaple.—The Bill enabling the Corporation to supply electricity within the borough has been reported for second reading.

Castleton.—The District Council have decided not to take any steps in reference to the Lancashire Electric Power Company's Bill.

Southampton.—An application for additional lighting in Chandos-street is before the Highways and Lighting Sub-Committee.

Surbiton.—An agreement has been sealed authorising the Kingston Corporation to supply electricity to Westfield, Portsmouth-road.

Buxton.—The Electrical Engineer stated at last week's meeting of the Urban District Council that he expected to have the electric light ready for use in about a month.

Oban.—The Town Council have engaged Mr. Malcolm Sutherland, of London, to make an exhaustive report on the introduction of the electric light within the burgh.

Prism Globes.—We are informed that the Prism Globe Company, Limited, are supplying their globes and fittings for the incandescent street-lighting at Poplar and Darwen.

London Gazette.—The date fixed for hearing an application for debtor's discharge *re* W. P. O'Reilly, Edgware-road, N.W., is April 27, at 11 a.m., at Bankruptcy-buildings, Carey-street, W.C.

Cheadle.—The Board of Trade have issued an order empowering the Urban District Council of Cheadle and Gatley to supply electrical energy for public and private purposes within their district.

Bishop Auckland.—The Board of Trade have granted a provisional order to the Urban Electric Supply Company, Limited, for the supply of electricity in the urban district of Bishop Auckland.

Newport (Mon.).—The Corporation are making an issue of £300,000 3 per cent. redeemable stock at a minimum price of £97 per cent. for the purpose, *inter alia*, of electric lighting, tramways, etc.

Ashton-under-Lyne.—Owing to the increased demands for electricity, the Council are considering an extension of the works, probably as much current again being required as the plant can supply at present.

Babcock and Wilcox, Limited.—An extraordinary general meeting will be held on the 27th inst. to confirm the resolution passed at the meeting of the 10th inst., referred to by us in our issue of the 13th inst.

Heywood.—The Corporation have agreed that the electric light works should be erected in the new town's yard, and the refuse destructor at Botany Bay. A suggestion to combine the two schemes has been discussed, but found little favour.

Waterloo with Seaforth.—The offer of the National Telephone Company with reference to the proposal to lay pipes for underground telephone wires through the district, and to pay £60 per annum, has been accepted by the Urban District Council.

Preston.—The Guardians have agreed to the erection of a boiler-house, the provision of a heating apparatus, and the carrying out of works for the installation of electric light at Fulwood Workhouse, the whole of the work to be completed at a cost not exceeding £13 472.

Lowestoft.—Suggestions as to the electric lighting of the town hall, and also with regard to the introduction of free wiring, are before the Town Council. The Norwich Mutual Telephone Company have made an offer to establish a telephone exchange at Lowestoft.

New Company.—Ernest Hutton and Co., Limited, has been registered with a capital of £5,000 to carry on the business of electricians, electrical, mechanical, and general engineers and contractors, and manufacturers of and dealers in electrical apparatus of all kinds.

"English Illustrated Magazine."—The April number deserves all we said of the March issue. Some of the stories this time are of a Christmassy, gruesome, ghostly character, quite suitable to the present weather. The illustrations are up to the usual high standard of the publication.

Fire.—With regard to the fire which occurred at Messrs. W. T. Henley's telegraph works early on Saturday morning last, we learn that the damage is entirely confined to part of one of the mechanical indiarubber shops, is of small extent, and will cause no interruptions to the business.

Newcastle.—The Tyne Improvement Commissioners have received Messrs. Handcock and Dykes's report as to the lighting of the entire dock system of the Commissioners by electricity, the estimated cost being £5,972. The report has been referred to the engineer for his observations.

Aberdeen.—A remit has been made to the Gas and Electric Lighting Committee to procure a return as to the price charged by corporations who have put in electrical installations for lighting and motive power, also the system by which the charges are made, and the cost of production per unit.

St. Pancras.—The report of the Electricity Committee states that the net profit for last year amounted to £6 841. A general reduction in prices to consumers is recommended. During the nine years the electric supply has been in the hands of the Vestry a net profit of £34,980 has been made.

Greenock.—The Greenock Police Board on Wednesday remitted to the Sub-Committee on Electricity to confer with the water trust engineer on a suggestion to utilise water for power in connection with future extension to the electricity works, which are likely to be required for tramway traction.

Walsall.—According to the last report of the Electric Light Committee the total number of consumers supplied on March 31 last was 159. The total units generated at the station during the month of March was 38,249. The machinery had been run for 513 hours during the past month. The wages paid during the month amounted to £75.

Manchester.—We understand that, mostly on account of the extensive repairs which have been carried out during the past year, relaying mains, etc., the Electricity Committee will probably not be in a position to hand over much of the profits to the relief of the rates at the end of the year. Last year the amount so handed over was £10,000.

Bury St. Edmunds.—The Electric Lighting Committee have received a report from Mr. A. H. Roe stating that since the last meeting two more applications had been received for current, making an addition of 33 8-c.p. lamps. He thought there was little prospect of many consumers applying for current until the station was in working order.

Hebburn.—The Board of Trade having made a provisional electric lighting order, the Walker and Wallsend Gas Company have withdrawn Hebburn from their Bill. The Council will oppose the Bill of the Tyneside Electric Supply Company. They have also asked the Electrical Power Distribution Company to withdraw Hebburn from their Bill.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to—British Electric Traction Company, Limited, further issue of £150 000 5 per cent. perpetual debenture stock, and City of London Electric Lighting Company, Limited, further issue of 20,000 ordinary shares of £10 each, fully paid, Nos. 100,001 to 120,000. The committee have also ordered Edmundson's Electricity Corporation, Limited, £75,000 4½ per cent. first mortgage debenture stock to be quoted in the official list.

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Handsworth.—The District Council have decided not to consent to a provisional order being made giving the Midland Electric Supply Corporation power to supply electricity for the lighting of the district. The District Council intend taking this work in their own hands. Prof. Kennedy has already visited Handsworth, and will shortly report on the best means of supplying the district with the electric light.

Harrogate.—In consequence of applications for the supply of electric light from shopkeepers in Strawberry Dale-road, mains will be extended at a cost of £80. The tender of Messrs. J. and H. McLaren for supplying and erecting a platform round the 600-h.p. engine at the electric light station, amounting to £48, has been accepted. It has been decided to improve the illuminating power in the existing lamps on the station.

Appointments Vacant.—The Corporation of Brighton are prepared to receive applications for the position of resident electrical engineer.—The Tramways Committee of the Manchester Corporation invite applications for a foreman platelayer, a foreman pavior, and a yard foreman.—There is also wanted second assistant at the Corporation electricity works at York, a wireman, several pupils, etc. Full particulars of these vacancies will be found in our advertisement columns.

Coatbridge.—A letter from the House-to-House Electricity Company asking the Council to consider the extension of the lighting of the streets with electric light is before the Lighting Committee. The letter suggests incandescent in preference to arc lamps. The application of the National Telephone Company to erect telephone poles in Main-street eastward from Water-street to Coatbank-street, and also one behind the police station in Whifflet, has been refused.

Portsmouth.—On Thursday last week, the Town Council adopted the committee's recommendation to submit to counsel the letter of Messrs. Ashurst, Morris, Crisp, and Co. as to a suggested preliminary meeting before the arbitrator, and that, subject to his concurrence, a writ be applied for in order to obtain a decision of the Court upon the question raised by the tramway company, and to require possession of the tramways to be given to the Corporation without the omnibuses, carriages, hearses, etc.

Perth.—At a recent meeting of the Sanitary Committee it was stated that the question of whether or not a refuse destructor should be erected came up for consideration now, as in the preparation of the electric lighting station plans provision had been made for increasing the height of the chimney stalk, in order to make it available for use in connection with a destructor. After considerable discussion on the whole subject it was remitted to a committee to enquire into the cost of the present system of removal to the manure depôt, and the probable cost if a destructor were to be erected, and to report.

St. Andrews (Fifeshire).—In connection with the Wormit and Woodhaven electric light provisional order Mr. Robertson has recommended that the Board of Trade be asked to insert a clause providing that the Tayside Electric Company shall on opening any of the streets be bound to maintain them for one year from date of opening to the satisfaction of the district surveyor, failing whom of an inspector appointed by the Parish Council of Forgan. He also recommended the desirability of having as many of the wires as possible carried underground. The poles already put up were complained of as being large and clumsy, taking up a considerable portion of the footpath. Besides, the fear of the wires being blown down during a storm was great. The matter is now before the Road Maintenance Committee of the District Council.

Cardiff.—Messrs. Ferranti have commenced to make the alterations agreed upon in court in connection with the engine which they had supplied to the Corporation. It was suggested that an arrangement should be entered into with Messrs. Ferranti to do the work necessary to put the engine in thorough working order, in addition to what they were required to do under the agreement in court. Subsequently Messrs. Ferranti offered to increase the output from 300 kw. to 400 kw. by an alteration in the valve gear and other improvements, at a corresponding increase in the price. Mr. Burstall, the expert engaged by the Corporation in their law proceedings against Messrs. Ferranti, has been asked to inspect the engine and advise the committee on this proposal. The engine has been stopped since April 5, and it is not to resume working until it has been certified by Mr. Burstall as being in an efficient and satisfactory condition. The chief electrical engineer reported on Tuesday that for the year ending March 31 there had been an increase of 75 per cent. in the units of electricity used from the borough supply, and an increase of revenue of £1,500. Up to March, 1900, the total number of lamps fixed was 27,463, as compared with 21,782, the number at the close of March in 1899.

Southend.—The Council sat in private last night to discuss a report submitted by the Light Railways and Electric Lighting Committee referring to tenders for tramcars, referred to in another column, and containing the following minute: "Your committee have had under consideration the desirability of obtaining supplementary powers for the construction of light railways along additional routes, and your committee are of opinion that it is desirable that application should be made to the Light Railway Commissioners forthwith, otherwise an application cannot be made until November next. Your committee therefore recommend that it is desirable that application be made forthwith to the Light Railway Commissioners for the construction of light railways along the following additional routes: (1) from the Minerva Hotel, Marine-parade, to the Halfway House, Southchurch; (2) from the Middleton Hotel in a southerly direction to the end of High-street, thence down Pier-hill and along Marine-parade to the Minerva Hotel; (3) from the Cricketers' Inn, along Milton-road, thence down Scratton-road, Cambridge-road, Capel-terrace, Alexandra-street, joining the proposed line in High-street; (4) from North-road, opposite Prittlewell Vicarage, along West-road to the Plough Inn; (5) from Holy Trinity Church, Southchurch, along the main road to the Cambridge Hotel, Shoeburyness."

St. Annes.—At a recent meeting of the Electric Lighting Committee the clerk read a letter from the St. Annes Land Company declining to approve the plans of the electric lighting station, etc., on the land in St. Andrew's-road North, together with a suggestion from the Electric Lighting Sub-Committee that a deputation be again appointed to wait upon the directors of the company, and to make the best arrangements possible. It was thereupon resolved that the same deputation which had already had the matter in hand be now given full power to act as suggested. It was resolved that incandescent street lamps of 32 c.p. each be adopted. The sub-committee reported that they had considered two proposals for free wiring, but had postponed the discussion of the matter. They had also under consideration the adoption of an induced-draught plant in lieu of a chimney stack. The British Insulated Wire Company's quotation for bitumen, at 84s. per cwt., was accepted.

Londonderry.—The Corporation have received a lengthy report from Sir William Preece upon Mr. Macrory's revised estimate for the private electric lighting scheme, an extract of which appears in the *Londonderry Journal*. Sir William Preece said he observed from Mr. Macrory's revised estimate that the latter scheme made provision for a greater number of streets and mains than he (Sir William) had proposed, but he cordially agreed with its increased scope. Almost the whole of the additional cost of the revised scheme occurred apparently in connection with provision for the mains for which Mr. Macrory estimated £26,000. It appeared to him that that amount required some modification, and he believed £14,000 would cover the necessary cost for the added mains needed. Furthermore, it was not necessary to spend such a sum as Mr. Macrory had proposed for feeder cables, while an increase was suggested for buildings of from £13 000 to £17,000. After giving a number of details, technical and otherwise, in support of his calculations, it was seen that Sir Wm. Preece's estimate was £35,000 as compared with £42,000 sent in by Mr. Macrory. After discussion the Lighting Committee decided last week that the report be printed and circulated, and to recommend the Council to take steps to ascertain by plebiscite the feelings of the ratepayers as to continuing or abandoning private lighting by corporate trading.

Ayr.—The cattle market sub-station and the Prestwick-road extension have been completed. In view of the continued high price of coal, which now stands at double that paid for it last year, consideration of reduction in the price of current has been postponed. The minimum charge for small consumers will be made £1 per annum, payable by equal portions quarterly. With regard to Doonholm, the electrical engineer's report states: "Referring to the proposal to run our cables to this house, I find that it would require 2¼ miles of high-tension cable, which, together with the necessary excavating, laying, and making good of the roadway, would cost about £800. To ensure a reasonable profit on this, about 5,000 units would require to be consumed at 7d. per unit, and I would suggest that the minimum charge be fixed at £150. I would also suggest that the charge of 7d. per unit be reduced to 3d. per unit after the above-mentioned is consumed. Of course should others in the district be induced to take in the light, the above minimum charge would naturally fall to be reduced." The Lighting Committee have decided to adhere to their former resolution as to procuring a switchboard similar to that in use at Paisley. Mr. Sidney Price, chief assistant, having secured the appointment as engineer to the Pembroke Commissioners, Dublin, Mr. Fuller is about to enquire at Glasgow and Edinburgh in order to ascertain if a suitable assistant is available, the wage to be £3 per week. The question of procuring an engine to supply electric current at low pressure within the central area has been shelved.

Grimsby.—The following letter has been received by the town clerk from the Local Government Board: "Local Government Board, Whitehall, S.W., March 28, 1900. Sir,—I am directed by the Local Government Board to state that they have had under their consideration the report made by their inspector, Mr. Bicknell, after the enquiry held by him with reference to the application of the Town Council of Grimsby for sanction to the borrowing of the sum of £11,500 for purposes connected with the supply of electrical energy. The Board have decided to comply with the application so far as it relates to the borrowing of a sum of £5,066, and their formal sanction to a loan of that amount is forwarded to you herewith. From the information furnished by their inspector, it appears to the Board that if the existing tramways are altered so as to be made suitable for the employment of electric traction a very considerable outlay will be necessary. The Board will therefore defer giving further consideration to the part of the application relating to the provision of additional plant, which appears to be required almost entirely for the supply of energy to the tramways, until the Town Council have (1) either definitely decided to take over the tramways at the expiration of the existing lease, and to fit them properly for the employment of electric traction, or (2) have entered into an agreement with a company of good standing and accustomed to similar undertakings, to carry out all the necessary works of reconstruction, and to take the supply of electrical energy from the Corporation.—I am, Sir, your obedient servant, NOEL T. KERSHAW, Assistant Secretary."

Islington.—An ordinary meeting of the Vestry will be held on April 20. The agenda contains the following notices: Consideration of a report from the Electric Lighting Committee, stating

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that, pursuant to Vestry reference of the 16th inst., it has considered the letter from the clerk to the London County Council, dated March 9, 1900, intimating, in reply to the Vestry's letter of the 19th ult., in which it declined to accept the provisional sanctions of the Council to the borrowing of £10,000 and £38,000 respectively on account of the loans of £13,200 and £56,261, that the matter has been very carefully reconsidered by the Finance Committee of the Council, which is unable to take any further steps until the Vestry has supplied the details and information for which it has been asked, and that the committee is of opinion that the Council would not be performing the duty imposed upon them by Parliament if they sanctioned the borrowing by local authorities on estimates and opinions furnished by such authorities without being satisfied from the reports of their own officers that the amounts proposed to be borrowed are reasonable; and recommending that application be again made to the Council for their sanction to the borrowing by the Vestry of the sums of £13,200 and £56,261, and that they be requested to specifically state what further particulars they require. Further report from the same committee, stating that when the arc lamp in Caledonian-road opposite Wynford-road is extinguished at 12 30 a.m. the latter road is badly lighted, and an accident having recently occurred at that point, it is of opinion that additional lighting should be provided, and recommending that an arc lamp be erected a short distance along Wynford-road at an estimated cost of £100; also that additional transformers being required for the purpose of meeting the demand in the district now supplied, it recommends that 25 transformers be placed on order at an estimated cost of £4,125, such expenditure to be incurred when the sanction to the borrowing of the necessary funds has been received from the London County Council.

TRACTION.

Salford.—Sixty poles have been ordered for immediate delivery for the Trafford-road route.

Hastings.—The Corporation's Tramway Bill will shortly come before Parliament as an unopposed measure.

Southampton.—Mr. Neville Hinves has been appointed clerk of the works at the Portswood depôt, which has just been started.

Sligo.—The Corporation will be asked shortly to sanction a project to establish a light railway between Sligo and Rosses Point.

West Hartlepool.—The Corporation have agreed to purchase a piece of land which will enable the work of laying the electric tramways from West Hartlepool to Seaton Carew to be proceeded with.

Blackpool.—The new cars are to be smaller than those in use on the front, and they are intended to run round Marton, and to carry 60 persons. The fare has been fixed at 1d. for the whole distance.

Brighton.—Extensive alterations have been made to Volk's electric railway. The local Press is still occupied in criticising the rejection of the committee's report relating to the electrical engineer.

Horbury.—The Urban District Council have appointed a committee in connection with the proposed tramway between Wakefield and Horbury, which will shortly form the subject of a light railways enquiry.

Jarrow.—The Electrical Power Distribution Company have made arrangements with the Corporation for the introduction of an electrical supply at an early date in conjunction with a system of electrical trams.

Ramsgate.—The Corporation have appointed a committee for the purpose of inspecting the plans and going over the course proposed to be taken by the lines mentioned in the Isle of Thanet Light Railways (Extension) Order.

Southport and Lytham Tramways Bill.—According to Sir Courtenay Boyle's report, the opposition of Preston to this Bill is carrying considerable weight. The main part objected to appears to be the proposed conveyor bridge.

Musselburgh.—Several omissions in the draft of the provisional order of the new National Electric Traction Company, which is the old Drake and Gorham Electric Power (Pioneer) Syndicate under a new name, have now been rectified.

Bredbury.—Statutory notices appear in the local Press showing that an order has been made by the Board of Trade authorising the Urban District Council of Bredbury and Romiley to construct a tramway in their district and for other purposes.

Grimsby.—The Corporation have decided to oppose the tramway company's Bill, and have rescinded a former resolution referring to the continuation of negotiations with the company. They now appear to be bent on taking over the tramway company's undertaking in July next.

Ashton-under-Lyne.—The Corporation intend to enter into communication with the Manchester Corporation as to the terms they would be prepared to offer for running powers over the present route of the Manchester Tramway Company within the borough when the lines have been taken over by the Corporation.

Wimbledon.—At a recent meeting of the Wimbledon and Putney Commons Conservators it was reported that the London County Council having enquired whether the Conservators' opposition would be withdrawn if a system of traction which required no overhead wires were used, the Conservators had replied that they could not see their way to withdraw their opposition.

Morecambe.—At the last meeting of the Urban District Council it was stated that a letter had been received from the town clerk of Lancaster to the effect that the shareholders of the tramway company had refused the offer of the Corporation, and expressed the hope that the Morecambe Council concurred in the advisability of not proceeding at present with the negotiation.

Brierfield.—At the last District Council meeting it was stated, in regard to the proposed trams, that it was definitely decided that they would be electrically equipped. Whether it was to be overhead or conduit was practically left with Burnley. The negotiations had been abortive, but they would try to work as amicably as possible with Burnley and try to get cheap fares.

Twickenham.—The District Council have sealed an agreement with the London United Tramways Company, and have decided not to proceed further with their petition against the company's Bill, except to see that the agreement is made to form part of the Act promoted by the company, and the clerk has been authorised to support the Bill before Parliament should the company so desire.

Wolverhampton.—The Town Council have received a letter from the British Electric Traction Company offering to work in the borough the tramways purchased by the Corporation and to pay 6 per cent. on £30,000. They have, however, decided not to reopen negotiations with the company until the Corporation had completed the purchase of the portion of the Dudley and Wolverhampton tramway in the borough.

Blackburn.—A suggestion has been made by Sir William Coddington, M.P., that when next the Corporation obtain powers for further tramways extensions that the Guide district and Grimshaw Park may not be forgotten. It appears, however, that the Tramways Committee are already so deeply pledged in the tramway enterprise that they cannot even see their way at present to entertain the suggestion in any shape.

Manchester.—The balance-sheet of the Tramways Committee of the City Council shows that £22,555. 9s. 11d. (free of income tax) were received by the Corporation from the Manchester Carriage and Tramways Company during the past year for the rental of the tramlines. The capital expenditure required for the electric service during the current financial year for land, buildings, cars, lines, and preliminary expenses, is stated at £398,750.

Aberdeen.—The Town Council on the 16th inst. approved of a report of the Tramways Committee embodying the decision of the Parliamentary Committee with regard to the Corporation Tramways Bill. The committee found the preamble of the Bill proved, but disallowed tramway No. 4 so far as proposed to be laid on Market-street, Upper Quay, and Palmerston Quay, and fixed the commencement of the tramway at a point opposite Poynernook-road.

Greenock.—The town clerk has been instructed to intimate to the Greenock and Port Glasgow Tramway Company that the Greenock Police Board mean to acquire, in terms of Section 64 of the Greenock and Port Glasgow Tramways Act, 1887, that portion of their tramways situated within the burgh of Greenock. The Police Board have decided to proceed, with consent of the Board of Trade, as early as possible thereafter to reconstruct and electrically equip the whole lines within the burgh, with a view to the Police Board working or leasing the same, as may then be resolved upon.

Warwick.—The Town Council have adopted a report authorising the Council to enter into an agreement with the tramway company in connection with the overhead electric tramways. One of the clauses gives the Corporation the option of purchase at the end of seven years. At the last meeting of the Town Council an agreement was signed with the British Electric Traction Company extending the lease of the present tramways to the company another 25 years, with the option of purchase in seven years. As far as Warwick is concerned, there now remains only the consent of the Board of Trade to be obtained before a system of electric tramways may be established.

Dumbarton.—The County Council intend to oppose the Glasgow District Tramways Bill. At the last meeting it was stated that the Committee on Standing Orders of Parliament in the House of Lords had decided to allow the Glasgow District Tramways Bill to proceed so far as it referred to the burgh of Dumbarton. While the tramways were restricted to the burgh, there were clauses in the Bill authorising the construction in the county of a generating station at Milton and Balloch, while the company also sought power to lay and maintain pipes in the intervening roadways. That would confer a right to interfere with the county highways between the generating stations and the burgh, and the sub-committee of the Road Board on Bills resolved that unless these provisions were withdrawn the Bill should be opposed.

Birkenshaw.—An agreement has been signed by the Council conceding the British Electric Traction Company the right to come as far as the Half-Way House with their line, on condition that they did not oppose the Bradford Corporation's scheme, and that they paid all expenses incident to the agreement. It was originally the intention of the Traction Company to construct their line as far as the boundary at Tong, passing through both Birkenshaw and Hunsworth. Both these townships have strongly opposed the company, and at the same time looked with favour on the Corporation's scheme for the extension of the Tong-street line to the Half-Way House. By the arrangement which has eventually been come to the two tramways will have their termini at the Half-Way House, and there will be direct communication between Bradford and Dewsbury.

Huddersfield.—Mr. C. P. Trevelyan, M.P., has given notice that, on consideration by the House of Commons of the Huddersfield Corporation Tramways Bill, as amended by the Parliamentary Committee, he will move that it be recommended to the committee

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to consider and report as to the expediency of reinserting in the Bill the power to construct additional tramways to and in the borough of Brighouse, the urban districts of Mirfield, Marsden, Slaithwaite, Linthwaite, Lepton, Kirkburton, Honley, Thurstonland, New Mill, Netherthong, Holmfirth, and the parishes of Fixby, Clifton, and Hartshead, in the rural district of Halifax. The extension of the Corporation tramways from the top of Paddock to Quarmby Clough, Longwood, a distance of 1,200 yards, was inspected on Thursday last week by Colonel Yorke, R.E. The inspector expressed himself satisfied with the manner in which the lines had been laid. Colonel Yorke also examined the first portion of the tramway lines being laid by the Linthwaite Urban District Council through their township, on the Manchester-road from Huddersfield to Slaithwaite. The route so far completed covers a distance of about 1 mile 7 furlongs. The whole length has been leased for 45 years to the Huddersfield Corporation, in connection with whose system it will be worked. Colonel Yorke said he should report favourably upon the line. Application has been made to the Local Government Board for an inspection of the tramways to be made from Spring Mill to Bar Gate.

LEGAL INTELLIGENCE.

PORTSMOUTH TRAMWAYS.

Before Mr. Justice Ridley and Mr. Justice Darling, sitting as a divisional court in the Queen's Bench Division last week, **Mr. Balfour Browne, Q.C.**, moved for a rule *nisi* for a mandamus directed to two tramway companies, the Portsmouth Street Tramways Company and the Provincial Tramways Company, calling upon them to show cause why they should not give up possession of the tramways and undertakings belonging to them to the Corporation of Portsmouth. He thought the whole question turned on two sections of the Act of 1899. Section 8 was the first. It showed that "at any time within three years from the passing of the Act the Corporation may, by written notice addressed to the company under the hands of the town clerk, require them to sell to the Corporation, and the company shall thereupon become bound by virtue of this Act to sell and the Corporation purchase as a going concern, the undertaking authorised by the Act of 1863," so that the matter to be sold was there defined as that authorised by the Act of Parliament, and it was to be sold under the provisions of the Lands Clauses Act. That was much more favourable to the company than a purchase under Section 4 of the Tramways Act, and the land there meant was the undertaking authorised by the Act of 1863. The short point was this: these companies had, besides the tramways that the Corporation were seeking to purchase, established a business in hearses, funeral and wedding coaches, omnibuses and cabs, and various other things, and they insisted upon the Corporation purchasing not only the tramways but the funeral coaches, hearses, etc. The Corporation said they had no power to purchase them, and that the only obligation upon them was to purchase and the company to sell the tramway undertaking. It was true they might be legally carrying on these undertakings. They might be selling milk, but the only thing the Corporation were bound to purchase was the specific matter authorised by the Act.

Mr. Justice Ridley: Have they got power to do anything except run tramways?

Mr. Balfour Browne said none under the Act, but under their own articles of association had power to run these hearses and other things. But the Corporation were not purchasing the company, they were purchasing the undertaking authorised by the Act. If they were to purchase these omnibuses and things, they would have no power to run them. It was decided only the other day by Mr. Justice Cozens Hardy that the London County Council could not run omnibuses. Section 7 was important. It said at the same time that the Corporation gave notice requiring the company to sell the undertaking authorised by the Act of 1863, they should give notice in accordance with the provisions of Section 4 of the Tramways Act, 1870, to the Provincial Tramways Company. That was the other company. By Sub-section 4 it was enacted that the Corporation must purchase all the tramways, and not one only, to prevent them buying one and running it in competition with the others. Section 5 was the one he wanted to have enforced. It said: "Possession of the tramways and the undertaking referred to should be given to the Corporation immediately on the expiration of the said period of 12 months, and if on the date the purchase shall not have been completed and the purchase money paid, the Corporation shall pay interest on the purchase money from that date until the date of payment, at such a date as, failing agreement, shall be determined by an arbitrator." The 12 months' notice expired on Dec. 31 last, and, therefore, the Corporation under the section were entitled to possession of the tramways on that date. Arbitration as to their value had not taken place, but the Corporation were bound to pay interest as provided by the section. The companies had always refused to sell the tramways without these other matters, and the Corporation had always refused to take them. They had attempted to get before an arbitrator in order that he might express an opinion on the matter, and then state a case, but the tramways company objected. He did not think they improperly objected, but they objected because they said if it were done as an interlocutory proceeding there would be no appeal from their Lordships to the higher court. He believed that was so. They pointed out the other way was to bring the matter before the Court, as the Corporation were now doing. He therefore asked for a rule *nisi* calling upon the companies to show cause why they should not give up possession. The affidavits he had showed they had persistently refused, and he had a great number of cases to show that all the Corporation were authorised to purchase was the undertaking authorised by statute. Section 21 said the tramways authorised were tramways and other works, conveniences, etc., in connection therewith. Mr. Justice Cozens Hardy's decision showed that omnibuses were not works connected with tramways, even though they were used to connect two tramways, as he pointed out that anybody, whether they were going by tramway or not, would have the right to go by these 'buses, and therefore it was *ultra vires* for the Council to run them.

Mr. Justice Darling: How about the hearses? Are they more immediately connected with the business of a tramway company?

Mr. Balfour Browne replied that he did not think so. The tramway company must be very badly conducted if they were.

Mr. Justice Ridley: Do they contend you are bound to buy all their conveyances?

Mr. Balfour Browne: Yes, but these were not authorised by an Act of Parliament, but only by their articles of association.

Mr. Justice Ridley: We think there ought to be a rule.

The rule was granted accordingly.—*Hampshire Telegraph.*

PROVISIONAL PATENTS, 1900.

APRIL 7.

6499. An electric meter depending on the electrolysis of mercury. Robert Alfred Lehfeldt, 22, South Molton-street, London.

6526. Improvements in electric fire alarms. Adolphe Münker, 10, Friedrichstrasse, Berlin. (Complete specification.)

6528. Improvements in or relating to electrolytic apparatus. James Charles Richardson and Mark Whitwill, 19, Claremont-square, London.

6536. Improved capillary diaphragms for electrolytic apparatus. James Charles Richardson and Mark Whitwell, 19, Claremont square, London.

6533. Photomatic-telegraphy by electricity for transmitting pictorial particulars so as to reproduce from distant places facsimiles of direct portraitures automatically and speedily. Frederick Murray Browne and Richard Rowe, 3, Copthall-court, London.

6540. Improvements in or relating to electric railways with underground conductors. Montz Stein and Gustav Freund, 111, Hatton-garden, London. (Complete specification.)

6548. Improvements in brush-holders for dynamo machines or electric motors. Harry Bertram Whitmore, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6564. Improvements in reflectors for electric incandescence lamps. Rudolf Gaertner, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 9.

6615. Improvements in terminals and binding screws for electric batteries and connections. William Rowland Edwards, 65, Chancery-lane, London.

6621. Improvements relating to electrical switches. Julius Sax and Co., Limited, 45, Southampton-buildings, Chancery-lane, London. (Gustav Busch, Germany.)

6637. Improvements in relays. John Ambrose Fleming and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

6642. Telephonic device for imitating the sound of guns. Charles Frank Morris and William Henley, 16, Lambeth-road, London.

APRIL 10.

6649. An improved bracket or pendant for electric light and similar fittings. Joseph Thomas, 47, Arngask-road, Catford, Kent.

6650. Improvement in telephone switches. Charles Petitjean, 19, Lower Ford-street, Coventry.

6662. Improvements in telephone transmitters. Archibald Duncan Hunter, 45, Southampton-buildings, Chancery-lane, London.

6671. Machine for filling accumulator plates with active material. Edouard Franke, 32, Ampthill-square, London. (Complete specification.)

6675. Electrical key or stencil-board contact apparatus for telegraphic communication. Emil Baer, Seestrasse, 5, Dresden.

6684. Improvements in electric coherers. Eugene Dervin, 78, Fleet-street, London. (Complete specification.)

6686. Improved apparatus for forming a silence chamber for telephonic purposes and the like. James Dewar and Bernard Sherman, 21, Finsbury-pavement, London.

6693 Improvements in electric transformers. The British Thomson-Houston Company, Limited, 83 Cannon-street, London. (Walter S. Moody, United States.) (Complete specification.)

6701. Improvements in the process of electrolytically preparing metals or alloys for lithographic purposes. Otto Carl Strecker, 72, Cannon-street, London.

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6703. Improvements in electromagnetic light machines for regulating the sparking moment. Theodor Bergmann, 72, Cannon-street, London. (Complete specification.)

6727. Improvements in electric contacts. Julian Adolphe Halford, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6728. Improvements in electric contacts. Julian Adolphe Halford, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

6731. Combined telephone exchange and alarm systems. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Albert Goldstein and John Morris Latimer, United States.)

6748. A new or improved alternating-current electromotor. Frank Michael Lewis, Norfolk House, Norfolk-street, Strand, London.

6768. Improvements in the construction of vehicle or car wheels and in electric motors therefor. Charles Edmund Isbills, 6, Lord-street, Liverpool.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published May 5, 1900.

1899.

516. Telegraphic receiving and translating instruments. Muirhead.

7525. Telegraphic transmitting, receiving, and translating arrangements. Muirhead.

7918. Manufacture or production of bands and strips of copper and other metals by electrolysis on rotary mandrels. Heys. (Dumoulin).

9989. Governing of engines used for driving electric generators in electric distributing systems. Mavor.

10406. Wireless telegraphy. Miller.

11678. Electrolytic apparatuses for extracting metals lighter than the electrolyte. Thompson. (Becker.)

11985. Overhead conductors for electric tramways. Smith.

12165. Electric motors. Still.

12417. Supports for conductors for electric railways. Wynne.

12627. Manufacture of electric battery plates. Andreas.

17211. Holder for telephones. Wheatley. (Wohlgemuth.)

17319. Grips used in the laying of underground electrical cables. The Steel Nut and Joseph Hampton, Limited, and Hampton.

18132. Clocks, more particularly in electric winding mechanism therefor. Getby.

25446. Electric railway motors. British Thomson-Houston Company, Limited. (Priest.)

25447. Brakes for electric railway vehicles and the like. British Thomson-Houston Company, Limited. (Case.)

25448. Controllers of electric motors. British Thomson-Houston Company, Limited. (Case.)

25450. Systems of electric train control. British Thomson-Houston Company, Limited. (Potter.)

25751. Electric time switches. British Thomson-Houston Company, Limited. (Van Slyck.)

1900.

1464. Surface-contact electric railway systems. Murphy.

3371. Electric heaters and switches thereof. Porter.

4262. Electric batteries, and in the method of making electrodes therefor. Newton. (Knickerbocker Trust Company.)

4508. Electric signalling systems for railways. Garl.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Apl. 14	4 254	3,865	+ 389	59,768	57,176
Blackpool-Fleetwood	,, 14	488	222	+ 266	2,767	3,346
Bradford City Trams	,, 8	385	351	+ 34	541	—
BristolTramways Co.	,, 6	2,738	3 587	- 849	—	—
City & South London	,, 15	1,159	1,051	+ 108	18,477	16,265
Dover Tramways	,, 14	210	151	+ 59	2,239	2,261
DublinU.T., elec. cars	,, 13	3,934	940	+2,996	—	—
Dublin S.D. Electric	,, 13	1,167	645	+ 522	—	—
Halifax Corporation	,, 8	593	499	+ 94	— *a*	— *b*
Hull Corporat'n E.S.	,, 7	752	—	—	—	26,665 *c*
Liverpool Corporat'n	,, 7 *d*	7,178	7,035	+ 143	93,806	83,045
Liverpool Overhead	,, 15	1,351	1,404	- 53	20,805	20,103
Sheffield Corporation	,, 15	2,050	—	—	—	—
South Staffordshire	,, 13	670	614	+ 56	9,176	9,203

a Since April 1, 1899. *b* Since June 29, 1898. *d* Partly electrical. *c* Since July 5, 1899.

NOTE.—Other returns, received too late for classification, will be found amongst our "Business Notes."

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	..	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 6¼
—— 5 per cent. Mortgage Debentures	100	..	98-103
British Electric Works, Ordinary, 50,001-95,000	1	..	¾-1
—— 6 per cent. Cum. Pref., 1-50,000	1	..	¾-1
—— 4½ per cent. First Mortgage Debentures	108	..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	4¾-4¾
Brush Electrical Engineering, Ordinary	2	..	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	..	2¼-2⅝
—— 4½ per cent. Debenture Stock	100	..	108-113
—— 4½ per cent. 2nd Debenture Stock	100	..	103-105
Callender's Cable, Debentures.	100	..	113-116
—— Ordinary	5	..	14½-15½
—— 5 per cent. Pref.	5	..	5½-6
Crompton and Co.	5	..	3¾ 4
—— 5 per cent. Debentures	—	..	99-102
Edison and Swan United, Ordinary	2	..	2-2¼
—— 5 per cent. Debentures	5	..	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	..	92-96
Electric Construction	2	..	2¼-2⅜
—— 7 per cent. Cumulative Pref.	2	..	2⅜-2½
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	104-107
W. T. Henley's Telegraph Works, Ordinary	5	..	13½-14½
—— 4½ per cent. Preference	5	..	5½-5¾
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	..	100-103
Telegraph Construction and Maintenance	12	..	36-40
—— 5 per cent. Bonds	100	..	102-105
Telegraph Manufacturing, Ordinary	5	..	10-11
—— 5 per cent. Cum. Pref.	5	..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5	..	12-13
—— 6 per cent. Cum. Pref., 30,001-60,000	5	..	7¼-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-
Bournemouth and Poole, Ordinary	10	..	11½-12¾
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8 xd
—— 7 per cent. Preference	5	..	8¼-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	7-7½
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	..	5½-6
Chelsea Electricity Supply	5	..	6½-7½
—— 4½ per cent. Debentures	100	..	108-111
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9½-10½
—— 6 per cent. Cum. Pref.	10	..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	..	100-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4¾-5¼
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	10-10½
London Electric, Ordinary	2	..	1¾-2
—— 6 per cent. Pref.	5	..	4¾-4¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	12½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	..	93-98
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1-1⅛
—— £5 Shares	5	..	7-7¼
—— £4½ Shares, New	4½	..	6¼-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6¾-7
River Plate Electric Light and Traction, Deb.	100	..	78-85
Royal Electrical Company of Montreal	1½	..	170-190
—— 4½ per cent. First Shares Mortgage Debentures	100	..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2¼-2⅜
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	5	..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 40,081-52,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	8¼-9½
Westminster, Ordinary	5	..	15 16
Electric Railways.—			
Central London, Ordinary	10	..	10½-10¾
—— Pref. Half-Shares	5	..	4¾-5⅛
—— ,, ,, deferred	5	..	5-5⅛
City and South London, Consolidated Ordinary	100	..	67-70
—— Ordinary	10	..	6-7
—— 4 per cent. Debenture Stock	100	..	125-130
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	..	13½-13¾
Waterloo and City, Ordinary	100	..	101-104
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17-18
Brisbane Tramway	100	..	104-106
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10-10½
British Electric Traction, Ordinary, 1-30,000	10	..	17-18
—— 60,001-75,000	10	..	16½-17½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	12½-13½
—— 5 per cent. Perpetual Debenture Stock	100	..	126-127
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	..	4¾-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4¼
—— 5 per cent. Deb. Stock, Red.	100	..	105-108
Isle of Man Electric Power, 1-95,000	1	..	11/16-¾
—— 6 per cent. Preference, 100,001-170,000	1	..	¾-13/16
Kidderminster and District Lighting and Traction, Pref.	10	..	10-10½
New General Traction, Ordinary	5	..	3¾-4¼
—— 6 per cent. Cum. Pref.	5	..	5-5½
North Staffordshire Trams	6	..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	18-19
—— Preference	10	..	10¼-10
Potteries Electric Traction, Ordinary, 28,667-40,000	10	..	11½-12¾
—— 5 per cent. Cum. Pref., 1-20,000	10	..	10-11
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	½-¾
National Telephone, Ordinary	5	..	5-5½
—— 6 per cent. Cum. First Pref.	10	..	14-15
—— 6 per cent. Cum. Second Pref.	10	..	14-15
—— 5 per cent. Non. Cum. Third Pref.	5	..	5¼-5½
—— 3½ per cent. Deb. Stock, Red.	100	..	97-100
Oriental Telephone and Electric Company	1	..	¾-1

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NOTES.

Personal.—Mr. Carl Hering has been appointed to act as a member of the Paris Exhibition jury of awards in the class of electricity.

Institution Conversazione.—The secretary of the Institution of Electrical Engineers informs us that the annual conversazione will this year be held on Tuesday, June 26, in the Natural History Museum, South Kensington.

The Electric Express.—We are informed that the Liverpool to Manchester Electric Express Bill is to come before a Select Committee of the House of Commons on or about May 8. The chairman of the committee, which is composed of half a dozen members, will be Sir John Kennaway, Bart.

Tramway Bills.—We notice in the report of the Board of Trade on the Bills for 1900 that the Bills relating to tramways deposited for the session 1900 are 51, as compared with 37 for the session 1899. The Bills for 1900 involve a total capital of £12,014,255, as compared with £3,550,447 in 1899.

Moscow Tramways.—Considerable activity is shown in Moscow in consequence of the report which has just been issued by a municipal commission on tramways. The commission have decided to recommend to the Town Council to buy all the existing tramways in the town, and to transform same into electric lines. If that report is adopted, tenders for the work will be advertised for almost immediately.

French Motor Races.—The Paris-to-Bordeaux motor race, which for the past few years has been the motor event of the year in France, has received a check at the hands of the Prefect of the Seine-et-Oise province. This official is only the leader of a number of other objectors, and his example is expected to be followed all over the country. The objection is obviously to the excessive speeds attained in the race in previous years.

German Export of Electrical Machinery.—From the German trade returns for the first two months of the present year it appears that the total exports of electrical machinery during February considerably exceeded the corresponding exports for the preceding month, aggregating a weight of 632 tons, as against 358 tons in January. Great Britain absorbed 44 tons of this machinery in February, as compared with 28 tons in January.

The Pacific Cable.—The Bill recently passed by the United States Senate respecting the America Pacific cable has, we learn, now been dropped in favour of the Sherman Bill, which deals with the same subject. The great point of difference between the two Bills is that while the Senate Bill provided for the construction and working of the cable by the Government, the Sherman Bill only provides for the construction of the cable by private contract under the supervision of the Government.

Electrolytic Interrupter for Weak Currents.—An electrolytic interrupter for currents of low potential—for example, 24 volts—may be constructed, says Herr A. von Ryewuski in the *Elektrotechnische Zeitschrift*, by directing a diluted stream of acid from below through a suitably arranged glass tube up on to an inverted active electrode of platinum. In order that the acid may issue at the correct pressure, a head of about 3ft. should be allowed for a potential of 24 volts. With too great a pressure the interrupter would not act.

Rontgen Society. — The next ordinary general meeting of this society, to be held on May 3 at 20, Hanover-square, is to be a very sociable one. Smoking is to be permitted, and tea and coffee provided. The evening is to be given up to exhibitions, demonstrations being given by Prof. Barrett, Dr. D. Harris, Mr. C. Williams, and Mr. M. Davidson. Amongst the exhibits to be shown will be a portable 8in. spark coil with an improved break, a semi-portable 15in. spark coil, etc., skiagrams of animals, a jet mercury break, and a special Wimshurst machine.

Tramways in Mexico.—We understand that Sir W. Pearson, of Pearson and Son, the large contractors, is now at Vera Cruz, Mexico, making arrangements for the changing over of the local tramway system from horse power to electric traction. This firm, we are informed, has obtained the control of these tramways, and it will bring the whole system thoroughly up to date. We trust that the generating plant at least for these tramways may be supplied by English firms, and also the engineering materials required for the alterations to the permanent way.

Venice.—We are pleased to notice that the electric launches which have been placed on the canals of Venice are quickly coming into public favour. The steamers which have for some few years plied up and down the Grand Canal are losing their popularity in favour of the quicker and more comfortable electric boats. One of the great advantages of these launches over the steamers is that the latter cannot go in other canals than the Grand Canal, whereas, with their very small size and draught, the launches can run in all but the very smallest of the water highways.

Automobiles in War.—At a dinner of the Automobile Club on Saturday last, the Right Hon. J. H. A. MacDonald, commanding the Forth Brigade, read a paper on "War and Power Traction." In this he commended the use of a moderate-sized self-driven wagon, which dragged another behind it, for army transport trains. The motive power, he thought, would be best furnished by explosion engines worked with heavy oil. He deprecated the use of traction engines drawing long lines of wagons, for the reason that if one broke down a large number of trucks were stopped and great delay ensued.

Sweden.—We gather from a Swedish consular report that the importation of electrical machines is steadily growing, and that the Swedes are waking up to the fact that there is an enormous amount of cheap power to be obtained from the numerous burns and mountain streams in their country. There is now, we understand, about to be constructed an electric railway to Trollhaettan, and electric tramways to Gothenburg, Lund, Bjerroed, and Joenkoeping. The report states that electric motors are much preferred in the Swedish towns to those driven by benzine, which have a reputation for being noisy and for giving off bad-smelling gas.

Tramways in Newcastle.—It is interesting to note that on Thursday, April 19, the first rail of the new electric tramways was laid in Newcastle. There are to be 20 miles of double track, and horse traction will be entirely superseded. The state of the streets in Newcastle is, we think, an evidence of the intention of the Corporation to get the work through as soon as possible. The piles of rails in the streets may be rather inconvenient to passengers in Newcastle at the present time, but the reward for this inconvenience will come in the shape of a vastly improved means of getting from one part of the town to another. The estimated time for the completion of the works is, we understand, about 12 months.

Johannesburg Tramways.—In view of the evidence which has been brought before us in certain daily papers as to the enlightenment of the Boer population generally

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in the Transvaal, and of the liberality with which they have always treated immigrants, it is interesting to note the comments made by Consul-General Stowe in a report to the United States Government. He states that "in Johannesburg the Government have refused to grant concessions for the building of an electric line for the reason that farmers would lose the sale of forage (oats and straw). Even a bicycle is objected to for the same reason, and a heavy tax is placed on it." We trust that the new Government, when it takes office at Pretoria, will not have the same kindly feeling towards the providers of forage.

A Pilgrim Wire.—The Berlin *Tageblatt* recently published details which it had received from Constantinople of an important project on the part of the Ottoman Government. This project is the immediate construction of a telegraph line from Syria to Hedjaz, that portion of Arabia containing Mecca and Medina. The line is to follow the old route of the pilgrimages to Mahomet's shrine at Mecca. The reason for its construction is stated to be that the Turkish Government wish to have a means of communication free from British control, which is not now the case. The total length of the line is stated to be about 931 miles. We trust that the correspondent of the *Tageblatt* is really reliable, as the enterprise seems rather too much for the unspeakable Turk to undertake without foreign help.

Tramway Accidents.—Referring to our note of last week, we are glad to see that at the Liverpool County Court on the 23rd inst. an action for damages brought by the owner of a horse and cart against the Corporation in consequence of a collision with an electric tramcar resulted in a verdict for the defendants. The case for the plaintiff was that the electric car frightened the horse, and caused it to shy and back upon the tramlines. In the collision which resulted, both the horse and cart were injured. The evidence on the other side was to the effect that the tramcar was going at a moderate speed, and that it actually was stopped before the collision took place. In consequence of this the claim for damages fell through. We are glad to see that in this case electricity was not made to cover defective driving, as is too often the case.

Hull Tramways.—We notice in the local Press an order of the Board of Trade authorising the Corporation of Hull to construct tramways in the city. The order states that the tramways, of which the length is just over three miles of double track, must be entirely in the city. Clauses are inserted for the protection of the North-Eastern Railway Company, and also for ensuring the safety of the public and the non-obstruction of the streets. Provision is also made for the future alteration of the tramway with the Board of Trade's consent, and also for additional crossings. After stating that mechanical power shall not be used without the consent of the Board of Trade, the Board thereupon give their consent to the working of the tramways by electrical energy, which the promoters may supply in pursuance of the powers conferred upon them.

Anglo-German Telegraphs.—From the Frankfort correspondent of the *Financial News* we learn that the Frankfort Chamber of Commerce has been compelled to complain on behalf of the various merchants and others in that town to the postal authorities in Berlin, owing to the very inadequate and frequently-interrupted telegraph service. The authorities, it is stated, have informed the interested parties that measures will be immediately taken to improve the situation, but that for the present no radical remedy for the existing state of affairs can be looked for until further direct communication between the two cities has been established. We also gather that negotiations have been pending for some time between the German postal authorities and the London General Post Office, in connection with the laying of a new Anglo-German cable.

The German Emperor and Electrical Engineering.—During a recent visit to the workshops of the Allgemeine Elektricitäts-Gesellschaft, Berlin, the German Emperor showed himself greatly interested in the work of constructing the eight huge 4,000-h.p. alternators for the Berliner Elektricitätswerke which is now in progress. The diameter of these machines is about 33ft., and one of them is to be exhibited at the Paris Exhibition. The Royal visitor also inspected the pavilion which is to form the main exhibit of the Allgemeine Elektricitäts-Gesellschaft at the exhibition. A feature of this exhibit will be 1,000 Nernst lamps arranged to illuminate the roof of a high dome. The new method of lighting was much admired by the Emperor.

Telephone Wayleaves.—The authorities controlling the Duke of Bedford's estate in London have issued regulations as to the wayleaves to be charged by the lessees on the estate to the National Telephone Company. These new rates for wayleaves are said by the company to be so excessive that they will be compelled to discontinue the service. Roughly, the new wayleaves would, we are informed, amount to 50 per cent. of the revenue obtained by the subscribers. Upwards of 700 subscribers will be affected by the proposed action of the estate authorities if persisted in. The National Telephone Company have given notice to the Strand Board of Guardians that they will have to discontinue the telephone service unless the London County Council grant them rights to lay cables underground, but this Board does not propose to act as a catspaw in spite of the inconvenience entailed on its officers.

Nickel Electroplating.—The difficulty of obtaining a thick layer of adherent nickel by electroplating was discussed in a paper read by Mr. C. F. Burgess before the Chicago Electrical Association. In his paper he states that a peculiar molecular strain is set up within the nickel while being deposited, which reaches such a value when a certain thickness is reached that the layer will detach itself from the iron or other metal surface, or be easily removed by subsequent polishing. In the electrochemical laboratory at the University of Wisconsin, experiments have been made in depositing nickel from the ordinary plating solution and under the ordinary conditions, with the exception that an alternating current is passed through the vat in addition to the usual direct current. It was found that this had a marked influence on the character of the deposit, it being possible thus to obtain a coating as thick as desired.

Cross Contacts.—On Thursday afternoon last week an accident occurred at Leeds to a wireman of the National Telephone Company, due to a cross contact between a telephone wire and the overhead trolley wire. A new telephone wire was being run, which first came entangled with a tree growing at the side of the road, and in clearing it from this contact was made with the trolley wire, which was at 500 volts. One of the workmen was standing in the road with the end of the telephone wire in his hand. The shock he received was exceedingly severe, and he is said to have been unable to let go the wire, which was afterwards cut by another wireman. This class of accident is, of course, liable to happen when new wires are being run, particularly if the earthing guard wire is not over the trolley wire at that particular place. It would be well in such a case for the National Telephone Company to provide their wiremen with indiarubber gloves, as it is evidently impossible to entirely avoid such cross contacts.

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Obituary.—We regret to have to announce the death of Colonel Sir Francis A. Marindin, who had been for nearly a quarter of a century connected with the railway department of the Board of Trade. The late Colonel Marindin commenced his engineering experience with the Royal Engineers, and attained the rank of major before retiring. He afterwards for several years held the position of adjutant at the Chatham School of Military Engineering. He did most valuable work in connection with the Egyptian State Railways, for which he was made C.M.G. in 1887. Of late years the bulk of the electric tramways which have been constructed in Great Britain have been examined by Sir F. Marindin before they were allowed to be opened, and the engineers who have met him on these inspections speak highly of his courteous treatment and of the practical knowledge which he displayed, even when objecting to work which they had carried out.

Water Power in Russia.—From a German source we learn that an English company propose to carry out an important hydraulic scheme on the River Dnieper in Russia, to include the partial utilisation of the water power represented by the same which has hitherto run to waste. At the spot where the Dnieper branches off from a south-easterly to a south-westerly direction in order to discharge itself into the Black Sea, near Kherson, it passes a succession of rapids which have offered an obstruction to navigation since time immemorial. The English company in question now propose to render the waterway navigable by constructing locks at the spot. The necessary capital, amounting to 4¾ millions, will be found by the company, while the Government is to guarantee 3 per cent. interest on this sum. The company seek permission to utilise the power of the rapids for the generation of electricity over a period of 80 years, the Government, however, is to have the option of purchasing the undertaking at the end of 30 years.

The Westinghouse Company.—While the British Westinghouse Company is getting straight in its new offices in Norfolk-street, the parent company is now moving into large and extensive offices in East Pittsburgh. The large business done by the firm can be gathered from the fact that the space taken up by these new offices is 250ft. long and 50ft. deep, and the buildings have seven storeys. An interesting feature in the equipment of these offices is the pneumatic dispatch system, by which all correspondence, etc., can be distributed to the departments. From a view taken in the drawing office, which is reproduced by the *Electrical Review* of New York, we see that this most important department in an engineering works is in the daytime exceedingly well lighted. It is difficult, however, to see from the view how the electric lighting is effected, but there certainly are not individual lights to each draughtsman. In a large drawing office of this kind inverted arc lamps give, perhaps, the best results of any.

Paris Congresses.—The Organisation Committee of the International Congress of Electricians, which is to be held in Paris from Aug. 18 to 25, has deputed several of its members to draw up a programme of the questions to be submitted and discussed on that occasion. These members are divided into five sections—viz.: those dealing with scientific methods and measuring instruments; those who have to do with the production of electrical energy, transformers, electric transmission and distribution, and lighting and traction; those dealing with electro-chemistry, electro-metallurgy, accumulators, and electric forces generally; those connected with telegraphy, telephony, and similar applications of electricity; and, finally, those dealing with electro-physiology. The programme prepared by the gentlemen in these five sections is to be submitted to the parent committee by April 28, and we are given to understand that anyone wishing to communicate a paper should send in the subject by this date. This is, of course, in order to facilitate the formation of a definite programme.

St. Marylebone Lighting.—At the Vestry meeting of St. Marylebone last evening motions were brought forward respecting the opposition to the confirmation of the granting of the provisional order to the Marylebone Electric Supply Company, Limited. The first of these motions was to the effect that the solicitor be instructed to take the necessary steps to oppose in all its stages the confirmation Bill, while Dr. J. Fletcher Little brought forward a motion that all members of Parliament living in the district should be asked to aid the Vestry to oppose the Bill in question, which, he states, will gravely endanger the success of the consistent efforts of the Vestry to acquire powers for the supply of electricity in the parish of St. Marylebone. At the time of writing no news of the fate of these motions has reached us, but we trust that some practical suggestions were brought forward towards a settlement of the question of the purchase of the works of the Metropolitan Electric Supply Company within the district. Unless some such arrangement can be come to before the Bill in question is considered in Parliament, we are afraid that the opposition will not be much good.

Separate Running v. Grouping.—Contrary to American practice, which seldom allows anything smaller than motors of 5 h.p. for driving machine tools, says the *Elektrotechniker*, experience in Germany has shown that driving with small motors, despite their lower efficiency, may be more advantageous than driving with larger motors, since the latter, when employed to drive groups of machines have frequently to run almost light. The ideal system of running is, therefore, the separate motor system, by which each machine is run independently, and light loads thereby avoided. But the introduction of this system depends to a great extent upon the initial cost of installation. The greater the perfection attained in the standardisation of motors, in which direction rapid strides are being made in Germany, the more reliable will, therefore, be the motors, and the greater the field for their employment. Particular success has been obtained with alternate-current motors of 2 h.p. without commutator, brushes, or regulating resistance. The increasing knowledge of the value of quick running is also favourable to the adoption of the separate system of running.

An Electrically-Driven Centrifugal Pump.—The *Schweizerische Bauzeitung* contained recently an interesting description of a large centrifugal pump driven direct by means of two-phase asynchronous motors of 1,000 h.p. The pump has been installed to supplement the existing piston pumps in the waterworks at Coulouvrenier, near Geneva, and is not only interesting on account of its size, but also on account of the considerable height—460ft.—to which it is required to lift the water. The necessary pressure is obtained by a simple tandem arrangement of two centrifugal vanes. Injectors are employed to fill the pumps, which are started up with closed valves. In starting, the motor has, therefore, the friction of the water only to overcome. When the normal speed of 600 revolutions per minute has been attained, the valve is slowly opened, and the lifting commences. In this manner the motor is gradually loaded. The pump delivers 5,000 gallons per minute, which corresponds to a useful output of 700 h.p. Current for driving the motor is obtained from the power station in Chèvres. In conclusion, it may be mentioned that the pump was constructed by Messrs. Sulzer Bros., of Winterthur.

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Brussels-Antwerp Railway.—A group of Belgian banks has been negotiating for some time with the Belgian Government with a view to obtaining concessions for the construction of an electric railway from Brussels to Antwerp. It is reported that the Ministers concerned have now given their consent to the scheme. One terminus of the proposed railway is to be situated in the Place Verte, in Antwerp; the line will then cross the Ruple by a viaduct, whence it will proceed in a practically straight line to Brussels after passing under the Willbroeck Canal. The length of the line would thus be about 28 miles, which distance is to be traversed in 35 minutes, while the present service of trains requires from 50 to 60 minutes to accomplish the journey. The material required for the permanent way is to be supplied by Belgian firms, while the electrical equipment of the line will be carried out by the Union Elektricitäts-Gesellschaft, Berlin, though the conditions of the contract permit of the car motors only being manufactured in Berlin. However, according to the information to hand, the carrying out of the undertaking does not seem to be yet assured, since jealousy on the part of the Imperial Railways naturally makes itself felt.

The 1,000 Miles Motorcar Tour.—We have on various occasions mentioned the route, etc., of this tour, of which the first day's journey took place on Monday last. Between 70 and 80 cars started on that day from Hyde Park, many eminent persons taking part in the trip. The first day's trip was to Bristol, the distance being 118 miles, during which run only one breakdown was recorded. The cars were on exhibition at Bristol on Tuesday, and on Wednesday a run to Birmingham was made, the distance being 92 miles. It is interesting to note that once outside Bristol the county chief constable kindly provided a cycle-mounted policeman as pacemaker to the cars, so that they should not go more than 12 miles per hour, this speed being reckoned by the constable. Yesterday the cars were on show at Birmingham, and on to-day Manchester will be the destination, the usual exhibition following on Saturday. A remarkable feature of the trip is the comparatively few accidents and mishaps which have occurred. While referring to motorcars, we would mention that the editor of the Vienna *Extrablatt*, wishing to visit the Paris Exhibition, has accomplished the 900 odd miles between the two capitals on a 9-h.p. motorcar, covering the distance in 10 days.

Electric Railways in Japan.—The Tokyo City Railway Company holds a concession from the City Council for the equipment electrically of some 200 miles of line. The engineers of the company have gone most carefully into the matter, the whole work being under the charge of the chief engineer, Mr. Farichi Kain. This gentleman has made a number of trips to the United States, in order to get information, and has also obtained estimates, but we understand that no actual orders have been given up to the present, so that there may yet be time for English manufacturing firms to quote. The total capital of the company is stated by the *Electrical Review* of New York to be about £1,500,000. The following are approximately the expenditures contemplated out of the same: For track materials, including rails, £350,000; 600 electric cars, £214,000; a power-house, with machinery of 600 h.p., £150,000; eight transforming sub-stations, £100,000; the feeders and distributing conductors will cost about £200,000. The expenditure on building, alterations to permanent way, etc., will increase the expenditure by about £400,000. The generating plant proposed to be used by the chief engineer consists of 30 water-tube boilers and five 1,200-h.p. triple-expansion engines. These will be coupled direct to five three-phase dynamos generating at 3,500 volts. We understand that in order to build these lines, serious alterations will have to be made in a number of streets in this most important town in Japan.

Thermo-Electric Generation.—For a large number of years it has been the aim of physicists and expert electrical engineers to discover some means of obtaining electricity direct from coal. There have during recent years been some more or less successful attempts to obtain electrical energy from carbon cells, but no one up to the present time has succeeded in devising any such cell which is at all practical. It is a question even if the energy obtained in these cells which have been devised is not due to the difference of temperature at the contacts. Mr. C. Libenow recently read before the Electrical Engineering Society of Berlin a paper on the possible efficiency of thermo-electric couples, which is most interesting to read as giving the possibilities in that direction. He estimates from the laws of Clausius and Carnot that if a difference of 980deg. C. could be maintained between the two junctions of the thermo-electric couple, an efficiency of about 77deg. is theoretically possible. This, however, is only on short-circuit, and the author finds that with the most economical case only about 28 or 29 per cent. of the energy would be realisable. This figure even could not be approached in practice, but Mr. Liebenow considers that even if an efficiency of 15 per cent. be obtained the plant would have a great advantage over the usual means of using the heat to generate steam, which drives a steam-engine, which drives a dynamo. Theoretically, the paper is of the greatest interest, and we wish we could chronicle the fact that some progress was being made in the solution of this problem from a commercial point of view.

Electric Fuses.—In a paper read before the American Institution of Electrical Engineers, Mr. J. Sachs dealt with the history of electrical fuses from the earliest period of their use. Mr. Sachs gave in this paper some necessary features for a protective device, the first of which was that it must have a definite, unchangeable, maximum continuous current-carrying capacity; and secondly, a constant, definite energy overload capacity, depending inversely on the overload and adjusted with the allowance of a reasonable safety factor for the apparatus to be used, or, in other words, its safety factor should be less than that of the circuit it protects. The fuse also must not be able to destroy its surroundings when it does give way. According to Mr. Sachs, if copper had not such a high melting point, it would be the ideal metal for fuses, lead and tin alloys requiring a large body of metal. Zinc and aluminium were, however, favourably looked upon. The author then described some experiments made with solid packed and enclosed fuses. In these fuses a small indicating wire of high resistance was shunted round the fuse wire and fastened to the exterior of the case containing the enclosed fuse. Great accuracy of rating was claimed for fuses of this type. The author said that it was possible to obtain safe and accurate fuses having a rating of 0·01 ampere which would blow after 15 seconds of 0·02 ampere. The conclusion to which he arrived was that perfection had not been reached, but that the principles which were set forth formed good foundations, and that similar devices constructed on the lines indicated could be built capable of accomplishing results hitherto impossible.

Electricity in the Philippines.—We notice in the *Western Electrician* an article from an electrician in the Philippine Islands, which gives information as to the prospects, etc., of electricity in that place. There has, he states, been for some months past a great demand for all kinds of electrical apparatus in the cities and towns on the islands. The brisk demand is probably due to the placing of

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American garrisons in the towns, and the efforts made by them to improve the condition of things. We gather that there are no electrical workshops at all in the country, and that metal-working shops are the only substitutes to be found. As sugar machinery and knife blades appear to be the principal articles repaired and manufactured, fine electrical work would, we are afraid, fare but badly when left in such hands. As a natural consequence of this, all machinery and tools for electrical work must be imported, and, of course, the bulk of this machinery comes from the U.S.A. Our correspondent, therefore, warns electrical machinists who are thinking of going into business in the Philippines to take a complete stock of machinery. Owing to the low wages paid to the native workers, we are informed that probably an electrical establishment could be run at a good profit if native labour were employed. The buildings also could be erected at a very low comparative cost. The power plant would have to be steam, as water power is so far not developed at all. In the future, however, some of the small rivers, which are numerous in the islands, may be pressed into this service. The fuel used would be easily obtainable from the large forests which are to be found on the islands. Finally, the correspondent states that at present the chief demand is for electric railways to connect up the important centres.

Electric Traction on French Railways.—In consequence of an order of the Minister of Public Works for France, we gather from *L'Industrie Electrique*, a commission has been formed to investigate the various questions which attend the application of electric traction to the great networks of railways now constructed. The commission consists of the president, Mr. Berthelot, who is a deputy of the French House of Parliament, and 24 members, these consisting of, amongst others, practically all the chief railway engineers in France. There are also three secretaries to the commission. The work of the commission has been divided into three sub-commissions. The first of these will deal with the attempts made to introduce electric traction. The questions this committee will have to answer are: what trials have been made or are projected on the French railways; are these trials sufficient; are they similar to those made in other countries; in what sense do these trials encourage others to use electric traction? The second sub-commission has for its work the revision of the agreements and rules governing the railways. The questions in this case will be whether the agreements which bind the railway companies are of a nature to promote and encourage the development of electric traction, and if not, what modifications or additions should be introduced in the system of charging and in the working rules. The third sub-commission is to investigate the utilisation of hydraulic power as a motive force, and to say if there is any reason for modifying or adding to the legislation affecting the management of watercourses, from the point of view of the railway companies. Also what provisional measures should be taken, pending the drawing up of new laws, to reserve for the railways the necessary water power available in different districts.

An Electric Brake.—The Helios Company, of Cologne, have recently introduced an electric brake on the tramcars in use at Landesberg, which contains some new features. The brake, which is fastened on to one of the axles of the car, consists of a six-pole electromagnet. These poles are mounted on a common yoke, and are concentric to the axis. The brake disc is securely fastened to the framework of the truck, but is kept concentric to the axis by means of a journal. Opposite the six poles of this electromagnet is an armature disc of iron, which revolves with the car axle. The novelty in the arrangement of the armature consists in a couple of levers worked by centrifugal force, which cause the disc to revolve through a small angle round the axle. A key in this disc engages in a spiral groove on a collar clamped to the shaft, so that the angular motion of the disc corresponds to a slight movement horizontally along the axle. The action of the arrangement is thus as follows: When the electric brake is to be applied, the motor on the car, acting as a dynamo, is switched on to the coils of the electromagnet. The car is then running at a fairly high speed, and the weighted levers, flying out by centrifugal force, move the armature away from the magnets, and interpose a large air-gap. The braking effort caused by the eddy currents is thus reduced to a reasonable amount. As the speed of the car, and consequently the E.M.F. generated by the motor, decreases, the armature automatically moves in nearer the magnets, so that the air-gap resistance is decreased and the braking effort maintained. Finally, when the speed gets exceedingly low, the magnet poles come into contact with the armature and act as a mechanical brake. This mechanical braking action, however, only lasts for an exceedingly small time, so that there is not an undue wear on the poles. The idea of varying the braking effort by altering the air-gap is a good one, and we trust that this electric brake will prove of commercial use after extended trial.

"Trade and Industry."—The birthday number of the above-mentioned monthly review has reached us. This special number is issued in honour of the fourth anniversary of the paper, and its contents chiefly deal with the town of Manchester, in which it is published. The history given of Manchester and of its public works and public men is worthy of preservation, both as a record of what has been done in the past and as a statement of the large new works now being undertaken. The tramway article by Mr. W. H. Taylor is of special interest at the present time, when the Bill for the extension of the tramway system is still before Parliament. These extensions, however, which Parliament is now asked to authorise lie wholly in areas outside the borough boundaries, so that one cannot be sure that Parliament will give its consent to their being constructed by the Manchester Corporation. The author states that the estimated expenditure now contemplated is some £860,000, but it is probable that the ultimate outlay will reach £1,500,000 owing to the additional car-sheds which are required and to the purchase of certain tramlines owned by the Manchester Carriage Company. The map which he gives of the proposed tramway system in Manchester shows the county borough of Salford as a blank. It will be remembered that in Salford an independent system is being constructed, there being sufficient difference between the two systems to prevent intercommunication. This is another instance of the common fault in municipal tramways—*i.e.*, that different municipal authorities will not work together for their mutual good. In a review of the engineering undertakings in Manchester, our contemporary gives a considerable section to electrical engineering, placing first the firm of Mather and Platt, who have by their Edison-Hopkinson type of dynamo laid the foundations of dynamo construction throughout the world. A number of other smaller firms are also mentioned, as are the cable works of the well-known firm of W. T. Glover and Co. The Westinghouse Electric Company, of the United States, are now establishing themselves in works in Trafford Park, so that Manchester will soon add another large electrical manufacturing firm to its ratepayers. The rest of this issue of *Trade and Industry* contains notices of various individual machines manufactured in the Manchester district, which are clearly illustrated and well described.

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THE CORPS OF ELECTRICAL ENGINEERS.

When it was first suggested that a contingent of the above corps should go out to South Africa, there was a certain amount of talk among electrical engineers in general as to what good a corps of this description could be in active warfare. We are able herewith to present our readers with a few photographs, taken both of the plant and of the contingent of the above corps which sailed for South Africa on March 16.

As the equipment was being assembled and the contingent got into working order, it became evident to everyone that saw the plant that the uses to which a corps of this description could be put were endless. A vast amount of ingenuity has been put into detail in connection with this corps, and when it is borne in mind that hitherto a searchlight for cross-country purposes consisted of an ordinary Admiralty pattern searchlight mounted on a wagon, it will be appreciated that a plant designed on the lines shown in the accompanying photographs is a great step forward. The first contingent, under the command of Captain Lloyd, R.E, took with it two complete equipments of searchlight trains—*i.e.*, four wagons, two traction engines, each traction engine being fitted with its own dynamo, and four searchlights and limbers. In addition to these, a spare dynamo, 24 arc lamps with portable lanterns, and 200 incandescent lamps were taken out. A number of cycles, about 20 in all, of which six were fitted with special cable-laying drums, went out to work in connection with the field telephones, and to help to keep the communications.

On April 14 Major Crompton himself, with a second contingent of about 10 men, sailed for South Africa, taking with them a third traction engine. This engine will in all probability join the first contingent, although Major Crompton himself has received instructions from the War Office to proceed, independently of his corps, to confer with Field-Marshal Lord Roberts on the subject of transports generally in South Africa, as well as on the question of electricity in the field.

We are given to understand that Major Crompton has submitted a scheme to the War Office for working the transport service of an entire division of the army, and that in connection with this he has been instructed to confer with Lord Roberts. The general principles of this scheme have been very favourably received by the War Office, and we may confidently expect that both Major Crompton and his corps of 75 men and officers will return home, after they have done their work, a credit both to their country and profession. Major Crompton is well known to everyone as one of the first all-round engineers in this country. To electrical engineers his name is a household one, but it must be remembered that in addition to this Major Crompton spent nine years in experimenting on road traction for the Indian Government long before electrical work occupied his attention, and it is this experience which will place him in a very happy position in any schemes he may take in connection with transport problems. It will be apparent from these illustrations that some of the uses to which a plant of this description can be put are as follows : (1) the traction engine, with its dynamo, can generate current either for the searchlights, arc and incandescent lamps, and motors; (2) the traction engine can be made use of for ordinary transport purposes; (3) the spare dynamo can be used as a motor, and, being light, can easily be placed in positions in which it would be difficult to use any other form of power, and in connection with some form of winch it can pull up guns or ammunition; (4) the searchlights can be made use of for signalling, reconnoitring, or defence purposes; (5) the arc and incandescent lamps will be found useful for lighting up camps or depôts, or for facilitating nightwork, such as building bridges; (6) the bicycles will be most useful for carrying messages and keeping the communications; (7) the telephones, the wire for which can be laid by means of the bicycles at the rate of from eight to fifteen miles per hour, will be most useful for keeping up communication.

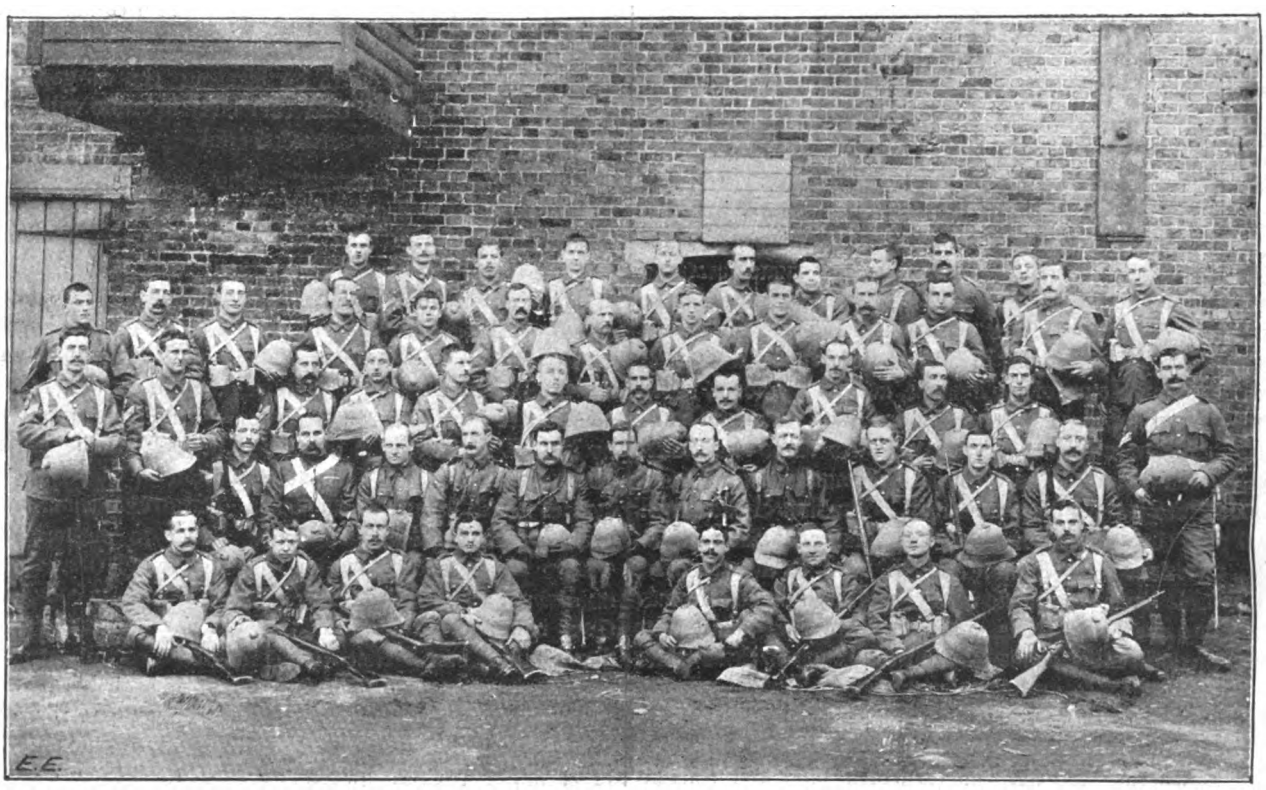

FIG. 1.—Group of the Members of the Electrical Engineers Volunteers Corps who sailed for South Africa on March 16th.

Fig. 1 represents a group of the contingent which sailed for South Africa on March 16, in which a number of familiar faces will be recognised.

Traction Engines.—Fig. 2 is an illustration of the traction engine, with dynamo mounted on it, which was taken out. It will be seen from the illustration that a roof has been provided, and from the top waterproof blinds can be let down to totally cover in the engine. The engines were designed by Messrs. Burrell, of Thetford, to indicate 18 h.p., and to weigh about eight to nine tons gross. Satisfactory results were obtained as regards the fuel consumption, it being found that between 6cwt. and 8cwt. of coal per eight hours' day was the average burnt when travelling, the exact amount depending, of course, largely upon the condition of the roads. When used for

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stationary purposes, about 32lb. of water were consumed per electrical horse-power developed per hour, whilst, when travelling, the engine could go about six miles with the water carried on the locomotive. It was anticipated that the water consumption would be somewhat reduced as soon as the sappers got used to the engines, and, in addition, the third engine has been fitted with partial condensation which will help considerably towards economising the water. To enable the engine to work for prolonged periods without rewatering and recoaling, a wagon has been given up per engine to carry exclusively water and coal. The engines were built to draw a load of 12 tons each. The single-crank compound type of engine has been adopted, the two cylinders being arranged one above the other, with the two piston rods working on a single cross-head, to the centre of which the connecting rod is attached. The dynamo is clearly shown mounted on the front of the engine in Fig. 2, and was belt-driven off one of the engine pulleys. The multipolar semi-enclosed type of Messrs. Laurence-Scott and Bruce Peebles type was adopted,

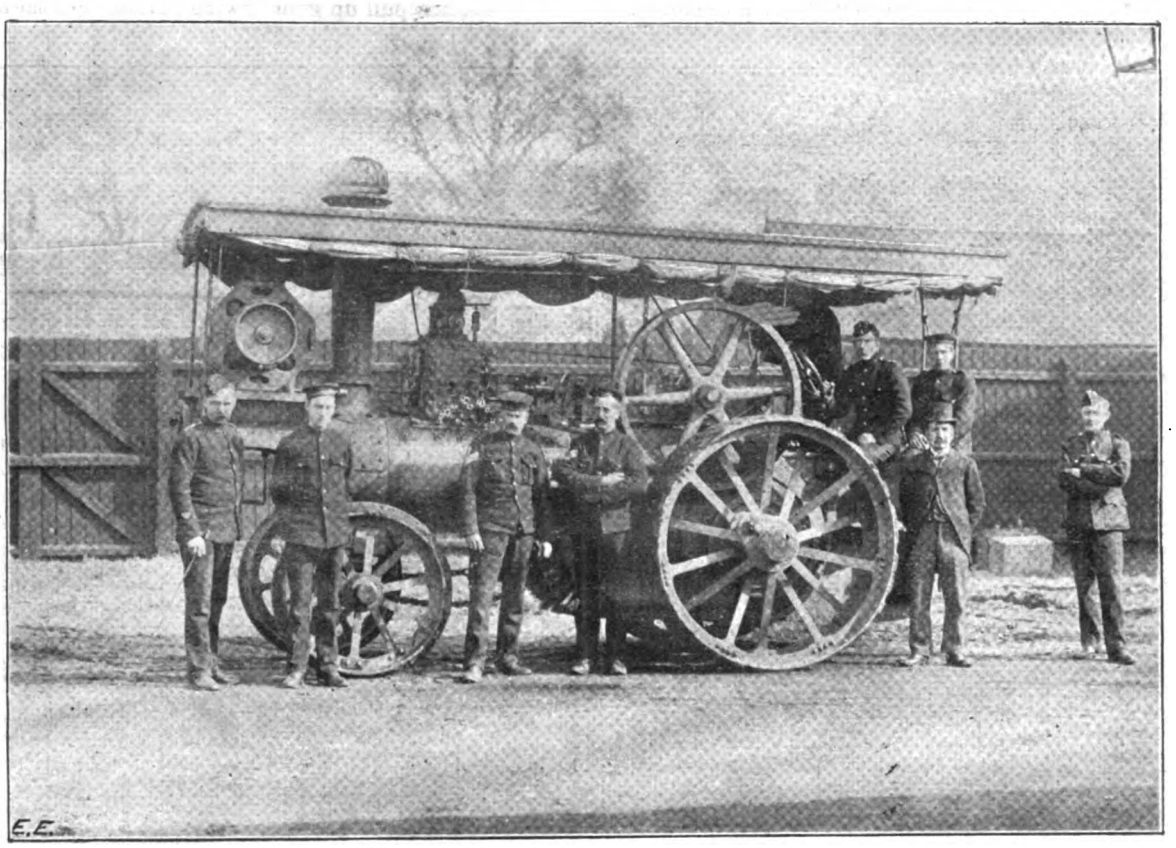

FIG. 2.—View of the Burrell Traction Engine, showing Dynamo in Position.

designed for an output of 110 volts, 80 to 100 amperes, 750 revolutions per minute. Eighty volts has hitherto been the most usual voltage for searchlight purposes, but by increasing the pressure in the present case to 110 volts, two arc lamps can be run in series, and it was anticipated that this would be a matter of considerable convenience. The jolting transmitted to the dynamos was found to be very severe at first, and consequently special spring arrangements had to be fitted to the front of the engine, which did away to a large extent with the shaking when travelling.

Searchlight.—In Fig. 3 is shown the searchlight fixed on its trail and complete with its own limber. Captain Lloyd, R.E., who took command of the first contingent, is also shown in this photograph. In Fig. 4 is shown the same searchlight fixed on its limber, with the officers in charge of the corps. Fig. 5 shows the details of the special steel trail for carrying the searchlight. A great many details have had to be worked out in connection with the searchlights. A searchlight suitable for cross-country work has never been designed before, and those illustrated here seem specially suitable for the work. The gunmetal bases of the searchlights revolve on ball-run turntables, and a degree circle is fixed in the centre, with a movable pointer, which enables the beams of light from a number of searchlights to be got into line with the least trouble. The wheels on which these trails are mounted are standard wheels from the Royal Arsenal, which ensures their all being interchangeable. The trails themselves are mounted on springs, but are otherwise similar to gun carriages. The searchlights can be detached from their trails, and, if required, can be used as stationary projectors on the ground. It has been found advisable to mount the mirrors, glasses, and divergers in aluminium, in order to lighten the designs as much as possible. The reflectors are manufactured under Cole's patent, and are of deposited copper faced with silver, with a thin coat of palladium to prevent tarnishing. The divergers are manufactured by Chance Bros. The searchlight lamps have had to be entirely remodelled, as it was thought that the pattern service lamp was far too heavy and clumsy, and at the same time unsuited to withstand the vibration that must be encountered on the road.

The new mechanism in the lamp locks the movable carbon-holder in position after the arc has struck, the feeding movement being controlled by a shunt coil acting on the other carbon. A drop in volts of 52 can be allowed between the traction engine and the searchlight, which enables the engine to be distant a mile or two from the searchlight if necessary. The elevating motion of the searchlight is worked by a worm, whilst the horizontal motion, which is used largely for signalling purposes, has to be worked quickly, and is, therefore, done by hand, the turntable being fixed when required by a lock-nut in the centre. It is of some importance to get the vertical motion accurate, whilst this is of small importance in the case of the horizontal motion. Draghooks are fixed at the end of the axle, and by means of these the searchlights can be hauled along by hand. The searchlight trail is fitted with a powerful screw brake, which is worked from the back when travelling. On to the trail is attached an ammeter, voltmeter, and main switch, and these can be placed either in front or on the back, and can be changed about if found necessary. The searchlight trails have been manufactured by Messrs. Thornycroft, while their design and the manufacture of the searchlights and lamps have been carried out by Messrs. Crompton and Co.

Limbers.—One of these is clearly shown on the left in Fig. 3. They are intended for carrying the parts required

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for the searchlight in the way of mirrors, glasses, etc. They are made of wood, lined with steel, the underframes being built up of angle iron. To stand rough usage they are mounted on springs, with the axles, and wheels interchangeable with those of the projector trail. The pole is so arranged that they can be drawn either by mules or traction engine, whilst for draught by hand ropes are used.

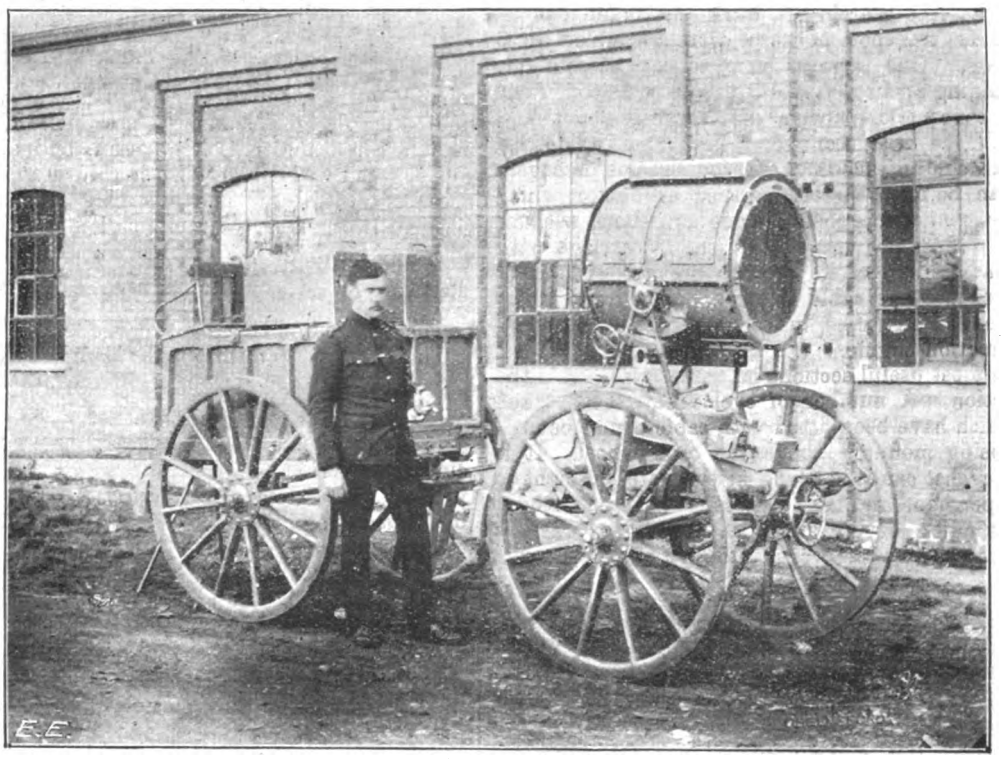

FIG. 3.—Searchlight with Limber.

To the back of the limber is attached the searchlight trail by means of a French pin. The inside of the box is lined with felt and divided into partitions, and a hinged door gives access to it. The shelves are arranged to accommodate two projector lamps, two mounted mirrors, one plain glass and one diverger. The necessary carbons, tools, drag ropes, ammeter, and voltmeter are carried in the box underneath the seat. The driver's seat accommodates two persons, and from it a screw brake is worked. A small box, containing the necessary variable resistance, will be seen on the top of the limber, and this resist ance can be removed and used on the ground, or it can be worked in the position shown in photo, if preferred. After the ordinary coils of resistance which one is used to seeing in connection with work of this description, the

FIG. 4.—Searchlight with Officers.

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present form is far superior, and is not likely to give trouble from short-circuiting when the wire heats and expands. It consists in small lengths of solid wire, rigidly supported between asbestos clamps. It is mechanical, and takes up little room. The limbers were made by the Gloucester Wagon Company.

The cable for the searchlight work was taken out on drums, which, for transport purposes, were assembled three on each carriage. One carriage went to each searchlight, each drum holding about 200 yards. The cable taken out was chiefly concentric, capable of carrying about 100 amperes, with the outer conductor bare and braided to prevent its unwinding should a section become damaged. All fittings can be fixed on the earthed conductor, which will facilitate connections being made on them without fear of shock. Each drum, mounted on its carriage with two others, has a brake of its own to prevent unwinding at will. After use the cable is rewound by hand. The drum carriages can be pulled in either direction either by hand or by traction engine.

One of the most useful sections of this equipment is the telephone section. A number of cycles have been taken out, six of which have been fitted with cable drums behind, the drums being mounted above the back wheel. It is found that a cyclist can ride along at the rate of eight to fifteen miles per hour, and lay the wire behind him without any fear of kinking or breaking. A very light brake is fitted on these drums to prevent the wire over-running.

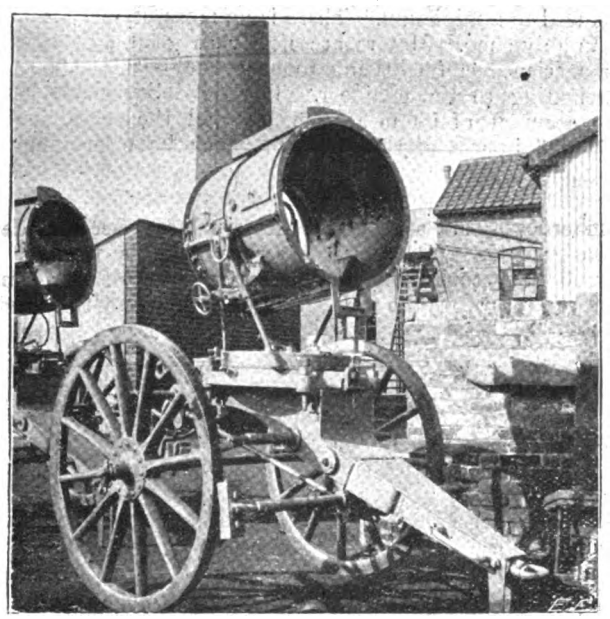

FIG. 5.—Searchlight showing Special Steel Trail.

Each of these drums hold about two miles of bare copper wire. After use the wire is wound up by hand; the cyclist wheels his bicycle with one hand, and with the other winds the drum by means of a detachable handle, the wire being led over the handle bar by means of a guide. The wire can be picked up at the rate of about four miles per hour. It is found that with a bare copper wire of this description, and using the earth as the return circuit, one can speak for three to four miles with the wire trodden into wet ground, and even with a broken wire.

The telephones themselves are of the Swedish cavalry pattern, and can be used either for speaking purposes, or, by using the "buzzer," through a high resistance or leaky circuit for signalling by the Morse code. The telephones are arranged with a third terminal, coupled up through a condenser, and this will enable an enemy's wire to be tapped without in any way interrupting the conversation. By the same means a commander can make contact with his own wire and hear the orders being given by his subordinates. By being able to provide speaking communication between two fixed points at the rate of 15 miles per hour, considerable advantage may be derived, whilst the remaining bicycles are likely to be of use in the way of carrying messages, etc.

THE RELATIONS BETWEEN ELECTRICITY AND ENGINEERING.*

BY SIR WILLIAM HENRY PREECE, K.C.B., F.R.S.,
PAST-PRESIDENT INST.C.E.

The nineteenth century is distinguished in our profession chiefly by the knowledge we have obtained of the constitution of matter and of the qualities of the materials we utilise for the service of man, of the presence and characteristics of that medium—the æther—which fills all space, and of the existence, indestructibility, and protean character of that great natural source of force, motion, work, and power which we call energy. Electricity is only one of many forms of this energy. It is measurable in well-defined and accurately-determined units. It is produced and sold, utilised and wasted. It is, therefore, something distinctly objective. It has even been defined by Act of Parliament.

There are four great principles underlying the practical applications of electricity: (I.) the establishment of a magnetic field; (II.) the establishment of an electric field; (III.) the disturbance or undulation of the æther; (IV.) the work done by the generation and maintenance of electric currrents in material systems. It will smooth our journey over somewhat difficult ground if I commence by illustrating these principles with some elementary experiments.

1. *The Deflection of a Needle.*—A small magnet like that freely pivoted in the mariner's compass is always forced into a position at right angles to a conductor maintaining an electric current. I am using energy from coal burnt in the electricity works in Millbank-street. It is brought into this building through conducting mains laid in pipes under the streets in its electrical form, and you see how its presence affects the needle. An electric current is not like currents of air, of water, or of gas. They are due to the flow of liquid or gas, and each current is confined to the interior of the pipe conveying the material. The so-called electric current affects not only the conductor that directs it but all the surrounding space, including any matter that it contains, and especially the æther that fills it. You have here evidence of the existence of a magnetic field—a field of force, of strain, and of motion. In fact, a condition of matter and the æther, and not a form of matter.

2. I take a portion of this conductor and wind it around a bar of soft iron. When the current is turned on, the iron is impressed with magnetism. We have made an electromagnet. Some of the energy of the electric current is transformed into its magnetic form, and we have powerful evidence of direction and stress—in fact, a magnified magnetic field.

3. We thus get attraction, repulsion, and we are able to produce rotation and to strike great blows.

4. I take two coils of insulated wire, one of which I superimpose upon the other. I send intermittent electric currents through the one and insert a telephone in the other. A loud sound is emitted by the telephone, which gradually dies away as I remove the coils away from each other. The sound is restored in its loudness as I approach the coils together again. Here we have evidence of ætheric disturbance. The electrical energy in the primary coil is transferred by waves through the æther and converted again into electric energy in the secondary coil, appealing in its sonorous form to our consciousness through the ears.

5. This ætheric disturbance is also the accompaniment of sparks in air. The sudden rupture of an air-gap, the conversion of the air into a conductor, its immediate restoration to an insulator again, give sudden periodic undulations to the æther, which, owing to its inertia, set waves in motion that extend to unknown distances. There is nothing but the air and the æther between me and that clock; yet I can control the movements of the clock by producing these sparks.

6. When I direct an electric current through acidulated water, the current breaks up the water into its constituent

* The "James Forrest" Lecture, delivered before the Institution of Civil Engineers.

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elements, oxygen and hydrogen; and if I insert a bar of white aluminium into a bath of blue sulphate of copper it is coated with a thin layer of brown copper. The electrical energy does work upon the water and upon the copper solution, and we have ocular demonstration of the mechanical operations effected.

7. The work done by an electric current upon matter is still further shown by this platinum wire, which I can first make hot, then incandesce to redness, and finally fuse into drops with the evolution of brilliant white light.

We thus perceive that electricity is purely mechanical in its effects. It requires matter to render it evident to the senses. Its transference is characterised by motion, chiefly undulatory when we consider the æther, but partaking of the most known forms when considering conductors and insulators. It is, therefore, essentially a dynamical agent in the hands of the engineer to carry out his duties.

The Application of Force.—Electricity enables the engineer to direct energy to great distances, and there to apply force at his will. Force is that which produces, or tends to produce, motion. It is the function of the engineer to utilise this motion. An electric current is by no means so simple a phenomenon as its name implies. The term itself is a survival of exploded doctrines. It is not alone the conductor that has to be considered but the whole circuit, especially its insulating portion, or dielectric, and the surrounding medium—the æther. The earth also frequently plays a very important and essential part. Moreover, the energy takes both the electric and magnetic forms, and one or other is dominant whenever the current is rising or falling or persistent. The rise and fall of lines of electric force produce a magnetic field and *vice versâ*, the rise and fall of lines of magnetic force produce an electric field. In my experiments I converted this theatre into an electric and magnetic field, and if you possessed an electric sense you would have been conscious of unwonted disturbances. An electric field is that portion of space which is characterised by the presence of lines of electric force; a magnetic field by lines of magnetic force. Each line indicates the direction of stress, and the number of lines passing through unit area (one square inch or centimetre) the intensity of the stress. Matter through which they pass is in a state of strain; in conductors they produce currents; dielectrics are displaced electrostatically; magnetic substances, iron, nickel, and cobalt, are polarised electromagnetically. The motion produced is molecular motion—rotation, revolution, or oscillation. Lord Kelvin has very recently shown that an electrified body is set into rotation in one direction if positively excited, and in the other direction if negatively excited by the generation of a magnetic field around it, and that it will remain in rotation in virtue of its inertia during the existence of the field. When the current is alternating, it is always either rising or falling and changing its direction. The behaviour of alternating is more complicated than that of continuous currents, but each are subject to well-known conditions and to simple mathematical treatment. Each has its own particular sphere of usefulness. Some of the energy is wasted in the form of heat in the conductor, in the dielectric, and in the iron; some in the neighbouring conducting mains, and some is conveyed away—dissipated in limitless space. The ratio of the useful energy to that which is generated is known as the efficiency of the system. The steam-engine utilises only 15 per cent. of the energy of the coal, the gas-engine utilises 25 per cent. of the same energy, a turbine can utilise 80 per cent. of the energy of falling water, but the efficiency of a dynamo has reached the high figure of 98 per cent. Alternating currents differ in their frequency. Those generated at Niagara pass through each cycle 25 times per second. The favourite frequency in the United Kingdom is 50, but many installations in the United States reach as high as 130. These frequencies in closed circuits can, however, be increased to millions per second in open circuits. In fact, Maxwell proved the identity of electricity and light by showing that they moved through the æther with the same velocity—196,400 miles per second—and in the same undulatory fashion. If the alternations could be generated with a frequency of 50 billions of waves per second we should see electric waves as light rays. Electric waves and light waves differ only in their length. Hertz detected and measured these electric waves. Attempts have been made to utilise them, but so far not with much practical success. Whenever a conductor is forced through a fixed magnetic field so as to cut transversely the lines of force of that field an E.M.F. is set up in that conductor which varies with the length of the conductor, the number of lines cut by it, and the rate at which they are cut. This is the principle of the dynamo. Work is done upon the conductor in moving it against the resistance of the field. Energy is thus transformed from its mechanical to its electrical form. At Niagara 5,000 h.p. are converted by one machine into electric currents of 1,500 amperes driven by 2,200 volts. If a conductor itself be free to move, and a magnetic field be projected through it while it is maintaining a current, it is forced into motion, and it becomes a rotating machine or motor. The electric energy of the current is transformed into its mechanical form. Its torque, or turning moment, depends upon the intensity of the magnetic field, on the length of the conductor, and on the strength of the current. This reversibility of the dynamo is of immense commercial value. Maxwell said it was the greatest invention of the century. Tramcars in our streets, trains on our railways, tools in our shops, and mills in our factories are thus worked by electricity. Dynamos and motors are subject to laws and conditions so thoroughly well known that exactness is assured and waste reduced to a minimum. There is no more perfect machine than a dynamo. Motors are nearly as good. Electricity as a science is fascinating to everyone, but it is deeply fascinating to the engineer. The reliability of its laws, the accuracy of its measurements, and the completeness and definiteness of the units to which its measurements are referred give him confidence in his estimates and a certainty of the performance of his preconcerted operations. It places in his hands the means of directing the energy out of sight in positions known only to himself, and of applying it with great efficiency at the exact spot desired. No magician or poet ever conceived so potent a power within the easy reach of man.

The Doing of Work.—The maintenance of an electric current through a conductor means the expenditure of work upon that conductor, and this expenditure of internal work means molecular motion. In solid conductors the result is heat. If the current be gradually increased, this motion is similarly increased. The result is successively incandescence, white heat, fusion, and disruption. In liquid conductors the motion probably becomes revolution. The result is decomposition by the activity of the centrifugal force overcoming chemical affinity. The atoms fly away in fixed determined lines, and collect at opposite poles. In gases the transference of electric energy in the form of sparks means dissociation. Compound gases are broken up into their component elements under the same directing influences. Work is done upon the gas as in the previous instances. Joule established the law of the relations of current and heat upon a definite and accurate basis. Faraday developed the laws of electro-chemistry with equal exactitude. Prof. J. J. Thomson has determined the action of currents on gases. The principle of work that lies at the very root of the profession of the engineer enables all these operations to be measured in definite mechanical units, reducible to the common English standard, the foot-pound, but which the electrical engineer, with greater precision, refers to the scientific unit of work—the joule.

The Purification of Matter.—The elements and their useful compounds are rarely, if ever, found pure. Impurities have to be sifted away. Ores, raw produce, rocks, and earths have to be subjected to various processes of refining and conversion to extract from them that which is wanted. The electric current by the above operations has proved to be a powerful agent to break up crude materials into their useful and useless constituents. The electro-chemical industries of the world are very extensive. According to Prof. Borchers, the eminent electro-metallurgist, the world manufacture of calcium carbide for the production of acetylene gas is utilising a power equal to 180,000 h.p.; that of

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the alkalies and the combinations of chlorine for bleaching, 56,000 h.p.; of aluminium, 27,000 h.p.; of copper, 11,000 h.p.; of carborundum, 2,600 h.p.; and of gold, 455 h.p. Electroplating is one of the staple manufactures of Sheffield and of Birmingham. There are nearly 200 firms working at the former place, and over 100 at the latter. The decomposing bath and the arc furnace are revolutionising many industries. Phosphorus is now being produced in England in large quantities from corundum, and aluminium from bauxite is extending in use and being reduced in price. The Post Office is using aluminium for telephone circuits. I have recommended its use on a very large scale in the interior of Africa, where transport is so costly. We can get the same conductivity as with copper with half the weight, and at a less price, and we can put up a line telegraphically 10 times better than of iron for less money.

The Annihilation of Space.—The elements of Volta and the battery of Galvani—zinc, copper, and a solution of sulphuric acid—gave a convenient generator of electric currents which could be directed along wires to great distances, and thus, by establishing magnetic fields, could deflect needles in such a way as to form the alphabet and so transmit words and, therefore, thought. In wires of great length, while the initial speed is that of light, it takes time for the electric waves to rise and fall, so that the number of currents which can be sent per second is limited. Between London and Liverpool the speed of speaking is virtually unlimited, but between Ireland and America it is restricted by the so-called capacity of the cable submerged in the ocean. This capacity absorbs energy and retards the rate of rise and fall of currents. While a thousand currents per second can be sent in the former case, only six per second are available in the latter. Nevertheless, sitting on the shore of the Atlantic in Ireland, one can manipulate a magnetic field in Newfoundland so as to record simultaneously on paper in conventional characters slowly-written words. Thus we have bridged the ocean and annihilated space. We do this on a smaller scale in our own domestic circles, when we press a button and ring a bell in our servants' quarters. The sound of a bell and the drop of an indicator is a message, "You are wanted in the drawing-room." When the button is supplemented by the telephone, as it is in so many houses now, you can speak your message, "We want coals," and thus the servant is saved two journeys, and you have gained some time. Telegraphy is thus established in our homes. It becomes part of our daily life, not only in our domestic circles, but in our urban requirements and in our business relations. Not only is speech reproduced, but handwriting also. Town is connected with town and nation with nation. London and Paris, Paris and Berlin, Berlin and Vienna, speak to each other with clearness and distinctness in ordinary language. The scattered British empire is linked together. London and New Zealand are in communication with each other. All the world is joined in one unbroken whole, and we read on our breakfast-tables every morning the events of history made yesterday and the present condition of our friends in every quarter of the world. The regulation of the ever-growing traffic on our railways and the safety of passengers is secured by similar means. The telegraph not only places the manager of the line in communication with every station upon his system, but electric signals control the motion of every train. Trains are kept apart by a considerable space. Collision would be impossible were the human will infallible; but the world is made up very much of fools and temporary maniacs. We all do at times what we ought not to do. The annual return of violent deaths is an interesting document. When in England alone 138 persons choke themselves at their own tables, and 765 die by falling downstairs, we must not condemn the railway signalman, who is responsible for the death of only 58 in 1898. A railway signal-box is an electrical exhibition. Every line is protected by its own electric signal. Every distant outdoor mechanical signal is repeated back. The danger signal is locked, and cannot be lowered to "line clear" until it is unlocked by the train itself or by the distant signalman. Mr. F. W. Webb (member of council) is not only working the outdoor signals themselves by electrical energy, but he is moving the points and switches by the same means. So far the experience gained at Crewe during a period of about 12 months, from the working of a signal cabin containing about 60 levers, has been such as to justify confidence and the extension of the system, and some 10 cabins containing about 1,000 levers will be provided. The apparatus has been designed to work in with, as far as possible, the standard signalling apparatus of the London and North-Western Railway. The interlocking frame may be said to be the ordinary mechanical frame in miniature, occupying one-third of the space. The levers—about 6in. in length—are placed in two tiers, and are manipulated in the same way as the levers of a mechanical frame, consequently the signalman accustomed to the old type has nothing to learn in the new. The levers are mechanically locked by means of tappet locking, and they control carbon switches by which the 110-volt electric current is transmitted to the motors. The object of this electric working is primarily to reduce the manual labour of the signalman and enable him to pay more attention to the movements outside his cabin; increased speed of working; the removal of obstructions on the ground caused by the numerous wire and rod connections necessitated by the present system; and, finally, a reduction in the number of signalmen employed. Thus electricity adds to the security of life. It supplies the railway man with a new sense and the engineer with a new power. The abridgment of time necessarily follows from the annihilation of space, but the chief element which saves our time so much is the fact that we can, by electricity, do so much more from one spot. Indeed, in the United States the railway companies complained that their revenue between New York and Chicago suffered through the introduction of the telephone. People remained at home and did their business by wire. It is very curious when visiting the United States to find that their morning papers contain extracts from our London evening papers of the same day. One frequently receives messages in England that were sent off to-morrow. This is due to the difference of longitude. Wireless telegraphy, or, as it is better termed, setheric telegraphy, has made but small progress, owing to the simple fact that the demands for its services are so very few. There is no commercial business in it. The fascination of electricity and the sensation of breaking down space by apparent magical means, have led to much gratuitous advertisement on the part of the Press. I wrote in 1888: "The influence which electric currents exert on neighbouring wires extends to enormous distances, and communications between trains and ships in motion, between armies inside and outside besieged cities, between islands and the mainland, has become possible without the aid of wires at all by the induction which is exerted through space itself." The Post Office has for 16 years been developing this system. Several extensions are now in hand.

Transmission of Power.—The property that an electric current possesses of converting its environment into a magnetic field, and the fact that the projection of a magnetic field through a conductor induces an electric current in that conductor, are prolific of many valuable instruments by which we transform energy into different intensities, and thus economise the cost of its transmission. The pressure that drives the energy through a circuit is called the voltage, the electrical form which this energy takes is sometimes called the amperage, and the resistance which the conducting part of the circuit offers to this flow of energy may be called the ohmage. There are other conditions that lead to waste, but these three conditions effect utility. The amperage by Ohm's law depends simply on the voltage and the ohmage, and the product of the amperage and the voltage, by Joule's law, gives the wattage, or the rate of expending energy, usually called power. The higher the voltage the smaller the amperage, and hence the less the weight of copper needed. The present practical limit of voltage along aerial conductors appears to be 40,000 volts. Beyond this pressure the dielectric strength of air breaks down. Higher voltages are practical in insulated mains, but their expense is a ban to their use. It is not considered advisable to construct dynamos giving higher voltages

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than 2,500 volts, although in many cases 5,000 volts are produced; but these high voltages are easily and safely converted by transformers to any other higher pressures. If I be an iron case made up of the thinnest and softest procurable iron sheet, and it be surrounded first by a primary wire maintaining the alternating currents at 5,000 volts; then if S be a secondary wire, having eight times the number of turns around the iron core that the primary wire has, then the voltage in the secondary circuit will be about 40,000 volts, setting up alternating currents of the same frequency, but of one-eighth the amperage. It would be exactly one-eighth if there were no waste of energy; but there is waste in the iron, the copper, and the air. Still, the efficiency is very high, and frequently reaches 90 per cent. Energy is also transformed in its continuous form by rotary converters, but in this case the process is usually the reverse. Direct continuous currents of 100 amperes and 3,000 volts are reduced to 500 volts by acting as motors to rotate generators, giving 600 amperes, for, say, tramway working. Again, at Tivoli, 18 miles from Rome, the energy of the falling water there is transmitted to Rome in the form of alternating currents at 6,000 volts, and is there converted by rotary transformers into direct currents at lower voltages for battery, traction, and motive purposes. The sun is the *fons et origo* of all the available energy upon the surface of the earth. Coal and oil are extracted from its crust; oxygen is found in its atmosphere. Grasses, corn, fruits, and vegetables become food and fuel for beast and man. Waters are converted into vapour, forming clouds, rain, brooks, rivers, torrents, and falls. The atmosphere is disturbed by wind, and the waters of the ocean by tides. Energy is thus found available for useful work in many different forms. The problem before the engineer is how to select the best form of energy for his purpose, and how to utilise these waste energies of nature so as to secure the best economical result. Falling water can, by a turbine or impulse wheel, convert the energy it possesses in virtue of its fall into the form of electricity. By the aid of transformers it can be raised to very high voltages; 40,000 volts is employed in California, 11,000 in Niagara. We use 10,000 between Deptford and Trafalgar-square. It can thus be transmitted to any reasonable distance, and there it can be utilised to do useful work. The waste forces of nature are thus within our reach. The waterfalls of the Highlands may work the tramways of Glasgow; Niagara already works those of Baltimore. The economy of this system for large industries is a question of the relative cost of the generation of energy by other means. Energy on the coalfields can be produced cheaper by burning coal than by any water scheme that I have yet examined in this country. The price and abundance of coal renders the transmission of energy to great distances at present a very limited question indeed. Where coal is scarce and dear and water abundant, as in Switzerland, water power is very much utilised. Where coal is abundant and cheap, as in England, it is uneconomical to adopt it. The transmission of power within limited areas by electricity in our cities, is now within the range of practice. In Edinburgh it is supplied at the rate of 1¼d. per unit; this is 0·83d. per horse-power hour. It is is invaluable for small industries. It is there ready to be used when it is wanted; it wastes nothing while idle. The economy and efficiency of distributing power over mills, factories, and workshops by electricity instead of by shafting, gearing, and belts, is so pronounced that the change is being effected in every country with great rapidity. If it were a question of the mere efficiency of the two systems, the advantage of the change would not be so obvious; but it is shown by the horse-power hours expended, which means the coal bill. The efficiency of an electrical system is rarely less than 75 per cent., while that of shafting is frequently as low as 25 per cent.; but the economy is the continuous waste of the latter that tells on the coal bill, while in the electrical system there is no such waste. The motor runs when it is wanted, and expends only what energy is wanted for the particular work to be done. Electrical measurements are so exact and so easily applied that automatic records can be obtained of the work done by each machine. Every up-to-date shop should have its electric plant for healthy light, cheap power, and handy distribution of material. Its economy is demonstrable in the smallest, but in the largest shops it is at once most marked. It is always available and it costs little. Ignorance or timidity restricts its use very much. The number of works that are run by electric motors in different parts of the country is very large indeed. The efficiency, handiness, and economy of doing so is so marked that the practice is extending with great rapidity. Motors themselves are being daily improved. We underrate very much the progress made in the United Kingdom in different industries, owing to the secretiveness of the British manufacturer. He will not report what he is doing in the Press, and the Press leaves him severely alone. Electricity as an economiser, by increasing the speed of output and by reducing waste, is as much at the disposal of the British as of the American manufacturer. But John Bull clings with affectionate and conservative fervour to the capital expended by his grandfather, while Uncle Sam does not hesitate to chuck obsolete plant on the scrap heap, if, by doing so, he can increase his business. Progress in the States is also not so seriously checked by trades unionism as it is here. I am told that the Bricklayers' Union in England limits a man's daily work to laying 400 bricks, while in the States he does 1,200! This limiting of the output of labour is a much more serious tax on the nation than a war tax. It drives trade out of the country, it restricts the intelligence and lowers the tone of morality of our working classes. It is a disease to be grappled with. On the Clyde and the Tyne, and, indeed, wherever shipbuilding is flourishing, there we find electrical energy driving machine tools, holding up plates, and assisting in various processes. In many large machine works cranes and travellers are moved by it. At Boston, U.S.A., crossing the Charles river and uniting Charlestown, the scene of the famous battle of Bunker's Hill, with it headquarters, is a new bridge 100ft. wide and 1,920ft. long, having a draw of 240ft. span, weighing 1,200 tons. This draw is opened and closed by electric motors. In the Post Office we have introduced electric motors very largely. At Leeds they are used for driving pneumatic pressure and vacuum pumps, employed there to work the pneumatic tube system. They are also used for working automatic stokers, ventilating fans, and lifts.

Traction.—It is for traction purposes that electricity is making such gigantic strides. In the United States tramway working by its means has become practically universal. In the United Kingdom it is making rapid way, and in connection with electric lighting it is giving great economical results. The combination of the two systems is most effective. In St. Helens, in Lancashire, where 13,435 8-c.p. lamps are connected, and a small tramway system of nine cars simultaneously running is at work, the works costs have been brought down from 3·23d. per unit to 0·67d. per unit. The price for electric light has been reduced from 6d. to 4½d. per unit, and it will probably be lowered to 3½d. This is after only 8½ months' working. St. Helens is an object lesson to all municipalities, especially to Glasgow, where a very false start has been made. Electric railways are also growing apace. A bold attempt is being made by the Metropolitan Railways to work the existing line in such a way as not to interfere with the existing traffic or even with the permanent way. A new train of six coaches weighing 180 tons, having a motorcar at each end weighing 54 tons, is about to run between Earl's Court and High-street, Kensington. Each motorcar is mounted on bogies, and each bogie has two electric motors, so that there are eight driving wheels, each bearing 6·75 tons. The driving wheels have diameters of 47in. The length of the train is 240ft. Each motor is rated at 200 h.p., or a total of 800 h.p. for each motorcar. But there is a wide margin, and we have already applied 950 h.p. in starting a load of 270 tons on the incline of 1 in 43. Electric traction has an immense advantage over steam traction in impressing a continuous and uniform torque or turning moment on the shaft, and consequently a continuous and uniform effort on the trend of the wheel. The action of the steam locomotive is intermittent and the bite not continuous, hence such frequent slipping on greasy

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rails. Again, the maximum torque can at once be applied by the current, and, in combination with the constant effort, it increases the acceleration so that a train acquires its maximum speed much more quickly. We shall increase the mean speed of the Metropolitan trains from 11 miles per hour to 15, and thereby increase the capacity of the line over 30 per cent. The stoppages on the underground railways are so frequent that the trains are always either accelerating or stopping. They never reach their top speed as they do on main lines. Electric traction enables them to start quicker and stop more promptly. On the Metropolitan the 180-ton train acquired 20 miles an hour in 200ft., and when going at the same speed it was stopped in 130ft.—half its length. Smart work on such a railway depends on the rate at which trains can be emptied and filled. The English system of compartments and side doors facilitates this. It would be still further expedited if we could have one platform for entry and one for exit, and one class only. The Liverpool and Manchester Lightning Express Railway, promoted by a very powerful representative syndicate of those two great commercial centres to carry out the scheme of Mr. Behr, is a very bold and promising venture. The line is to be monorail, 34 miles long, direct between the two cities, without any intermediate station and with no crossing. There are to be cars every 10 minutes. The speed is to be 100 miles per hour, and the time of transit 20 minutes. I know of no reason why this should not be done with safety and comfort. The automobile car of the future has not yet seen the light. It will be electrical. Immense progress has been made in motors and in batteries. Lundell has shown how to store up the energy now wasted in descending hills, and to recover some of that absorbed by the inertia of the car. Although a battery has already been able to drive a car 100 miles with one charge, we are waiting patiently for the real automotor storage cell.

Electricity in War.—A strong contingent of electrical engineers has volunteered for service in South Africa. They are all scientifically-trained practical young engineers. Bicycles, field telegraphs, telephones, arc and incandescent lamps, cables, searchlights, traction engines, and generating plant will be under their care. It is strongly hoped that we may soon hear good accounts of their performances at the front. They are under the command of Major Crompton, a member of the Institution and an old soldier. Electricity has been extensively applied to the development and utilisation of explosives in both the civil and military divisions of our profession. Charges are safely fired under water and blasted in mining and demolition operations by small exploding dynamos, magnetic-electric machines, or induction coils acting upon high-tension fuses. Our honorary member, Sir Frederick Abel, has specially distinguished himself in this direction. His fuse, composed of phosphoride and subsulphide of copper, is universally used by our War Department. Time guns are thus fired at stated hours at different sea-ports by currents originating in Greenwich Observatory. Broadsides in battleships and guns in turrets are similarly discharged. Torpedoes are even directed by currents from the shore. The defence of our coasts by submarine mines and their explosion by currents when the enemy's ships are properly located by position finders, is the last development of the application of electricity to war. Electrical blasting has revolutionised the operations of tunnelling and driving galleries. It is much used in quarrying with great security to the men. The deepening of harbours and channels and the removal of obstructions, such as wrecks and rocks, are facilitated. On Sept. 23, 1876, 63,135 cubic yards of solid rock were completely demolished by one discharge at Hell Gate, in East River, New York. The preparation for this great blast took four years and four months. There were 4,427 charged holes, each containing its mercury fulminate fuse and charges of dynamite. There were 49,914 explosions used in that one blast. Batteries were used to generate the currents, and they were arranged in large groups. Each battery exploded 160 charges. This was the record blast. The battleship is the home of electricity. It controls the rudder, it ventilates the interior and the living space of the ship, it forces the draught and assists the raising of steam, it revolves the turrets, it trains and controls the fans, it handles the ammunition, it purifies the drinking water, it lights up the ship internally, it enables the captain to sweep the horizon with the brilliant rays of the searchlight, and to communicate with his tender or with his commanding officer across space independent of weather, night, season, fog, or rain.

Sanitation.—No branch of our profession fulfils the true function of the engineer more efficiently than that which deals with sanitation. Pure air, pure water, pure food, pure soil, pure dwellings, and pure bodies are the panacea for health and comfort. Electricity helps us very much in attaining some of these qualities. An electric incandescent lamp does not vitiate the air. It does not throw into circulation in the air any product of combustion. The question of ventilation is very much reduced in importance and rendered more simple to effect. Much less air need pass through our sitting-rooms and meeting places. The air vitiated by our lungs can be easily withdrawn and fresh air can be forced in by fans worked by electric motors. Even the air during its entrance can be warmed, and impurities floating in it can be sifted out of it by the attraction of electrification. Heating by Dowsing's luminous electric radiators is very much on the increase; they consume 250 watts, which cost about ½d. per hour. In many post offices sealing-wax is melted and kept in a liquid state by currents. Water can be sterilised by ozone, a product of electrification, and even by the nascent oxygen, when broken up into its constituent elements by electric currents. Sea-water thus electrolysed supplies us with chlorine, and converts the water into a powerful antiseptic, disinfectant, and deodoriser. Its economy is, however, doubtful, and in consequence its adoption has been much restricted.

Industries.—The applications of electricity to other industrial processes are innumerable. I have time to mention only one. Mr. T. A. B. Carver, who was a pupil of Lord Kelvin and an officer on our staff in this institution, has brought out a new Jacquard loom for weaving; 600 hooks are controlled electrically. The twill as well as the pattern is under complete management. It has been warmly taken up in Glasgow, and a factory has been started there. The pattern on this cloth is woven directly from a photo-print of the artist's design, mounted on a metallic sheet, the threads of the warp being picked up by electromagnetic action, owing to the figure of the pattern being cut away, and thus allowing the circuit to be completed by the metallic sheet.

The theme of the relations between electricity and engineering is too great for an hour's discourse. Electricity tends to economise labour and to cheapen the cost of living. It increases national wealth, and promotes international friendship. It enlightens the invisible, and it alleviates suffering. It conduces to avert war, and it certainly facilitates the conclusion of peace. Its practical applications have run *pari passu* with our revered Queen's reign. They are growing with great rapidity. Who can forecast the future? One simple lesson that I have learnt is that in the practical developments of electricity the only thing that occurs is the unexpected. There is now a distinct line of demarcation separating the physicist from the engineer. The former dives into the unknown to discover new truths; the latter applies the known to the service of man. Research is the function of the one; utility that of the other. In the past the engineer had to rely on himself for his facts, but the advance of modern science, the growth of technical education, the formation of laboratories, and the endowment of chairs have changed all that. We can scarcely hope for new sources of energy to be discovered, but there are some existing ones we have not touched yet. When the evil day arrives for our coal supplies to give out we may perhaps be able, by the aid of electricity, to utilise the heat of the sun and the tides of the ocean. There is, however, a vast illimitable store of energy not only in the rotation of the earth upon its axis, but in the internal heat of the globe itself. As we descend the temperature gets higher and higher. It ought not to be difficult to reach such temperatures that by thermo-electric appliances we might convert the lost energy of the earth's interior into some useful electric form.

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GLOUCESTER CABLES.

The photograph which we give herewith was taken a short time ago at Gloucester, and shows the system of laying mains in that town, which is being carried out by the Callender's Cable and Construction Company under the superintendence of their district engineer, Mr. H. Schiasse. In the photographs five feeders, each with a section of cable of ·4 square inch, are being laid, and their respective pilot wires can also be seen in the trench. The feeders are laid in troughing 3in. by 3in., which is filled in afterwards with bitumen on the solid system. This secures great immunity from mechanical damage, and from any action from surface water in the soil. The pilot cables, which are laid between the iron troughings, are lead sheathed and armoured, and are laid direct in the ground. The photograph in question was taken near the electric light station in the Commercial-road. Amongst those gentlemen who appear in the photograph are Mr. Read, the surveyor to the borough of Gloucester, and Mr. Basche, the electrical engineer.

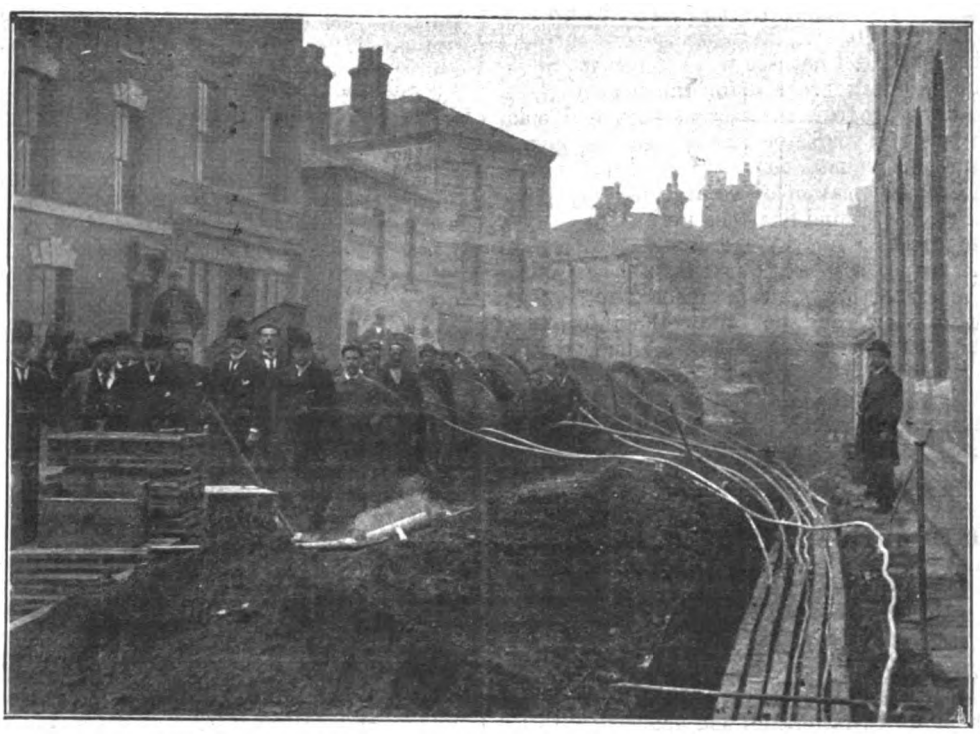

FIG. 1.—Cable Laying at Gloucester on the Callender Solid System.

THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

INAUGURAL DINNER.

The inaugural dinner of the above association was held in the Victoria Hall of the Hotel Cecil, London, on Wednesday, April 25, under the presidency of Sir Charles Rivers Wilson, G.C.M.G., C.B. About 200 guests were present, among them being Mr. Alfred Baker, manager of the London County Council Tramways; Mr. John Young, manager of the Glasgow Tramways; Mr. S. C. Cunningham, London Central Railway; Mr. R. Alf. Smithson, chairman of the Leeds Corporation Tramways; Mr. Gerald A. R. Fitzgerald, Mr. J. H Balfour Browne, Q.C., Dr. S. P. Thompson, F.R.S., Colonel G. F. O. Boughey, R.E., Mr. C. W. Gordon (Dublin), Mr. Andrew Nance (Belfast), Mr. J. E. Pitcairn (Edinburgh), Lord Vaux of Harrowden, Major-General C. E Webber, C.B., R.E, Mr. James Bell, Mr. A. P. Trotter, Mr. J. S. Raworth, besides the members of the council: Messrs. Philip Dawson, A. R. Monks, R. Alf. Smithson, W. M. Ackworth, L. A. Atherley Jones, Q.C., M.P., Sidney Morse, John Fell, Wm. Anderson, S. Sellon, E. Garcke, Geo. Richardson (vice-president), J. W. Courteney, J. Clifton Robinson, etc. The proceedings commenced at 7 p.m., and if their success may be regarded as a criterion, then the popularity and utility of the movement to which this association has pledged itself—namely, the promotion of the various interests connected with the tramway and light railway undertakings of the United Kingdom—may be looked upon as established. One of the principal features of the evening was the unusually even merit which characterised the after-dinner speeches. Coming, as these did, after an excellently-served dinner, accompanied by music, they were a pleasure to hear.

After the usual loyal and patriotic toasts had been duly honoured, the PRESIDENT proposed the toast of the evening, "The Tramway and Light Railway Industry," coupled with the name of Dr. S. P. Thompson, F.R.S. He briefly reviewed the work of the association, and congratulated the promoters and directors upon the marked success which had attended their efforts. Continuing, he (the president) said that tramways first came into vogue in this country in the year 1860, when the first line was laid in Birkenhead, but it was not until 1870 that a serious development of the tramway industry took place. The Parliamentary Act of that year, however, far from encouraging the industry, had greatly retarded it. For several years there was a complete stagnation in its development, with the result that private enterprise stepped aside, and municipal enterprise came to the front. But in 1896 a distinct step forward was taken with the passing of the Light Railways Act. Since then a new and great impetus had been given to the industry, the success of the operations under the Act having been largely due to the enlightened views and action of the Board of Trade. Many questions of an important and conflicting nature had pointed to the necessity for some organisation to guard the interests of the industry, hence the establishment of the association. Its founders had endeavoured to secure representatives for every description of light railway and tramway. There were certainly many cases where municipal authorities should own and work tramways, though at times they seemed to have a tendency to go beyond what was reasonable. There was room for all, and if the great corporations would only take the interests of their own ratepayers to heart they would have no difficulties with the companies. Although he (the president) might be looked upon as a representative of private enterprise, he wished to see all united for common action in rendering the greatest possible service to the community at large. There existed a

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great deal of friction between the two interests, which it would be one of the objects of the association to help in removing. Amongst the other objects of the association, it was sought to promote, develop, and facilitate the construction of tramways and light railways, whether electric or mechanical; to deal with questions affecting their construction and working; to bring pressure upon the legislative and public bodies; and to promote the industry in every way. Four working committees had already been appointed, and these were taking practical steps to give vitality and efficacy to the association. Questions which would be dealt with were the attempts of local authorities and companies to oppose light railways, the advisability of appointing a special arbitrator to deal with disputes affecting the industry, and the present limitation of speed on tramways, etc.

In replying, Dr. SILVANUS THOMPSON referred to the objections which had been raised in certain quarters to the development of electric traction, owing to the disturbance of observatory instruments, etc., through vagabond currents. But he (Dr. Thompson) did not see why science should be allowed to interfere with progress for the benefit of the community. Recent progress in traction work had made the Acts passed 20 years or more ago to govern such work quite inadequate for present requirements. Systems of intercommunication over large densely populated areas such as that around Sheffield, for instance, would be most advantageous. We no longer lived in an equine but in an electrical age, and the point was whether Parliament would consider the question from the broader economic point of view, and not allow the interests of petty local authorities to interfere with what was good for the nation as a whole.

"Our Guests" and "The President" having been duly proposed and responded to, the official programme thereupon terminated.

ELECTRIC DISTR BUTION OF POWER AS APPLIED TO WORKS AND FACTORIES.*

BY GEO. HARLAND BOWDEN.

The subject of electricity is now causing the greatest amount of interest to the engineering world generally. To the engineer the study becomes one of absorbing interest, and covers a field varying so much in its characteristics and applications that it will be hard to find an engineering establishment or scheme in which electric power may not play an important part.

I have taken for my subject "Electric Distribution of Power as Applied to Works and Factories," and I saw immediately that my difficulty would be in condensing the subject to the customary length of an engineering paper. I do not propose to traverse the whole breadth of the subject, but to deal with it almost entirely from the point of view of economy and increased efficiency. Economy, however, is not the only important consideration. Increased output is equally if not more important. With electric power a works is never tied up with its arrangements for driving, but with the greatest convenience may expand as required. When cables are being put down to carry power to a certain part of a works at a small cost, provision may be made in the cables to allow of extensions being added at will. This provision could not be made in a steam-pipe without at once plunging the works owner to the most uneconomical method of transmission possible, his only alternative being to increase the size of the steam-pipe as more power is required; and here the question of first cost at once proves how desirable it is to have an electric power installation, if only to meet such a requirement as this.

The progress made in the manufacture of electric machinery and the application of electricity to home industries and into our towns and large cities for the convenience of our citizens during the last few years needs no comment, and the steps taken by Glasgow and other leading towns in Great Britain are well known. Electricity is now a subject which can no longer be put aside by municipal authorities, but must be met and dealt with. It has already proved one of the greatest boons of the nineteenth century to our citizens in the shape of an almost perfect lighting system in our streets and thoroughfares, and by giving them increased facilities for travelling short journeys at a good rate of speed and at a very moderate cost. At the same time we have already proved that electricity thus applied can be made a source of great revenue to the town itself. One can, then, but wonder, when these conditions have existed so long on the Continent and in America, why it is that the authorities of Great Britain have only so recently roused themselves to take up this question in a serious manner for the benefit of the people whom they represent. It is still more surprising that we meet isolated cases where such proposals are opposed by quite a number of those who should be the first to push on the welfare of their municipality, as such an attitude can only result in holding their town back a number of years, and placing it in a rank below the more go-ahead township.

No less do the above remarks apply to the works owners and engineers, as it is only quite recently that the question of distribution of power as applied to works has come into prominence. Six or seven years ago we had very little to show in this country in the shape of works driven electrically, and until quite recently it has been a most uphill task to induce engineers and works owners to regard electric power in this application as anything but an experiment. The whole tone of the country in this respect has now, however, quite changed, and works and factory owners recognise that the question of electric driving is not a boom of the electric trade or a luxury, but a question which to them is absolutely a necessity, and that the longer they put off the day when they give this matter their serious consideration, the more money they will be out of pocket, and they will also rank behind their competitors who have had the foresight to place a modern installation into their works. One of the very first installations in this country was that of Messrs. Dorman, Long, and Co., Middlesbrough, and this installation, which might, as far as this country was concerned, be considered as experimental, has turned out the greatest possible success, both from an engineering and financial point of view.

To the works owner at the present time the high cost of all material in the engineering trade, and also the increased cost of labour, necessitates every advantage being taken of new methods of transmitting power which show a saving in comparison with present arrangements. It is often remarked at the present time that all firms, particularly our ironworks and shipyards, are so very busy that they cannot afford the time to seriously consider these proposals. But one remarkable feature about the introduction of electric power into such works is that the whole of the work is carried out without any inconvenience to the existing operations, and not a single machine in the yard is allowed to be stopped. The motors are fixed in position, and one by one set to work. Electricity, not only a more economical drive in itself, allows arrangements to be made in various ways in a works whereby other methods are distinctly improved, and at the time of reconstruction the same machinery is easily adapted to turn out even double the work at a much less cost. This remark applies particularly to cranes, where the smoothness of running when driven by motors, the ease of starting and stopping, the increased efficiency, and the ease with which the craneman can raise or lower ¼in. without any shock or jerk, are at once recognised as being a great convenience to the foreman of that department, as well as a saving to the works owner and his engineer.

In most of our shipyards, steelworks, and similar engineering industries, where the old arrangements are still in existence, a case can always be found whereby great economies can be derived. This is not because the plant is inefficient through age or neglect, but that the best possible arrangement on these lines, if put down to-day, would have to submit to the same criticism. It will be found that groups of machinery are to be driven differing so much in character, and so widely spread about the works, and requiring to run at different and varying rates of speed in an intermittent manner, that it would be seen few cases exist where great economies will not be derived. In most of these cases it will be found that there are numerous engines scattered about the works varying from 5 h.p. or 10 h.p. to 50 h.p. or 60 h.p., and elaborate tests have proved that these engines are actually taking in some cases as high as 15lb. to 20lb. coal per brake horse-power per hour, while 10lb. or 12lb. coal is quite a common figure to meet with. If, however, the whole of the power absorbed by these engines were placed into one central station of one or more generating plants, as the case may require, power can be generated at such a very low cost and transmitted in the ordinary works at a loss of not more than 3 or 4 per cent., thus enabling the same operations to be carried out at an expenditure in fuel of not more than 3lb. coal per brake horse-power, this being the power actually expended at the work. If, also, as in the case of a shipyard, the whole of the power for driving purposes is generated in a central station, the hydraulic plant and pneumatic plant to be also placed in the same building, the whole of the power necessary for driving the works can thus be in the hands of one man, and one boiler plant can supply the whole place. Thus it is advisable that this plant should be as near as possible to the smithy, for supplying steam to the hammers. By this means numerous boilers and engines are dispensed with, together with several firemen, engine-men, etc.; the cost of upkeep is considerably reduced, in many case doing away with gangs of men who are kept solely for the purpose of repairing and looking after the joints of underground steam-piping, and repairs necessitated by

* Paper read before the Glasgow University Engineering Society.

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the jarring of the small engines on the steam-driven punches and shears, bar straighteners, rolls, etc.

A brief review of the results which have been obtained at a few important works will be interesting. At the works of Messrs. Dorman, Long, and Co., Middlesbrough, one by one motors have been installed until there are now 60 motors at work driving all the outlying machinery. The plant at present consists of three 200-i.h.p. direct-coupled engines and generators, and in a few weeks a fourth plant consisting of one 500-i.h.p. slow-speed direct-coupled plant will be installed. This installation, being the oldest electrical installation of its kind in this country, is the one to which we turn for the cost of upkeep, and this has proved to be absurdly small. In fact, after allowing for replacing brushes when worn out, and the cost of the necessary oil, etc., there has been practically no further expenditure, and the saving from the first has been enormous. An extract from the directors' report to their shareholders for the year ending Sept. 30, 1895, will thus be interesting. At this time the installation had not reached anything like its present dimensions, and even then the work in hand at the time of this report was not by any means fully completed. The extract from the report reads as follows: "One decidedly encouraging feature in the year's working is the large reduction in the cost of manufacture due to the improvements of the last few years having come into full operation. This is seen in the fact that nearly the whole of the profit has accrued during the last six months of the financial year, although the prices then realised were lower than for the first six months. The saving effected by the expenditure during 1894 in applying electrical power to the outlying machinery was found to be so satisfactory that your directors felt justified in a further outlay in this direction, and hence the greater part of the capital expenditure this year is for electrical machinery. Up to the present time the total amount spent under this head is about £8,000, and the saving is at the rate of £3,000 to £4,000 a year, in addition to increased efficiencies."

Messrs. G. and J. Weir, Limited, of Cathcart, have extended their works considerably, and now drive the whole place electrically. At the same time they have dispensed with boilers and engines from various parts of the works. Messrs. Furness, Withy, and Co., Limited, have a most interesting plant. Their large shipyard, employing a great number of workmen, is now entirely driven from a central station. Since the electrical plant was installed they have doubled their output, and are still working at a less cost than before. This is perhaps more important to shipbuilders at the present day than the question of economy and the question of saving for the same amount of output. In fact, nothing compares with electricity as a means, and that an economical means, of permitting expansion to such industries. The same remarks apply to Messrs. Furness, Withy, and Co.'s engine works at Middlesbrough, and to go round one of these large concerns which were previously driven by not only numerous engines, but many boilers, is not only interesting but conclusive proof of what can be done. Messrs. Workman, Clark, and Co., of Belfast, have their large works also entirely driven from a similar plant, and similar plants with the same end in view are being now carried out in such works as Messrs. Scott and Co.'s, shipbuilders, Greenock; Messrs. D. Y. Stewart and Co.'s, ironfounders, St. Rollox; Messrs. Paul and Co., engineers, Dumbarton, etc.

The arrangement of the engine-house of various schemes may be seen in Fig. 1, which shows a central station designed for a large steelworks.

Every machine in a shipbuilding yard can be driven electrically, with the exception of the steam hammers in the forge. The same remark applies to all the outlying machinery connected with iron and steel works, except that the powers required will be found to be heavier, and the driving plant necessarily more powerful. Owing to the very intermittent nature of the work done by this class of machinery, and the ever varying powers from light to full load, it will be found that the total power indicated at the generating station is very much less than what may be expected, or what would be required if the powers were transmitted by methods less flexible than electricity. Suppose a motor plant was designed to be of a certain horse-power, say 500 h.p., this being the total brake horse-power of the complete installation of motors, it is not necessary for that work that 500 h.p. should be generated in the central station. Results obtained from cases actually in operation show that 60 to 65 per cent. of the power in motors is all that is required in the generating station, and the engine and dynamo plant may be designed accordingly. For a number of motors equal to a total horse-power of 500 when fully loaded a 300 e.h.p. to 350 e.h.p. combined set is all that is required. In addition to this, allowance must be made for any possible future extensions and power required for lighting. Of course, great attention must be paid to the economical means of producing electricity. In this country we are not able, as in America, Norway, and Switzerland, to utilise water power, which allows electricity to be generated at so small a cost, and perhaps it is due to this fact that our neighbours have so many years ago carried out the driving of their works on these lines. But we have in this country, in the iron and steel works, waste gases, and where these are available it is highly desirable that boilers are laid down to be driven with these gases, thus giving at once a method of generating power at the lowest

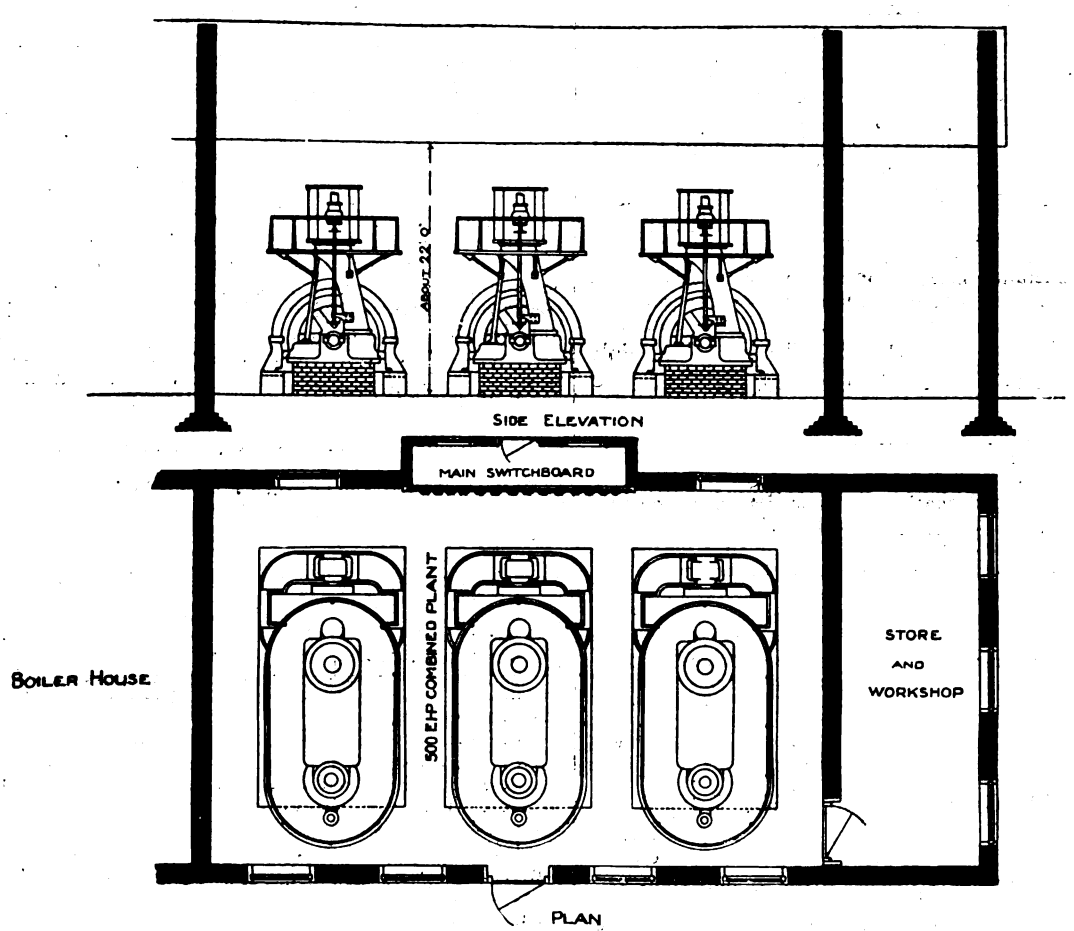

FIG. 1.—Plan and Elevation of a Power House.

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possible cost. In all cases, however, careful attention should be given to the boiler plant, which should be of the most modern type, and where a plentiful supply of water can be had for the pumping condensers should be used, and the boilers, engines, and dynamos should be of the highest possible class, and the most efficient that can be obtained. It is the greatest possible mistake to think that a good electric installation can give satisfactory results, either from the point of view of efficiency or of running, by putting in a cheap plant. It is much better to use that money for putting in a first-class plant, rather than try to do more work in a manner which cannot recommend itself to the engineer. The scattered steam-driven plant has been proved to be most wasteful, and that system cannot be continued even where the situation of the works allows of the price of fuel to be very low indeed.

It will also be seen that it is not only in the fuel item where the great savings are made. There are many large works driven from one or two powerful engines, and the whole of the transmission of power is carried out by shafting and belts. There is not the slightest doubt that the plant can be driven more cheaply by means of electric motors, but the savings in works thus arranged in comparison with the scattered steam-driven plant are necessarily much less, unless the shafting is extremely bad, and rarely, therefore, as a whole are such works owners justified in altering their driving arrangements, owing to the great expense necessary to instal an electric power plant. As an application to works, electricity must simply be regarded as a method of power transmission, and given a certain amount of work to do, which can be placed close to the engine, no very great improvement can be made on such a drive. I refer now to works such as thread and cloth mills, etc., or engine-shops which are driven entirely from one main engine. But in even this type of works there will invariably be found isolated machines, taking, say, 5 h.p. or 6 h.p., where there is an enormous loss constantly going on while conveying this power to the machine. Cases where square shafts drive cranes always repay the expense of altering to an electric drive, and thus dispense with the shaft. A case to illustrate this fact was one where an engine of some 220 h.p., compound, condensing, driving large engine works was considered to be overloaded. A dynamo was put down and driven off the same engine, and by this means cranes, driven by square shafting and ropes, were altered to an electric drive, and one or two isolated cases, bad drives, such as a wood saw and a small department, which were formerly driven by an underground shaft, were then driven by electric motors. Although the cranes were speeded up to do their work at a considerably higher rate of speed, the engine, which was doing all the work as before, was found to indicate much less power, owing to that desirable portion of the works being driven electrically. In this case a considerable saving was made on a very small outlay, and the engine was able to work under much more favourable circumstances. It is only under such circumstances, however, that a dynamo should be driven from old existing engines.

To be continued.)

THE INSTITUTION OF CIVIL ENGINEERS.

At the annual meeting of the Institution of Civil Engineers, held last Tuesday evening, the result of the ballot for the election of officers was declared as follows:

President.—Mr. James Mansergh.

Vice-Presidents.—Sir William White, K.C.B., Mr. Charles Hawksley, Mr. J. C. Hawkshaw, M.A., and Mr. F. W. Webb.

Other Members of Council.—Mr. Barton (Dundalk), Mr. Horace Bell, Sir Alexander Binnie, Mr. B. Hall Blyth, M.A. (Edinburgh), Dr. Henry Taylor Bovey, M.A. (Montreal), Mr. C. A. Brereton, Mr. T. Forster Brown (Cardiff), Mr. R. Elliott Cooper, Mr. G. F. Deacon, Mr. W. R. Galbraith, Mr. G. H. Hill, Mr. J. C. Inglis, Mr. Alexander Izat, C.I.E. (Gorakhpur, India), Dr. Alexander B. W. Kennedy, Sir James Kitson, Bart., M.P. (Leeds), Mr. A. G. Lyster (Liverpool), Mr. John Allen McDonald (Derby), Mr. E. Pritchard Martin (Dowlais), Mr. William Matthews, Sir Guilford L. Molesworth, K.C.I.E., Mr. Alexander Siemens, Mr. Thomas Stewart (Cape Town), Mr. John I. Thornycroft, Mr. William Thwaites, M.A. (Melbourne), Prof. W. C. Unwin, B.Sc., and Sir E. Leader Williams (Manchester).

The council have also made the following awards for papers read and discussed before the institution during the past session: A George Stephenson medal and a Telford premium to Sir Lowthian Bell, Bart., LL.D., F.R.S.; Telford medals and premiums to Messrs. H. H. Dalrymple-Hay, B. M. Jenkin, F. W. Bidder, and F. D. Fox; a Watt medal and a Telford premium to Mr. J. Dewrance; a Crampton prize to Sir Charles Hartley, and Telford premiums to Messrs. C. N. Russell and R. A. Tatton. The presentation of these awards and also those for papers which have not been subject to discussion is to take place at the inaugural meeting of next session.

THE NEW COUNCIL OF THE INSTITUTION.

At the meeting of the Institution of Electrical Engineers, held in the lecture theatre of the Civil Engineers last evening, the list of nominations by the council for council and officers for the new session was read. The list was as follows:

President.—Prof. J. Perry, F.R.S.

Vice-Presidents.—Mr. W. E. Langdon, Mr. James Swinburne, Mr. R. K. Gray, *Mons. E. Mascart.

Members of Council.—Major P. Cardew (R.E.), *Mr. H. H. Cunynghame (C.B.), *Mr. H. Edmunds, *Mr. S. Z. de Ferranti, Mr. John Gavey, Mr. Robert Hammond, *Mr. Hugo Hirst, Mr. A. J. Lawson, Mr. P. V. Luke (C.I.E.), Mr. W. M. Mordey, Mr. R. P. Sellon, *Mr. C. P. Sparks, Mr. A. A. Campbell Swinton, *Mr. A. P. Trotter, *Mr. J. E. Kingsbury.

Associate Members of Council.—*Mr. W. R. Cooper (M.A., B.Sc.), Mr. S. Evershed, Mr. R. W. Wallace (Q.C.).

Hon. Auditors.—Mr. F. C. Danvers, Mr. E. Garcke.

Hon. Treasurer.—Prof. W. E. Ayrton (F.R.S.).

Hon. Solicitors.—Messrs. Wilson, Bristows, and Carpmael.

The names marked with an asterisk are those of gentlemen nominated to fill the vacancies in the council in accordance with article 45 of the articles of association.

In making the above announcement, the PRESIDENT (Prof. S. P. Thompson) referred to the fact that M. Mascart was to be the president of the electrical congress to be held in Paris in August this year.

FORTHCOMING EVENTS.

FRIDAY, APRIL 27.

Physical Society.—At 8 p.m., ordinary meeting, at Solar Physics Observatory, Exhibition-road, South Kensington. A short account of the Physical Problems now being investigated at the Solar Physics Observatory, and their Astronomical Applications, by Sir Norman Lockyer. Weather permitting, the 36in., 10in., and 9in. telescopes will be used for the observation and photography of celestial objects and their spectra. The Apps-Spottiswoode coil and 21ft. Rowland grating will also be in operation.

Royal Institution.—At 9 p.m., discourse on "Nineteenth Century Clouds over the Dynamical Theory of Heat and Light," by Lord Kelvin, G.C.V.O.

Institution of Electrical Engineers (Glasgow Section).—At 8 p.m., paper on "Some Considerations Concerning Electrical Driving," by Mr. H. D. Mavor; also annual business meeting.

TUESDAY, MAY 1.

Royal Institution.—At 5 p.m., annual meeting.

THURSDAY, MAY 3.

Institution of Electrical Engineers. — At 8 p.m., special meeting, at Institution of Mechanical Engineers. Time permitting, paper will be read on "The Calculations of Distributing Systems of Electric Traction under British Conditions," by Mr. H. M. Sayers.

Royal Institution.—At 3 p.m., Lecture II. of four on "A Century of Chemistry in the Royal Institution," by Prof. Dewar, M.A., etc.

Civil and Mechanical Engineers' Society.—At 8 p.m., ordinary meeting. Paper on "Valve Gears and Valve Diagrams," by Prof. R. H. Smith, Wh.Sch.

Rontgen Society.—At 8 p.m., exhibition evening. Demonstration and exhibition of appliances.

Chemical Society.—At 8 p.m., ordinary meeting.

FRIDAY, MAY 4.

Royal Institution.—At 9 p.m., discourse on "Pottery and Plumbism," by Prof. T. E. Thorpe, LL.D.

Dynamicables.—At 7 p.m., dinner at Whitehall Club.

WEDNESDAY AND THURSDAY, MAY 9 AND 10.

Iron and Steel Institute.—Annual meeting, London.

Vienna Automobile Exhibition.—We learn that motors intended for this show, which will be held from May 31 to June 10, will be admitted into Austria free of duty.

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AUTOMOBILISM.

"The automobile car of the future has not yet seen the light. It will be electrical." These sentences are extracted from the "James Forrest" lecture just delivered at the Institution of Civil Engineers by Sir W. H. Preece. They are emphatic and consoling. The same conclusion has been given before, but though we agree with it under certain conditions, the time of the future car is not yet. Electricity at present cannot compete against petrol, and this fact is driven home by seeing that not a single electrical machine has started for the Automobile Club's thousand-mile run, which begun on Monday last. There is a fascination about a thousand-mile run which is apt to overshadow everyday requirements. It may be that the latter are, in the long run, more exacting, but few recognise this in the earlier stages of development of a new enterprise. For our part, we have steadfastly put forward the view that at present the great want of the age is to replace horse traction by mechanical traction. If this view be accepted, the real problem becomes the ascertaining of the maximum demand from horseflesh with a certain margin of safety. On the other hand, the aim of present automobilists seems to be competition with railways. This aim will prove of inconceivable value, for it will result in the construction of machines quite capable of replacing horses under any conceivable circumstances. Hence we welcome any trials similar to those now going on. At the present time two phases of motor development present themselves—the substitution for horses in ordinary life, and the substitution for horses in warfare. The latter field is open to all. With the exception of a few traction steam-engines, no mechanical motors have been used in warfare, but the situation in South Africa has directed attention to the capabilities of such apparatus in war. It is well known that before Major Crompton left for the front he had given close thought to the possibilities of oil for traction purposes, and decided that at present steam only can be of use. This is the opinion of an expert whose experience is, perhaps, greater than that of any other man, and thus we may put aside all thoughts of electrical propulsion taking an early share in traction in war operations. For ordinary purposes petrol seems to take the lead, with electricity in the rear, except so far as regards tramways. The indications are that electricity will rapidly become the source of energy for traction on tramways and light railways, and will then come into use upon the shorter heavier railways, while for separate vehicles electricity must wait. Perhaps this view will be held not to say much for the inventive capabilities of electrical engineers, but, then, too many people think that the electrical folks hold success in their own hands. This is a great mistake, as the purchaser of an automobile in Brussels said the other day, "I am going to run to Paris and afterwards to Nice; how could I do this if my machine was electrical? I could not 'charge' when, where, and how I wanted to; so I am compelled to use petrol—not that I like

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it altogether, but there is nothing else." The remarks were made anent a discussion on the respective merits of various classes of machine. The ordinary user of a horse or carriage requires flexibility, to go where he pleases, and not to be restricted to one particular route. It is here that electricity fails. When the route is fixed, as with a tramway, all may be well. The lack of flexibility in a tramway is, we believe, destined to be fatal to its longevity, as it can serve only a limited area parallel to the track. Recent investigations into motorcar traffic on the Continent led to the conclusion that there must be an enormous development in motorcar work in this country. There are plenty of troubles attached to the use of petrol machines, but for the moment their conveniences overshadow their weaknesses. With the exception of the exhaust they are sanitary, stabling of an elaborate character is not required, nor is forage, nor has manure to be removed, when running less space is occupied, speed is greater, cost of running is less, so that summing up these advantages the total will prove a gain in favour of mechanical motors. Probably maintenance will about equal the bill of the veterinary surgeon plus bran mashes and the various incidental expenses horseflesh is liable to. Then the cost of maintenance will decrease as roads are better laid and maintained. Altogether the automobilists' outlook is a favourable one, and we believe a properly organised company competing with mechanically-driven carriages as against those of the existing livery stable-keeper would be most successful. Where is the promoter that means business and not company-mongering? His chance has come.

THE AUTOMOBILE IN FRANCE.

The automobile industry has grown to a very large extent in France during the last few years, and it is interesting to notice that another issue of the "Annuaire Général de l'Automobile" is about to appear. This book is published by Messrs. F. Kévin and Ch. Houry at 21, Rue du Louvre, Paris, and contains a considerable amount of information dealing with automobiles and with allied industries. In the 1899 edition, of which we have received a copy as a specimen of what the 1900 edition is to be, we find a list of makers of all kinds of automobiles, the list containing all the principal motorcar makers in the European countries. Thus in the portion devoted to Great Britain we find 50 names given as making motorcars, while other countries are looked after quite as well. In order that no difficulty shall be met with in finding the maker of any particular kind of motorcar, the volume then has a section given up to the classification of the names given in the first part. The various makers are divided up into those who manufacture petroleum carriages, motor cycles, electric vehicles, steam motors, and compressed-air cars. In this section the makers of motors only of the various kinds above mentioned are given. The next section is naturally a large one, dealing as it does with the makers and sellers of accessories for motorcars. These accessories are all given in the index, and total up to a quite astonishing number. The next section is a very useful one, giving as it does a list of the large towns in the countries of Europe, and the various makers and repair shops to be found in each. In addition to this, the hotels which are reputed to be the best are detailed, and also, which would be of great use to those using electric cars, a list of central stations and electricians in the various towns. After this follows a list of automobile associations, clubs, etc., throughout Europe and the United States. The volume finishes up with information concerning inventions, etc., and a list of automobile journals.

We understand that the new volume will be very much on the same lines as the one just described, and we should say that such a volume would be very valuable to an automobilist who did not mind carrying it. This, however, seems to us a great drawback to the book, as when riding on a motor cycle, for instance, it would be large enough to cause some amount of consideration as to the best place to carry it. The book might be considerably thinned down by the exclusion of thick pages, which, scattered all over the book, advertise some speciality in motorcars. This is a very ingenious way of advertising, as the book naturally stays open at this place, but in a volume of this sort it seems rather out of place. However, the book, on the whole, would seem to us to be well worthy of purchase by the touring automobilist, and would repay the expenditure of the 10fr., which is the price charged for it.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Electrical Equipment of Ships of War.

BY C. E. GROVE, MEMBER.

(Concluded from page 557.)

Boat-Hoisting Engines.

A British battleship carries two sets, one on either side, of such power that each set can lift by means of tackle a boat weighing 18 tons at not less than 20ft. per minute. This is a favourable case for electric driving, and in the latest British ships electric motors are specified for the work. The actual net horse-power for the lift is approximately 24, and as the motors have to drive through a worm gear and a wire-rope tackle, the maximum input may be taken at about 50 e.h.p. The motors are specified to run at not more than 750 revolutions per minute, to be watertight, and to be fitted with reversing switches and automatic brakes. The rating of the motors is determined by the temperature limit of 80deg. F. rise after one hour's run at full load, which enables the weight of the total equipment to be about the same as that of the steam hoist. An electric compound deck-winch, as fitted in the

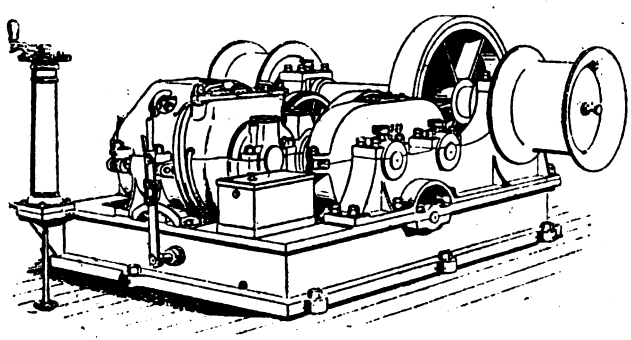

FIG. 31.—Electric Deck-Winch (General Electric Company, U.S.A.).

U.S. battleships "Kearsarge" and "Kentucky," is illustrated in Fig. 31.

Coal Hoists.

These machines (of which two sets are carried) are of the same class as the boat hoists, but work at a quicker rate. The latest British specifications define their work to be the lifting of one ton at 250ft. per minute, but on test they have to lift 1½ tons at this rate. On the test load they have to exert 25 actual horse-power, and though the efficiency may be a little higher in this case than in that of the boat hoists, the total input will be 40 e.h.p. to 50 e.h.p. The motors, therefore, may well be of the same size; they are governed by the same specification as to temperature limit, control, etc. The weight of the motors and gears will probably be a few hundredweights more than that of corresponding steam hoists.

Ash Hoists.

One of these is usually fitted to each boiler-room; the "Albion" carries five. Their work is not definitely specified, but may be described as lifting with wire-rope tackle a bucket of ash, weighing when full about 1¼cwt., at from 200ft. to 250ft. per minute = 1½ actual horse-power, the maximum indicated horse-power of the steam-engines being about five on a weight of 14cwt. Being placed on the boat deck, machines of this class may well be electric, and as the motors will run at higher

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speed than steam-engines no increase of weight need be involved.

Ventilating Fans.

These are employed for ventilating all compartments below the protective deck and some of the compartments above that

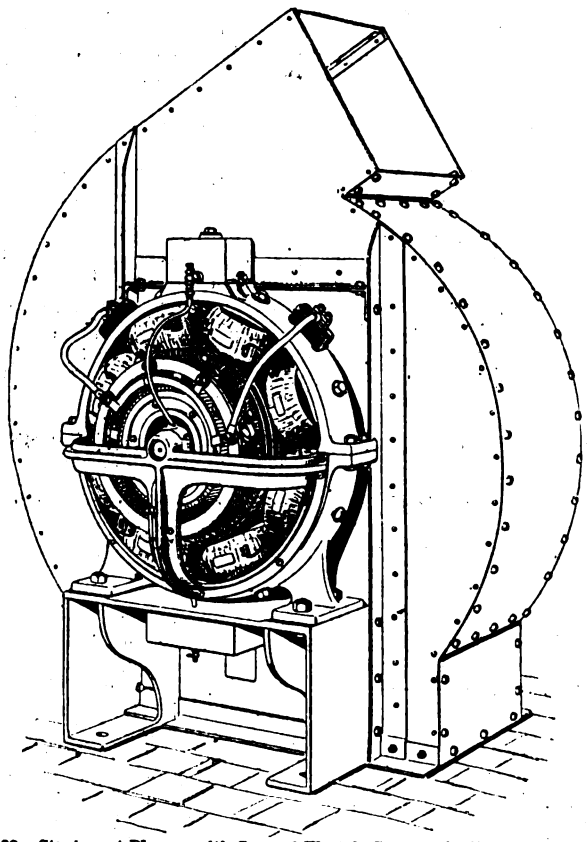


FIG. 32.—Sturtevant Blower, with General Electric Company's (U.S.A.) Motor.

deck, such as mess and living spaces. The general practice up to 1898 was to provide six 5ft. 6in. double-breasted steam fans on lower deck, three at each end of ship, driven at a maximum speed of about 400 revolutions per minute, and connected together to main ventilating trunks, besides an auxiliary system of ventilation with one 4ft. 6in. fan at each end of the ship. The electric driving of ventilating fans is now common in most navies. Fig. 32 shows a Sturtevant fan with open-type motor as used in the U.S. navy. In a few recent ships, electric fans of from 3ft. to 4ft. diameter have been fitted taking about 7 h.p. at 600 to 700 revolutions per minute, the same number (eight) being employed and connected to the same system of trunk as designed for steam fans. Figs. 33 and 34 show a 3ft. 9in. electric fan of this sort designed by the author and fitted in the I.J.B. "Shikishima." These fans have been adjusted to deliver 7,500 cubic feet of air per minute, each at 2in. pressure at 480 revolutions per minute, at which output they consume 5 e.h.p. apiece, but their speed and output can be increased if desired. Experience has shown that the matter of ventilation has been somewhat overdone in recent years, such powerful fans being seldom worked at their full speeds and powers. Accordingly, in the latest British ships—*i.e.*, all designed since 1898—a large number of smaller fans with shorter and simpler trunks are employed. The "Duncans," for example, will each carry 14 fans not exceeding 24in. in diameter, with motors of about 2 b.h.p., delivering 1,500 cubic feet of air per minute at 2in. pressure.

Air-Compressors for Torpedo Work.

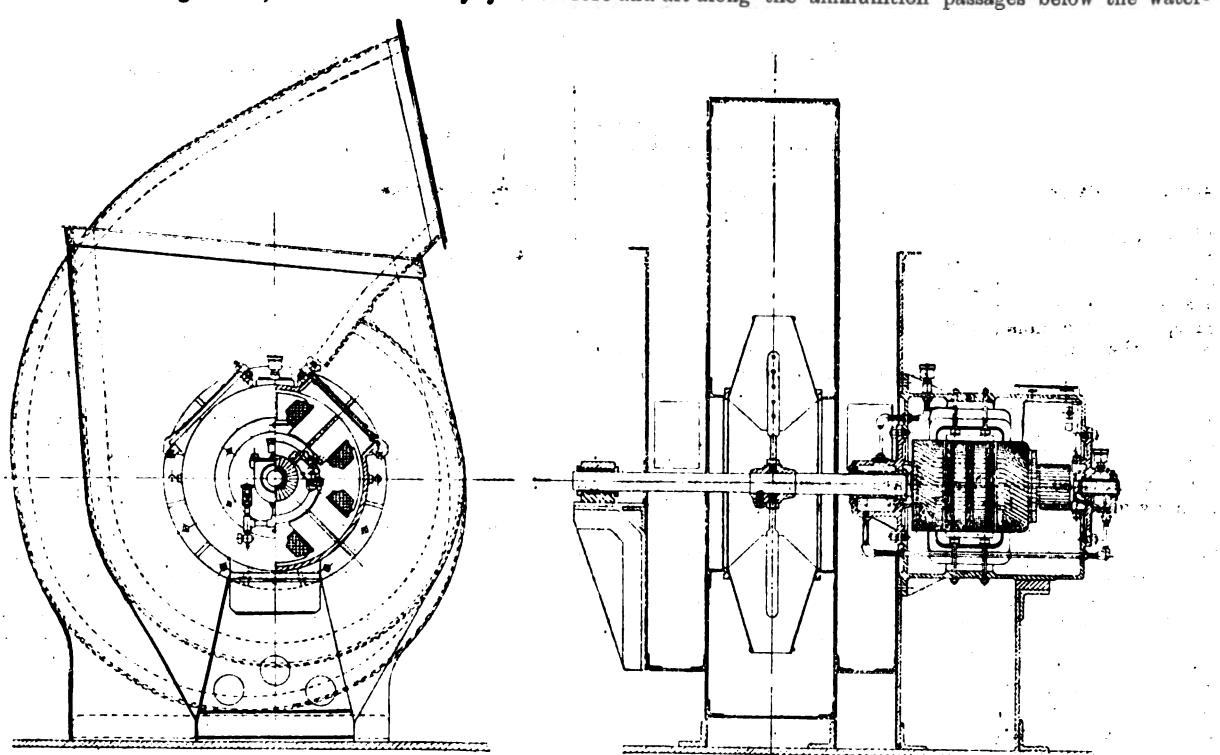
A modern first-class battleship carries usually four sets each capable of delivering 30ft. of air compressed to 1,700lb. per square inch in 70 minutes. This involves an average brake horse-power of about 50 to 60 per set of pumps on a little less than three tons weight. Electric compressors would involve quite a different design, but would result in much quiter and smoother working. The weight would remain approximately the same.

Workshop Engine.

This is a small engine of about 5 h.p., driving one or two short lines of shafting actuating half a dozen machine tools in the engineers' workshop. It is an obvious case in which electric driving is handier than anything else.

Gun-working Mechanism.

A modern battleship, mounting two pairs of large guns *en barbette*, carries quite a nest of machinery for working the guns. There are engines for training the turret, independent engines for each gun for elevating and depressing and for running in and out, rammers for loading, hoists for bringing up powder and shell from the magazines below, besides lifting and traversing gear for transporting shot and shell from the bins in the shell-rooms to the handing-up cage. Some of the machines are duplicated and some triplicated, and there are always in conjunction hand gears for continuing the work if the mechanism fails.* In a ship carrying hydraulic mountings the power is supplied by a steam hydraulic pumping engine of about 250 i.h.p. situated below and adjacent to the barbette. A pump in the barbette itself is used for circulating the water in the pipes under pressure for use over and over again if the pumping engine below is out of use. The hydraulic supply to each barbette is interconnected with that to the other, pipes running fore and aft along the ammunition passages below the water-line. Hydraulic power has been almost universally used in our navy for the last 20 years. Steam is used a good deal in the



FIGS 33 AND 34.—Ventilating Fan and Watertight Motor, H.I.J.M.S. "Shikishima" Thames Ironworks

* Illustrated descriptions of the turrets and gun-mountings of several British and foreign ships are given in a paper entitled, "The Rise and Progress of Rifled Naval Artillery," by Sir Andrew Noble, K.C.B., F.R.S (*Proceedings*, Institution of Naval Architects, 1899).

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United States navy, possibly because their ships have to operate in latitudes where extremes of temperature are common, and where, therefore, hydraulic appliances are liable to be disabled by freezing. But steam has great disadvantages for the purpose. The working being intermittent, there is great difficulty in starting owing to condensation, and there is, further, the serious liability to injury to the steam-pipes in action, with possibly disastrous results to the gunners. Electricity has come to the front in recent years as a rival to the older hydraulic system. By the English Admiralty it has scarcely been used at all. In the "Majestic" class of battleships electric motors have been put in as an auxiliary for training the turrets, but these are small-powered machines intended only as a help to the hand-gear, the primary installation being hydraulic. A beginning was also made in cruisers by applying electromotors to the 9·2in. guns of H.M.S. "Terrible." In the Japanese battleships fitted with Elswick armament an auxiliary electric training gear is carried, but the motor is about 15 h.p. capacity, and is able to train the turret at the rate of about 2deg. per second. The pump referred to above is also electrically driven. In the United States navy electricity has been more largely used, and, as compared with steam, earned in the late war good reports in respect of quickness of action and precision of control. The "Brooklyn," which carries two 8in. turrets superposed on two 13in. turrets, had two turrets trained by steam and two by electricity, which favoured a direct comparison. The electric turrets are said to have been started and stopped 37 times in a minute and to have been capable of very small motions at a time. The success of the electric motors in the first ships led to their extended use in later ships, and in the "Kearsarge" and "Kentucky," not merely are the turrets trained, but the guns are elevated and the ammunition hoists and rammers worked by electric motors. At the present time there seems to be a revulsion of feeling against electric installations. Lieutenant Norton (speaking apparently on behalf of the American constructors) said* that in the new large triple-screw ships being designed for the United States navy it has been decided not to use electrical power in the turrets except for the hoist, for the reason that "you can tell what is the matter with a steam or hydraulic engine instantly; but you may chase for hours to find a broken circuit, and by that time the action is over and you are out of the deal." To understand this remark the difference in the character of American and English installations must be borne in mind. For controlling turrets the Americans use an ingenious method devised by Mr. Ward Leonard, which may be fittingly mentioned here. In the turret is a motor (or a pair of motors in parallel) separately excited at constant voltage; its armature is directly connected with that of a generator in the dynamo-room which is steam-driven at constant speed in a field of which the excitation can be varied from maximum to zero, reversed, and increased to a negative maximum. The voltage of the generator accordingly varies as its field varies, and the motor armature receiving the varying voltage while its field remains constant, its speed will vary in a corresponding manner. The regulation of the generator field is effected from a controller under the sighting-hood in the turret. The control is said to be extremely sensitive and precise. Retardation is effected with smoothness and rapidity by dropping the excitation of the generator to a point which gives a voltage below that corresponding to the speed at which the motor is at the instant moving; the latter immediately begins to generate current, and therefore quickly absorbs the kinetic energy of the turret. In the latest ships the current so generated is taken up on a braking resistance. Most nations are now employing electricity to greater or less extent in turrets. Even Sweden is building cruisers in which the working of the turrets and guns is entirely electric. Among the best examples of electric turrets are those designed by M. Canet, and built in France for many Governments. The essential feature of M. Canet's design is that the turret is, as a whole, primarily designed for electric working. He arranges that the centre of gravity of the moving mass should as nearly as possible lie in the axis of rotation. This ensures moving with minimum power. In the Chilian "Capitan Prat," for example, a 9in. turret, weighing 87 tons complete, was rotated by a 15-h.p. motor at two-thirds power, and could be turned by four men through 270deg. in 107 seconds. It could be moved through one-fifteenth of a degree at a time. If electric power is to render its best services in connection with ordnance work, it seems pretty clear that the turret must be designed throughout for electric working. To tack electric motors on to an unbalanced turret designed for hydraulic working is not the way to success. If the turret be fairly balanced, a great saving in power, weight, and complexity might be effected by employing electrical gears. Of course, a large margin of power and strength are needed to ensure the successful operation of the turret when the ship takes a list in a rough sea or while turning; but, allowing for this, it would seem that the aggregate power, if everything were electrical, might be of the order of 100 b.h.p. normal to 150 b.h.p. maximum under worst conditions. Allowing 259 b.h.p. maximum in motor capacity to provide for duplication where possible, the motors with their gears, switches, and connections would certainly show a saving of 5 to 10 tons per turret on the aggregate weights of the hydraulic cylinders and gears, while the weight of the main hydraulic engines and transmission pipes (about 25 tons) would be a set-off against the weight of the electric generators.

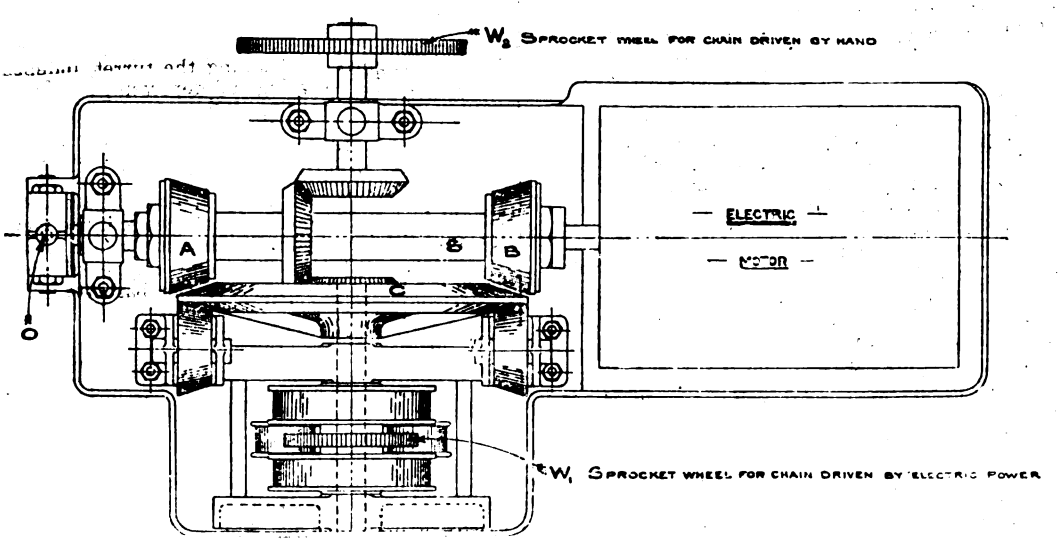

FIG. 36.—Electric Ammunition Hoist Gear (Sir W. G. Armstrong, Whitworth and Co.).

Electric Ammunition Hoists.

Electric hoists for serving the 6in. and smaller guns are in use in many navies. The "Powerful" and "Diadem" classes of cruisers were fitted with them, but the later English ships are fitted only with hand gears. In the United States and Japanese ships they are usually found. The apparatus consists of a quick-running motor of 2 h.p. to 5 h.p. geared in some way to a light whip or chain tackle for lifting small parcels of shot and shell at high speed. The motors must be so controlled that they start, stop, and reverse very quickly, with automatic brakes to hold them as soon as the current is switched off, or else the motions must be effected by clutch gears thrown in and out of connection with a continuously-running motor. The latter arrangement is used by Messrs. Armstrongs with friction gears. Fig. 36 shows the arrangement in plan. The motor shaft being in rotation, a vertical lever, acting at O along the axis of the shaft, puts either of the speed cones, A or B, into gear with C, thus driving sprocket wheel, W1, over which an endless chain runs, passing also over a fixed sheave at the top of the hoist. The cones, A and B, being out of gear, and therefore running free, the cartridges or projectiles in a bag are hooked on to the chain at the bottom, the friction gear brought into action, and the ammunition rapidly hoisted. Then, while this bag is being unhooked at the top, another round is being hooked on the other side of the chain at the bottom, the cone gears are reversed, and the second charge hoisted, and so on. There is an automatic arrangement for throwing the cones out of gear at the right time for each lift, there is an alternative hand gear work-

* Discussion on Admiral Melville's paper, "The Logical Arrangement of the Motive Power of Warships," Inst. N.A., March, 1899.

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ing through the sprocket wheel, W2, with arrangements for preventing both the hand and power gears being in operation at once, and other details not shown in the sketch.

Summing up the power requirements enumerated in the foregoing paragraphs, we get :

	Total motor capacity installed, including duplicates. E.H.P.	Maximum demand for power, duplicates excluded. E.H.P.
Ship ventilating fans	40	40
Engine and boiler room fans	100	100
Furnace air-blowing engines	200	200
Steering engines	400	200
Forward capstan	120	120
After capstan	50	50
Boat hoists	100	100
Coal hoists	100	100
Ash hoists	20	20
Workshop engine	5	5
Air compressors	200	100
Turret motors	500	300
Ammunition hoists for 6in. and smaller guns	50	50
Totals	1,885	1,385

If these figures err, they err on the large side. In working out details savings both in power and weight could probably be effected. There are no conceivable circumstances in which the whole of these machines could work simultaneously. The worst conceivable case supposes that in time of action all the gun-working machinery, air compressors, furnace engines, ash hoists, ventilating fans, and steering engine would be at work together. Then the aggregate horse-power demanded would be, according to the above figures, 1,015 e.h.p. input to motors = 760 kw. The lighting of the ship would involve 50 kw., and the searchlights—if it be conceivable that all this mechanism could be employed at night when searchlights were wanted—a further 50 kw. or 60 kw. But, taking into account the fluctuating demands of current made by the motors, and the fact that it is hardly physically possible for everything to be working at the top of its load at precisely the same instant, about 600 kw. output would meet all requirements and cover distributing losses, while 800 kw. to 850 kw. installed in the ship would leave an ample margin of spare plant in all ordinary circumstances. Now, this is an equipment not at all unlikely to be called for in the future. It will not come all at once, but it may come sooner than many would allow. What should be the arrangement of plant and system to successfully cope with it? It seems clear that an installation of 800 kw. is not to be provided by the multiplication of 50-kw. sets. Yet it will always be desirable for battleships to carry a few sets of 50-kw. size—(*a*) for lighting and ventilation when nothing else is doing; (*b*) for working searchlights; (*c*) for regulation of turret and steering motors, should that method not be superseded by something better. But after 200 kw. or 300 kw. are reached, it would be wise to introduce sets of 150 kw. or 200 kw. capacity—the latter for preference. Then for an 800-kw. installation we might well have three sets of 200 kw. each and four sets of 50 kw., there being enough sets of each size to form an efficient reserve. It would be most undesirable to introduce a lot of intermediate sizes.

In regard to the electrical system to be employed for distribution, two questions at once arise—(*a*) whether continuous currents should be employed throughout, or whether polyphase currents should be introduced for the motors; (*b*) whether the existing standard of 80 volts should be retained.

(*a*) In view of the fact that machinery on board ship gets very little attention, it has been urged that polyphase motors should be used on shipboard, because they do away at once with all commutator troubles. But it is to be urged that well-built modern continuous-current motors give next to no trouble at the commutator, and that even the polyphase motors would require collecting rings and starting resistances. But the chief objections to the introduction of polyphase machines on board ship are the disadvantage of having two systems of distribution in the ship, and the introduction of the third cable. Possibly the relative advantages and disadvantages are pretty evenly balanced. At any rate, polyphase motors have actually been introduced by the Austrian navy on their coast defence ships "Budapest," "Wien," and "Monarch," the currents being generated by composite machines which give continuous currents from a commutator on one end and three-phase currents from collecting rings at the other end of the armature.

(*b*) The question of the voltage standard is of greater difficulty; 800 kw. at 80 volts means 10,000 amperes to distribute, which represents a very formidable amount of cable work. If the pressure were doubled, the currents would be at once reduced to 5,000 amperes, and the saving in weight and cost of cables would be material. The United States battleships "Kearsarge" and "Kentucky" are wired on the three-wire system with 160 volts between the outers. The motors are in general arranged on the 160-volt mains, though a connection is usually taken from the middle wire to provide for changes of speed by switching the motor on to the low-voltage mains. Searchlights and incandescent lamps are arranged on either side of the system to make an approximate balance, as is usual. The results of experience in these ships will be watched with great interest. The author is a little diffident as to the introduction of a three-wire system on board ship, and would rather prefer a direct circuit of 160 volts for both lamps and motors. Indeed, having got so far, one might as well accept the 200-volt standard at once. Searchlights in such an installation could be operated with very little complication through "series-parallel" switches, which in the one position would put two searchlights in series, and in the other position put each searchlight on separate circuit on the mains, with the addition of a resistance capable of absorbing the remaining volts. With automatic lamps this should be quite feasible, and any difficulty attending the use of so large a resistance as would regulate the arc down from 160 or 200 volts would probably be less than the difficulty of maintaining a balance of voltage on the two sides of the three-wire system when the searchlights worked intermittently if that system were used. Of course, the use of 200 or even 160 volts generally would impose a greater strain on the insulation of the cables and fittings than is now experienced, and would require some improvements in the design of fittings established, but there are no serious difficulties here.

Instead of the tree system of wiring, as at present adopted, all the main cables should be run in rings round the several decks back to the switchboard; through connecting boxes being provided at intervals of 100ft. or so for rapid disconnection and testing. With such an arrangement a circuit might be injured or shot away in any place without affecting the main supply of current. Separate ring mains for lights, searchlights, and motors should, of course, be used with throw-over switches to connect one to the other on special occasions. It would be desirable to divide the main switchboard into two parts in the machinery-room, connected together by switches which would form the closing links of the ring mains, the object being to avoid the possibility of a total breakdown by fire at the main switchboard, which always exists when all the cable connections go through one narrow neck. Of course, all the casings and other woodwork now used about switchboards should be rigorously abolished. The cable distribution should be expressly taken into account and allowed for in the design of the ship, proper trenches or culverts being provided for the cables. At present no such provision is made, and it is often a matter of considerable difficulty to find suitable runs, especially where cables have to pass watertight doors and the like.

Returning, now, to the generators, the question arises as to the possibility of providing the necessary weight and space; 800 kw. in generators of the existing type, with double-acting engines, at speeds of about 400 revolutions per minute, would involve, with steam and exhaust connections, about 80 tons. This is the only increase in weight, as the motor weights balance out, the additional weights mentioned in the detailed descriptions of the motors above being counterbalanced by the saving which would be effected in the turrets if electrical machinery were substituted for hydraulic for gun working. The weight of the main hydraulic equipment, 25 tons, is a credit against the generator weights. There would, indeed, be a slight saving in the weight of distributing cables and switchboards as compared with the auxiliary steam and exhaust pipes now required for the services in question, but it would not be much. Approximately, 55 tons of additional weight then has to be carried. In discussing the question of coal consumption, it was shown on the figures there stated that the substitution of electricity for steam for all the auxiliary services would result in the saving of 262 tons of coal for every 25 days' steaming. This figure was calculated upon data assumed to represent the best possible conditions. Some of the engine and boiler room pumps have been assumed to remain steam driven, but if electric driving be applied to the services enumerated, and if only one-half or one-third of that estimated saving were realised, there would still exist a strong *primâ facie* case for the adoption of electrical power. The weight of generators might be materially diminished by the employment of single-acting engines driving dynamos at higher speed, and still more by the adoption of turbine-driven sets. The weight of the units mentioned could be done with Parsons turbo-generators, including condensers for about 60 tons. Single-acting engines and turbines have both been used in the navy; unfortunately both have failed, and, as a consequence, both are at present looked somewhat askance at for the purpose. They require dry steam, hence one of the principal sources of difficulty in the old arrangement, but one that should not occasion much trouble in the new. This consideration, coupled with the very great improvements that have been made in both since the days when they were used in the navy, may bring them into service again. The space required for the generators for the power mentioned would lie between 800 and 1,000 square feet, whichever of the three systems be adopted. It is not easy to find this room in an existing battleship; but on the hypothesis, the main hydraulic engines would not be wanted, and the space

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occupied by these two rooms would be available. If in consequence of savings on account of efficiency less coal were carried, though a saving of weight would be appreciated, little space would be added for the purpose of generators. Possibly the change to electric driving might be carried out in conjunction with some other change in the disposition of the *matériel* of the ship. For example: there are not wanting critics who consider that it is out of place in these days for ships of the fighting line to carry torpedoes. Should such a view obtain official support, a room equivalent to one of the existing submerged torpedo-rooms would make an ideal generating station. Its locality would be, for preference, immediately adjoining the forward boiler-room bulkhead, so that the steam connections might be short and direct.

The electrical equipment of ships of water is the product of many hands and brains. Naval authorities do not as a rule design. They formulate requirements, and the engineering experience of the country is laid under tribute to meet those requirements. Hence it comes about that much of the apparatus employed is of a proprietary kind, and the author has to acknowledge the kindness of many firms and friends who have allowed him to describe their apparatus and inventions. These have already been mentioned by name in the paper. He is also under obligations of a more general kind, and is pleased to acknowledge here his indebtedness to the Lords of her Majesty's Admiralty for permission to describe parts of the equipment of H.M.S. "Albion," and to make various references to Admiralty specifications; to the naval attaché of the Imperial Japanese Embassy for permission to refer to the equipment of the battleships recently built in this country for the Japanese Government; to the General Electric Company, of Schenectady, U.S.A., for the photographs illustrating American apparatus; to Messrs. Sir W. G. Armstrong, Whitworth, and Co., Limited, for permission to include particulars relating to the electrical side of their naval ordnance work; and to the directors of the Thames Ironworks, Shipbuilding, and Engineering Company, Limited, for permission to make general use of the information in their possession.

Discussion.

Captain Creak opened the discussion, and said there was one thing which he would like to mention—the question of the wiring affecting the compasses on a ship. He knew of no case where this had taken place, and thought the wires were safe in this respect. It was, however, the dynamo which was the great sinner, and he had been asking electrical engineers to build him one without an external field. In some cases this field affected compasses 50ft. away. Experiments had been carried on as to the wiring for many years past, and had proved that interference could be prevented.

In reply to **Prof. Ayrton, Captain Creak** said the return wires were insulated.

Mr. S. Evershed said that Mr. Grove's paper was of great value from two points of view—namely, it gave them a good idea of the present position of electricity in the navy, and it was of interest to them as Englishmen as well as engineers, as it showed that their navy was not so far behind the rest of the world. It seemed to be the idea that all novelties were kept out of the navy, but this was not so. A novelty had, however, to undergo a severe ordeal before it was accepted by the Admiralty, as it had to pass three branches—namely, the administrative, constructive, and executive branches. He himself called these three branches the constructive, obstructive, and destructive branches. It was clear from the paper that electricity in the navy was just in the transitional stage in which a few years would find an enormous difference in its use on warships. At present, on going on board a warship, one was struck with the rather casual electrical arrangements. All the machines were of the best type and quality, but the manner in which they were put in suggested that they were an afterthought. The author's suggestion as to a power station on the ships was a good one, and he thought that in a few years' time a properly-designed power station would be put in under a protective deck. Most of the novelties which had been introduced had come from the outside, and his (the speaker's) own part had been towards the establishment of communication on board ship. Speaking-tubes were very unsatisfactory, it being impossible to make any use of these pipes in many parts of the ships. The telephone would be a valuable improvement, because it would enable the voice to be heard almost as clearly as if the person speaking were quite near. As to the reference to the leakage from iron-clad dynamos, when it was first proposed to try them he had informed the Admiralty as to the disadvantage which would result from their use, but they had not heeded the warning. Although the dynamo could be isolated magnetically, the compass was the proper thing to isolate. With the four-pole machines now used, however, the danger was not so great as with two-pole dynamos. He had some instruments on the table which were invented to supersede the voice tubes. These instruments might be divided into two classes—first, the apparatus which contained a large amount of mechanism and took little electricity, and, secondly, the apparatus which took a considerable quantity of electricity and had little mechanism. The apparatus described by the author belonged to the second class. Figs. 26 and 27 were illustrations of this class of instrument, and were practically large ohm-meters. With the first class of instrument various devices had to be introduced to prevent them working too fast, but with the second class any speed of working could be obtained. This telegraphic signalling apparatus had been in use during two commissions of the "Narcissus" on the China station, and the apparatus worked as well afterwards as when put in, and was as good as new. The speaker then described the instruments on the table, including a telegraphic arrangement for showing engine speeds, etc., which was worked from the engine-room and could be read in the same way as a thermometer. These instruments had never really failed. One case had, however, been reported to him where a temporary failure occurred owing to the firing of heavy guns, but this was soon put right. A second, which was stated to be a total one, was reported to him. The apparatus was on a ship on its trial trip, and on investigation he had found that the failure complained of was because the switches had been left in the off position during the trial.

Colonel R. E. B. Crompton said the paper was similar to one he read some seven or eight years ago at Portsmouth before the Institution of Mechanical Engineers. What he said on that occasion rather upset the Admiralty, and resulted in his not having a contract for some years afterwards. He had, however, been afterwards thanked for what he then said, so he supposed he had been forgiven. He, however, was going to say much the same thing again. He considered the state of the navy as regarded electricity was nothing less than a disgrace to the country. They were much indebted to Mr. Grove for his paper, which was an indictment of their navy as compared with other navies. He would point out that the Admiralty did not do much towards putting electricity on board ship. This was left to private contractors, and was first tried on board a Brazilian ship. The reason it was adopted was because one of the members of the Admiralty was also connected with the fitting of this Brazilian ship, and he recommended it. As to the Siemens projector, shown in the paper, it was, he thought, maligning the house of Siemens to give it their name. They designed the really electrical parts, which were excellent. It was a 24in. projector with a 27in. focus. This long focus simply made it the worst projector in the world, and it was utterly useless where automatic lamps where employed. The distance of the projector from the arc made the shadow so large on the mirror that it blocked out 50 per cent. of the light, and gave a tubular beam. This was what he called the Admiralty beam. They got over it by using an inclined lamp worked by a blue-jacket. He would ask them to compare this projector with the one shown in Fig. 17, which was really the "white man's projector." In the Crystal Palace Exhibition some time ago there were projectors exhibited similar to the Schuckert type, but they had not yet been adopted by the navy, although they had been by the War Department. As to the question of placing a central station on board a warship, he had often said this should be so, and thought everything tended to the auxiliary machinery of a warship being driven from a central station placed below the water-line, the power being transmitted by a system of distributing mains, duplicated perhaps a great many times. It would also be much easier to teach the use of only one set of motors to the men who had to work them than to use hydraulic, steam, and some electric motors. Mr. Ward Leonard's arrangement for changeable speed and torque was one of the most beautiful inventions ever made, and it ought to be more used, that it had been. He saw that the author pointed out that even now electric motors were looked upon with suspicion, and he thought that in the navy it was a case of "steam they know, hydraulic power they know, but electricity they did not know much about." He thought it a much more common occurrence for a steam motor to break down than an electric motor. He had never seen an electric motor break down all at once, although he had seen them break down very slowly after giving ample warning. As to steam motors—well, he would not mention them. Hydraulic appliances on land were very liable to damage and to failure through frost, and he did not see why this should not be the case at sea. The way to work searchlights at 200 volts was by means of rotating transformers. Mr. Grove spoke of single-action engines and transformers having been both used and failed. He himself did not wish to speak of the turbine, but as to the single-action engine he thought it a scandal that the Willans engine, the best-acting engine in the world, had been kept out of the navy—and they knew why.

Mr. A. E. Richards said that, in reply to Mr. Crompton's speech, he felt sure the Admiralty did not prevent him obtaining a contract merely on account of what he said at the Mechanical Engineers' meeting. As to what Mr. Crompton had said in that the Admiralty projector was not automatic, he would like to say that the people who had to use them did not think automatic arrangements necessary. As to the use of the automatic projector by foreigners, he stated that the American Secretary of State had said that it was the general opinion that automatic devices were useless in the American navy, and that it was better to feed the carbons by hand. This was a report on the war in Havana, which justified, he thought, the Admiralty in using hand-fed projectors. He agreed with Mr. Crompton on the question of ship dynamos. The first Admiralty specification for dynamos when brought out caused a great deal of discussion in the Institution, but of those introduced during the first introduction of electricity into the navy he had not known one to fail. All the troubles had been on the engine side. There were dynamos in some of the ships which were installed in 1886 and they still worked well. With respect to the passing of cables through bulkheads by means of water-tight glands, the author stated that it was an objection that the cables could not be drawn back. He did not see why they wanted to draw them back, as the cables should last the life of the ship. He thought, however, that if required they could be drawn back. As to the relay, shown in Fig. 14, for indicating when the bow lights on a

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ship went out, he thought this an unnecessary piece of apparatus, as the lights did not go out. As to voice pipes, they were a very unsatisfactory means of communication, but until the Graham telephone was in good working order he did not see how Mr. Evershed was going to improve the system. With regard to the power in ships, Mr. Crompton thought that the ship should be really one big central station. He himself did not doubt that better results could be got on ships if they were designed for all the auxiliaries to be worked by electricity. But all battleships were not designed to be worked entirely by electricity, and they had to suit the arrangements to the ship, and not the ship to the machines.

Mr. A. A. Campbell Swinton said he did not altogether agree with what Mr Crompton had said. He had paid careful attention to the matter, and his own opinion was that up to a point the electrical arrangements on warships were pretty good, but they were not applicable in all cases. Thus, in the training of large guns hydraulic arrangements were better, as in this case particularly steadiness was needed. This could be got to a remarkable degree by hydraulic power, a degree which could not be attained by electricity. As to the turbines referred to in the paper, he was the first to put turbines on a warship which was sunk in the Chilian war. The reason why turbines were not adopted by the navy was the difficulty to make them economical in the smaller sizes. In the trials which were made of the turbines it was difficult to get the engineers to understand them, and they were also placed transversely in the ship instead of longitudinally. Owing to this last fact, heavy strains were met with in working.

Mr. G. C. Allingham said it was interesting to note that lead-covered cables were used, and apparently worked well, when cables in damp cellars and such places were supposed to rot very quickly. He wished to know whether fibrous insulation had been tried on board ship. He should also like to know whether twin cables had been so used, as he thought their use would save much complication in the cable work.

Mr. A. J. Lawson said that in the description of modern practice as described in Mr. Grove's paper, one thing which had struck him was the departure from the "central-station" method in the lighting of ships of war. The generating sets were distributed all over the ship, often a long way from the main engine-rooms and from each other. Consequently there was a great length of steam-piping, with all its attendant losses. There was also complication of the wiring, in which ring mains were a necessity. Many years ago, in 1884 and 1885, he was engaged in the lighting of steamships, and then their practice was to put engines and dynamos in the main engine-room, the dynamos being belt-driven, and supported, like the engines, on brackets built on to the frames of the ship. The speed of the engines was about the same as at present—350 revolutions, but the dynamos ran at from 1,200 to 1,800 revolutions per minute; and although the engines were anything but economical in steam consumption, he doubted if they were nearly so wasteful as those mentioned in the paper, of which the high consumption was to a large extent due to the long length of steam-piping used among other causes. Some of those present might have crossed Lake Superior on the vessels of the Canadian Pacific Railway, to which he referred on the occasion of the first visit of the British Association to Canada. Again, the Admiralty, for very inadequate reasons, had adopted a voltage which was used by nobody else—a standardisation of the wrong kind. He thought the sooner they went to 100 or even 200 volts, and got machines which had not to be specially wound, the better it would be. This increased voltage and the return to "central-station" methods on board ship would reduce the massing of cables shown in some of the illustrations, and produce better results in every way.

Mr. C. E. Grove, in reply, said he was glad the paper had elicited so much criticism. Mr. Evershed thought the Admiralty were well to the front in electrical matters, and Mr. Crompton went to the other extreme. He himself thought the truth lay between those two statements. His paper, he thought, showed that in some respects foreigners were treating electrical enterprise better than our own navy. The Admiralty were too conservative. Mr. Richards showed that the Admiralty waited to see if anybody else made a success of a thing before adopting it, but he thought they often waited rather too long, and that there was room in this country for a little more liberality towards enterprise. If there were any differences at all between the reliability of an engine or a dynamo, the balance was on the side of the dynamo. People, however, would not believe that electricity would work successfully even tramways, and railways, and other things. In time, the mechanical engineer would have to be an electrical engineer also, and things would then stand on their proper footing. Mr. Richards had remarked that they must suit the machinery to the ship, but he thought this opinion was erroneous. Ships had again and again been built round various objects. They had been built round special guns, and within the last few years the Admiralty had built ships round the Belleville boiler, this being different to the usual type. There was then no reason why a ship should not be designed round an electric power station. Mr. Swinton showed how necessary it was to have slow, steady action in the working of guns. He (the speaker) was an admirer of the beauty of hydraulic power, but he thought the reason why hydraulic power was used for these guns was that the principal firm of gunmakers—viz., Messrs. Armstrong and Co.—were also great hydraulic engineers, and therefore the two things went together. He thought that if Messrs. Armstrong and Co. had been electrical engineers, the same might have applied to electricity. Electricity seemed to be especially applicable to the moving of turrets on ships, it being used very successfully in the American navy.

ELECTROGRAPHS.

The following illustrations are taken from an article by Prof. Elmer Gates appearing in the *American Inventor*. In the article in question a number of other electrographs showing interesting

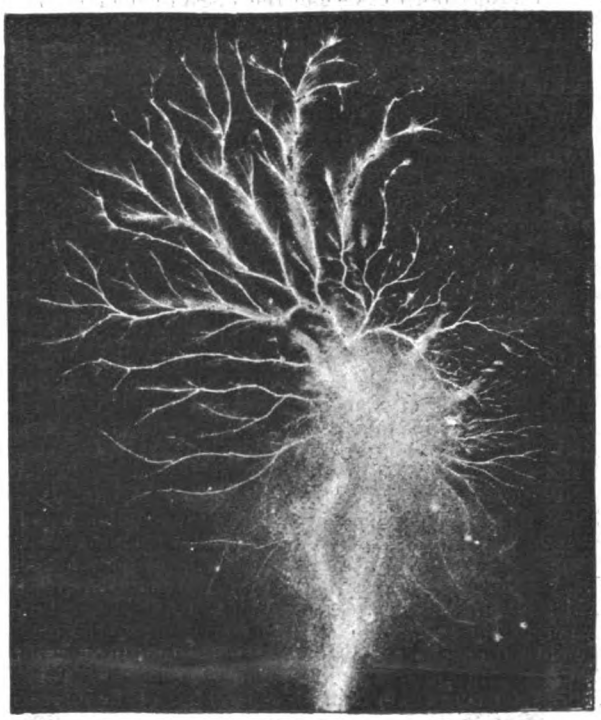

FIG. 1

details are given, but we have to confine ourselves to reproducing three of our contemporary's illustrations. Fig. 1 was obtained by placing a sensitive plate in a lightproof envelope and subjecting it to the action of a 10in. spark from a static

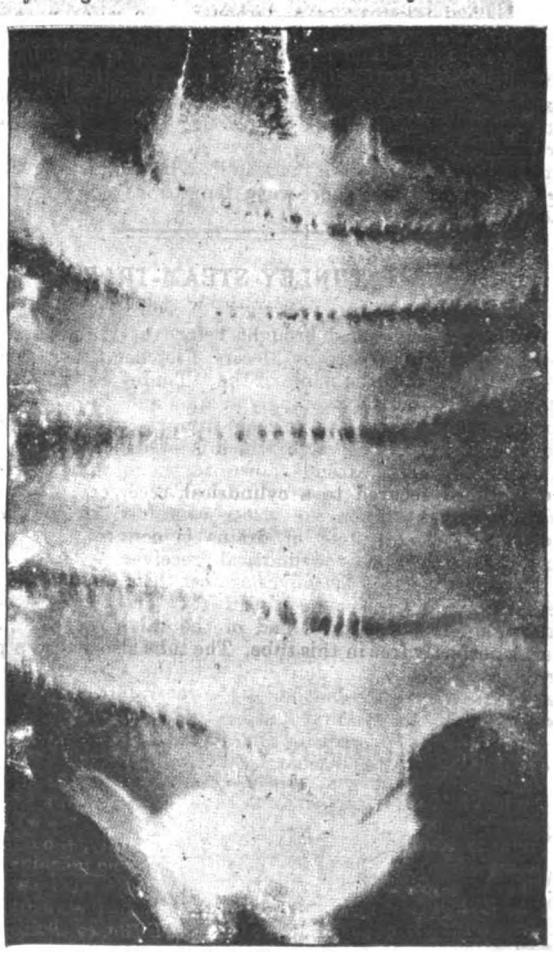

FIG. 2.

machine. The author discusses the variation in the effect produced when the spark takes place through other media than air. The curious effects shown in Figs. 2 and 3 were obtained by placing a sensitised film between two shellaced surfaces of

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glass, and the author claims that these are the first photographs in which an electrical wave length has been shown. He states that in Fig. 3 a lower potential was used, which corresponds to

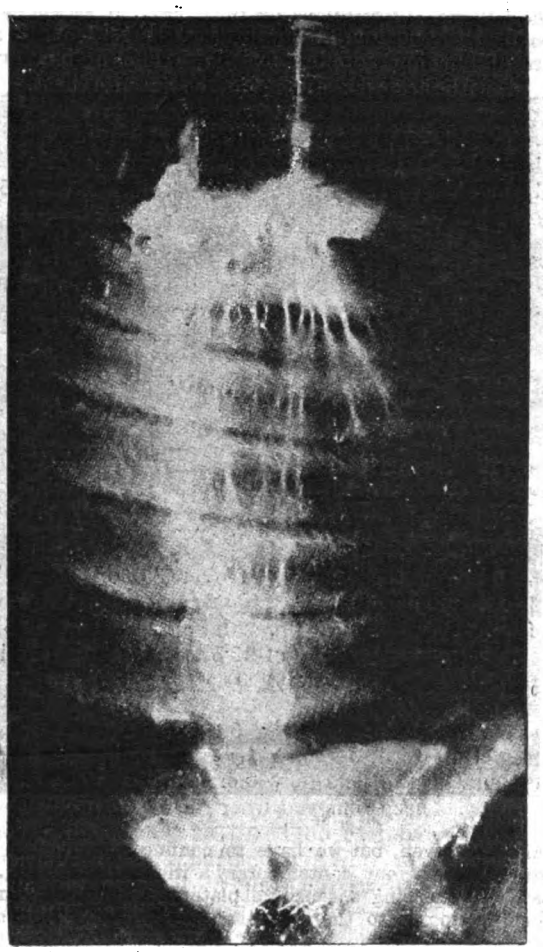

FIG. 3.

a longer wave length. Without more information as to the exact arrangements when these extraordinary photographs were produced, it is difficult to say exactly what has caused the stratification which is shown, but we do not think Prof. Gates is correct in his assumption that he has been able to get electric discharges with such short wave lengths as are shown in his photographs.

THE TUNLEY STEAM-TRAP.

We have recently had brought before us a new steam-trap now being manufactured by Messrs. Fletcher Bros., of Ashton-under-Lyne, under the name of the "Tunley" steam-trap. The action of the trap is exceedingly simple, and involves very few moving parts. These can be seen from the section of the trap shown in Fig. 1. The valve, which is a balanced one, is formed on a spindle, which extends down to the bottom of the trap, and is there secured to a cylindrical receiver, which in the ordinary way floats on the water contained in the body of the trap. The system of drains is connected to a pipe, which drips into this cylindrical receiver. The buoyancy of the receiver keeps the valves against their seats, except when discharging. A tube carried down from the body of the valve acts as a guide to the lower end of the valve rod, which, however, is perfectly free in this tube. The tube also acts as a passage for the condensed water delivered into the trap, which is thus always taken from the bottom of the receiver. This condensed water fills up the receiver until a point is reached at which its buoyancy is overcome, and the valve then opens and allows the water to discharge. The hand release which is provided to enable the receiver to be practically emptied is carried through a stuffing box on the top of the valve, and which keeps at the end of the valve spindle. It will be seen, however, that there are no stuffing boxes on the valve spindle itself which would introduce friction and uncertainty in working. The outlet valve being of the balanced type, there is absolutely no adjustment required for a variation of steam pressure, which is a common cause of steam-traps passing steam instead of water only. In the latest types the valves and valve seatings are made renewable. Another advantage in this trap is that it will respond at once to a sudden rush of water, there being no time lag as in those traps which are dependent upon temperature effects for their action. These steam-traps are being manufactured under Mr. A. E. Jackson's patent, and are finding, we understand, a ready sale. They are particularly suited to high steam pressures, and the bodies of the traps are

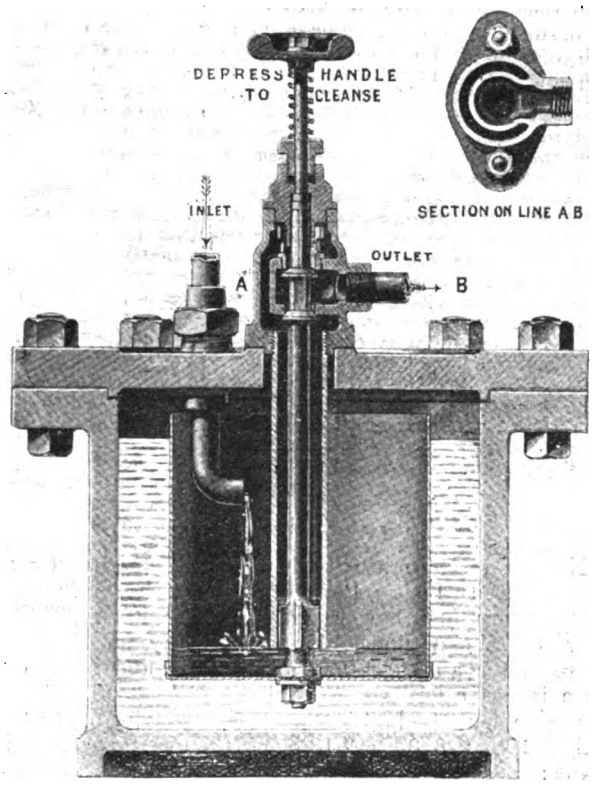

FIG. 1.—Section of the Tunley Steam-trap (Jackson's Patent).

all tested to double their working pressure before leaving the works.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

265. The armature of a stationary-field alternator has its halves connected in parallel. One of these halves is injured, and is completely disconnected. Explain what would happen if the alternator were now paralleled with other machines.—J. A. S.

266. What would be the best plan for arranging a negative booster on an extended system of tramways where several routes require to have the current on rails, as it were, sucked back by these apparatus? Would it be satisfactory to have the negative feeders connecting on to a 'bus bar, or to have a number of boosters working on each feeder separately?—MAGNET.

ANSWERS.

Question No. 259.—What is your opinion of oil *versus* coal as fuel? Describe the method of burning the former.

Best Answer to No. 259 (*awarded* 10*s.*).—A steam-boiler arranged for combustion of oil fuel should produce no soot. The tubes may be smaller diameter than for coal, and heating surface increased from 33 to 50 per cent. A boiler fired by oil may be from one-third to one-fourth smaller than when fired by coal for same evaporative power and draught. Amongst the advantages of oil fuel may be cited the follow

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ing: (1) reduction of weight by about 40 per cent., and bulk about 35 per cent.; (2) reduction of number of firemen about the ratio of 4 : 1; (3) prompt kindling and extinguishing of fires. The advantage or otherwise of oil will, of course, depend greatly on the relative prices of oil and coal. Roughly, the cost per 1,000 units of heat with coal at 12s. per ton would be 1½d., to 1¾d. per gallon with oil.

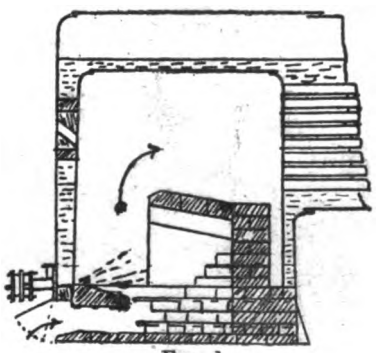

FIG. 1.

Natural oils are usually distilled, and the heavier portions used as fuels. Petroleum, petroleum refuse, tar, creosote tar refuse, have a higher calorific power than coal; they contain a much larger quantity of hydrogen. Petroleum is a natural hydro-carbon oil, and in its crude state it has calorific power 1½ times that of coal. The best petroleum fuel oil has a specific gravity of ·818, and weighs 10lb. × ·818lb. = 8·18lb. per gallon, its composition being:

Carbon	85·34
Hydrogen	13·51
Oxygen and impurities	1·15
	100·00

It contains three times the hydrogen contained in good coal. Theoretical heating power of fuel oil is 20,882 thermal units, and its theoretical evaporative power = 20,882lb. ÷ 966lb. = 21·56lb. of water, from and at 212deg. F. per pound of oil. Its actual evaporative power is 15½lb. to 17lb. of water, from and at 212deg. F. per pound of oil. Its flashing point is about 217deg. F. Generally, 104 gallons, or 104 × 8·18lb. = 851lb., of this oil are equal in evaporative power to one ton of good coal.

It may be interesting to note some figures from tests made in Philadelphia some time back to ascertain the relative values of coal, petroleum, and gas:

	Pounds of water from and at 212deg. F.
1lb. anthracite coal evaporated	9·70
1lb. bituminous coal evaporated	10·14
1lb. fuel oil, 36deg. gravity	16·48
1 cubic foot gas, 20 c.p.	1·28

The gas used was that obtained in the distillation of petroleum, having the same fuel value as coal-gas of equal candle-power. Taking the efficiency of bituminous coal as a basis, the calorific energy of petroleum is more than 60 per cent. greater than that of coal, whereas theoretically petroleum exceeds coal only about 45 per cent., one containing 14,500 heat units, the other 21,000.

Method of Burning Oil Fuel.—The oil is burnt in a boiler furnace in spray, after being pulverised by steam or compressed air. It cannot be burnt in a coal-burning furnace, as it makes an enormous amount of smoke. To prevent smoke, the oil is burnt with a large supply of air in a brick-lined chamber. The quantity of air required for complete combustion is one-third greater than for good coal. The minimum quantity of air that should be provided is 22lb. per pound of oil. The system of effecting combustion by pulverising the oil with steam involves the expenditure of from 8 to 13 per cent. of the total quantity of steam produced by the boiler in atomising the oil, or converting it into spray. In experiments on Russian railways with oil fuel, Mr. T. Urquhart obtained an actual efficiency equal to 82 per cent. of the theoretical heating value. In the Urquhart system of burning oil, the petroleum is fed to the furnace by means of a spray injector driven by steam. An induced current of air is carried in around the injector nozzle, and additional air is supplied at the bottom of the furnace. Figs. 1 and 2 show system of burning adopted by him. The firebox has to be lined with firebrick owing to the intense heat. The Holden system of liquid fuel burning consists of keeping the bars of the grate covered with about 3in. of solid fuel, on which the oil is sprayed. On the express engines on the Great Eastern Railway the coal consumption is 35·4lb.

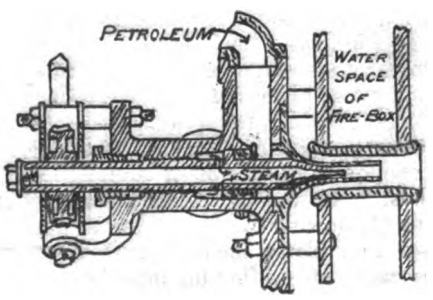

FIG. 2.

per mile, taking the average of over 3,000 miles. With liquid fuel the average for the same work is 11·8lb. per mile for coal for lighting up, standing, etc., and 10·5lb. of oil per mile, making a total of 22·3lb. of combined oil and coal per mile.—F. BRUTON.

Answer to No. 259 (*awarded* 5s.).—Oil, in the sense we now use the word, is the residual, amounting to about 60 per cent. of the charge, which remains after the pure petroleum has been removed from the crude product of the wells. Delivered free on board at any English port, it could be had, providing a demand existed sufficient to justify a supply on a large scale, at between 25s. and 20s. per ton. This fact—its high price—is the only material objection to its extended use for every purpose, whether of steam-raising or manufacturing process, for which we now employ coal. The question whether the indirect advantages of its use may not outweigh the single great defect of high first price is one which it will be our task to examine. The calorific value of good coal is 14,000 B.T.U., its efficiency in a boiler about 8,000 units. The calorific value of petroleum residuals is about 18,000, its efficiency in a boiler about 16,000 units. One ton therefore of oil represents a calorific value of two tons of coal. Under economical conditions this duty is found in practice to be increased by half. Therefore one ton oil equals three tons coal; one ton of oil occupies 39 cubic feet, one ton of coal 44 cubic feet. Therefore oil at 25s. per ton equals in efficiency good coal at 7s. 4d. per ton—not by any means an exorbitant price in these days of coal strikes. A ship carrying normally 7,000 tons of coal will travel as fast and as far carrying 2,000 tons of oil, and will have 5,000 tons capacity in addition for passengers or cargo, or carrying 7,000 tons of oil will travel three times as far without having to refuel—a distance increased to 3½ times if the same cubic capacity of bunker space be provided. The chief oil wells of the world are situated in United States, on the Caspian, in Galicia, Canada, Burma, Venezuella, and Baku. A nearer approach to any of these will reduce the price and increase the usefulness of oil fuel. "It is through the Suez Canal, along the Eastern trade routes, that the greatest triumph of liquid fuel may be expected. Every mile adds to the cost of English fuel in that direction, and renders competition with 'astatki' shipped at Batoum more difficult."

The other chief advantages are: (1) it is quite smokeless—an advantage to a man-of-war, or any power producer who lives within hail of an inspector of nuisances; (2) the fires are lit rapidly and easily suppressed; (3) the temperature of the flame is constant—useful in armour-plate bending and allied trades; (4) fire can be manipulated by merely turning a cock; (5) labour employed in stoking enormously reduced; (6) no soot being deposited, the boiler tubes will require very much less cleaning; (7) it may be fed aboard ships with very great rapidity, and may then be stored in spaces useless for cargo—between double

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bottoms, water-ballast chambers, etc.; (8) no clinkers, no ashes, no periodical cleaning out of grate; (9) hence a longer-lived boiler.

The disadvantages are as follows: (1) Difficulty of obtaining suitable oil, to be discounted against the more frequent fuelling with coal. (2) Danger of explosions. This is not serious. Petroleum residue is probably quite as safe as coal; its flashing point, 170deg. C., need never, if proper care is taken in design of storage tanks, etc., be nearly approached. Even crude petroleum, if exposed for a little time to the action of the air, loses most of its dangers. After a fortnight's exposure its flash point is about 70deg. C.

Methods of Burning.—The methods of burning oil are very numerous; they may, however, be divided into three classes, which we will consider in their order: (1) hearth furnaces, (2) gas furnaces, (3) spray furnaces.

1. Hearth furnaces, sub-divided into pan, step, drop, and oozing, all employ in one form or another the system of direct combustion of the oil. This is done by keeping it ignited while (1) flowing in a broad or a number of thin streams over iron plates inclined from the furnace door towards the back; (2) welling up into shallow fluted trays placed on firebars; (3) dropping over serrated plates; (4) oozing up under pressure through the pores of a pumice stone or asbestos slab placed in grate after the manner of an ordinary lamp wick. These methods, though all employed with some success, are now somewhat obsolete. The chief objection is a defective air supply, and consequent smoke nuisance and inefficiency.

2. A gas furnace is one in which oil is supplied to furnace in a gaseous state. The oil on leaving supply pipe flows over a hot plate, the more volatile constituents being evaporated, the less passed on in succession to still hotter plates until all possible is rendered gaseous, the residue falling on to and being burned on the firebars. The gas entering firebox is ignited and reduced to flame.

3. Spray Furnaces: In these furnaces the oil is divided into small sprays by a steam or air jet, and is then completely burnt in a vaporous condition by means of the introduction of air. They, again, take many forms, one of the simplest consisting of two concentric tubes brought to fine nozzles at the ends (as in the steam and water feed of an injector, and being in the same manner adjustable), the inner one of which is connected to the oil, and the outer one to the upper portion, filled with air, of a gasometer about half full, containing oil under an air pressure of about two atmospheres. The aerated and atomised gas issuing from the combined nozzle is ignited, and being deflected by a firebrick bridge, impinges on the heating surface of the boiler. In other forms steam is the disrupting agent, but all are worked on the same principle.—HUGO FLINN.

Question No. 260.—Give a rule for determining the proper distance between the driving centres of belt-driven pulleys and the minimum diameter of the same for a given power transmitted.

Best Answer to No. 260 (*awarded* 10*s.*).—It is rather difficult to lay down a hard-and-fast rule as to the proper distance between the centres of driving pulleys, as these conditions are in the majority of cases fixed by circumstances and not by rule; this also applies to the size of the pulleys. Authorities do not agree on this point at all. Prof. Jamieson, for example, states that pulleys should be as far apart as possible, and their diameters as large as possible; while, on the other hand, during a discussion on the paper "Belts for Machinery," Mr. Mavor stated that, where possible, the pulleys should be kept apart not less than three times or more than four times the diameter of the larger pulley.

These two opinions obviously do not agree with one another; both are probably the result of practical experience acquired under special conditions. In regard to the former, it is undoubtedly very injurious to belts to be bent round small pulleys, but a limit is soon reached when the increase in diameter of the pulley has no practical effect on the life of the belt as far as continual bending is concerned. There must also be a limit to the distance apart of the pulleys, as the weight of a long and wide belt would absorb a great deal of power, and a long and narrow one would be always stretching and need tightening. A practical rule for the minimum size of pulleys is to make their diameter 100 times the thickness of the belt. In regard to their distance apart the matter is rather more involved. We must assume that the belt is straight from one pulley to the other—that is, that there is no sag—as it is not always possible to have the slack side on the top. In Fig. 1 let A and B represent the centres of the two pulleys and D E the line of the belt. Draw B C parallel to D E, and let ϕ = the angle which the radius perpendicular to the belt makes with the vertical. Then the amount of surface of the pulley A in contact with the belt is $(\pi + 2\phi)$, and of the pulley B $(\pi - 2\phi)$. Now, it is obvious that when the

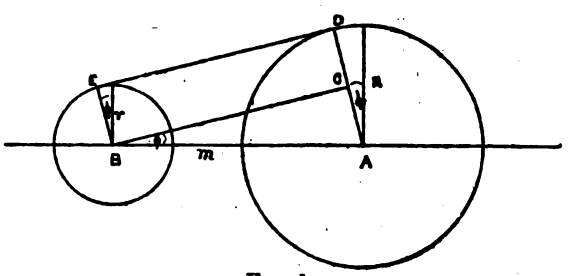

FIG. 1.

pulleys are of different sizes the larger has an area of contact greater than two right angles, and the smaller one less than two right angles, and the further away they are

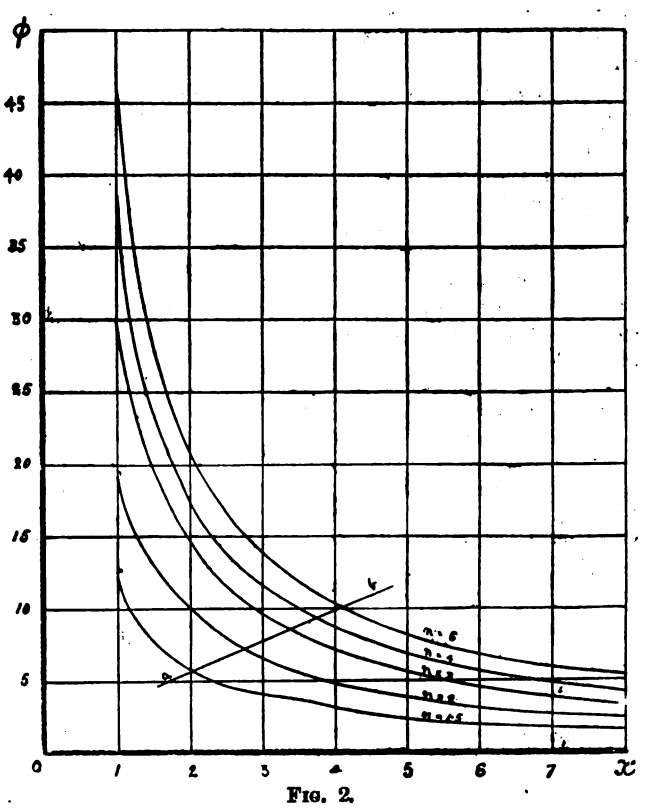

FIG. 2.

from one another the less the excess or defect is from two right angles. We must therefore find the law connecting the distance between the two pulleys and the angle ϕ.

From Fig. 1, $\sin\phi = \dfrac{R - r}{m}$,

when R and r are the radii of the pulleys and m the distance between their centres.

Let $R = n\,r$, then $\sin\phi = \dfrac{(n-1)\,r}{m}$.

Now, it will be simpler to explain m in terms of the radii of the pulleys:

Let $m = x\,(R + r)$, where x is greater than unity,

$$\sin\phi = \frac{(n-1)\,r}{x\,(R+r)} = \frac{n-1}{n+1}\cdot\frac{1}{x}.$$

Now, n is the velocity ratio of the two pulleys, and is therefore fixed in any given case. In any particular case, therefore, ϕ merely depends on the distance between the centres of the two pulleys.

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The curves shown in Fig. 2 illustrate this dependence in various practical cases. The line $a\,b$ gives the points on the curves where any addition to the length of the belt does not produce a great enough increase in the angle of contact sufficient to compensate for the extra space taken up.

Take an example.

Let $R = 6' - 0''$;

$r = 1' - 6''$;

then $n = 4$, and $m = x\,(R + r)$ feet $= x \times 7\,5$.

Now follow the $n = 4$ curve in Fig. 2, and at the point where it cuts $a\,b$, $x = 3{\cdot}75$.

$$\therefore m = 3{\cdot}75 \times 7{\cdot}5 = 28\text{ft. } 1\tfrac{1}{2}\text{in.}$$

Of course, with the longer belts there will be more lapping owing to the sag of the belt, so in these cases a less length than that provided by the curve would be permissible.

It is sometimes stated that a heavy and lengthy belt acts to a certain extent like a flywheel, and this has been advanced as an argument in favour of long belts. A little consideration, however, will show that this is a most expensive and unsatisfactory method of promoting steady running. It would be better to use a slightly heavier flywheel than depend on the inertia of an expensive belt, which is ever so much more liable to accident and depreciation, besides taking up very much more valuable space. On the other hand, when very short belts such as recommended by Profs. Ayrton and Perry have been used, difficulty has arisen owing to slipping due to the very small angle of lapping of the pulley by the belt.—W. B.

Answer to No. 260 (*awarded* 5*s.*).—This question is a difficult one to reply to in the form in which it is set, as the distance between the centres of the pulleys or the length of the drive for any particular case usually involves so many considerations of a more or less practical character that no formula can be framed embodying all of them. Further, belt driving may vary between fairly wide limits, and the success or otherwise of any arrangement will only show itself in the life of the belt. It is possible, however, to formulate the general principles underlying the successful practice.

In many cases the length of the drive is fixed by the special circumstances, and the belt has to be designed with a view to transmitting the load only, rather than efficiency of driving. We will consider that the case under notice is a main drive—that is, from the engine pulley to the second motion shaft—as this drive is usually the most important one. Moreover, any remarks respecting a primary drive apply equally well to a secondary drive. The resistance of a belt to slipping is directly dependent upon the least arc embraced by the belt, and this always occurs on the smaller pulley. Further, the least arc of contact varies with the ratio of the diameters of the pulleys and the length of the drive. The ratio of the diameters of the pulleys is fixed by the speed of the engine and the required speed of the second motion shaft, and for any individual case is constant. We have therefore only to consider the influence of the length of the drive upon the arc of contact. The shorter the drive with pulleys of unequal diameters, the less the arc of contact and the lower the resistance of the belt to slipping. The effective pull or twisting effort of a belt is the difference between the tension on the tight and slack sides, and for any given arc of contact the tension on the slack side must usually be some fraction of the tension on the tight side, and must be greater the less the arc. It follows, therefore, that if the arc of contact is small the effective pull of the belt is reduced, or, in other words, the maximum tension is increased, and, therefore, the size of the belt has to be larger than necessary. In practice the average arc of contact, on the smaller pulley, embraced by the belt is about $\frac{9}{20}$ of the whole circumference, or the belt subtends an angle of 162 deg. at the centre of the pulley. There are, however, many belts running successfully with less arc of contact, but this represents about the best practice. The arc of contact should not be less than $\frac{4}{10}$ unless this cannot be effected without a very long drive. The importance of making the arc of contact as large as possible is shown in the following table, which has been calculated for an average coefficient of friction of ordinary leather belting on cast-iron pulleys:

Angle of embrace of belt on small pulley.	Ratio of effective pull to tension on slack side just before slipping.
165	1·37
162	1 33
160	1·30
150	1·19
144	1·12
135	1 00

From the above table it will be seen that when the angle of contact is 162deg., or $\frac{9}{20}$ of the pulley circumference, the effective pull on the belt must not exceed about 1·33 of the tension on the slack side, and when the angle is 144deg., or $\frac{4}{10}$ of the circumference, it should not exceed about 1·12 of the slack side tension, otherwise the belt will slip. A rule may be given to connect the length of the drive and the difference of the diameter of the belts when the arc of contact of the belt on the small pulley is decided upon. Thus for the above two cases,

If C = distance between the centres of the pulleys, in feet;

Δ = difference between the diameters of the pulleys, in feet;

then for an arc of contact of $\frac{9}{20}$ of the circumference,

$$C = 3\,3\,\Delta;$$

for an arc of contact of $\frac{4}{10}$ of the circumference,

$$C = 1{\cdot}6\,\Delta.$$

The minimum diameter of the pulleys is governed by the thickness of the belt, and the thicker the belt the larger should be the minimum diameter. With thick belts running on small pulleys there is undue straining of the belt, and its life is unnecessarily shortened. It is considered that the diameter of the smallest pulley should, if possible, not be less than about 100 times the thickness of the belt. The thickness of the belt is, of course, determined by the power transmitted, speed, width, and effective pull on the belt, and may be obtained from any of the rules given in the ordinary text-books.—E. W. T.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Burnley.—The Corporation invite tenders for cables. Tenders by May 14.

Salford. — The Corporation invite tenders for cables and accumulators. Tenders by May 7.

Plymouth.—The Corporation invite tenders for overhead line construction, etc. Tenders by May 2.

Glasgow.—The Corporation invite tenders for a supply of electricity meters. Tenders by May 5. Details in our advertisement columns.

Wimbledon.—The Urban District Council invite tenders for the erection of additions to the electricity generating station, Durnsford-road, Wimbledon. Tenders by May 15.

London, E.C.—The Directors of the Great Eastern Railway Company invite tenders for the supply of stores and materials. Tenders by May 8. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the opening of trenches and the supplying and laying of underground conduits for telephone cables therein, etc. Tenders by April 30. Details in our advertisement columns.

Southampton.—The Corporation invite tenders for the supply and erection of one 300-kw. continuous-current generator, coupled direct to a medium-speed vertical compound steam-engine. Tenders by May 1. Full particulars in our advertisement columns.

King's Lynn.—The Corporation invite tenders for the supply and erection of the following plant: steam dynamos, Lancashire boiler, economiser, condenser, pipes, etc., switchboard, and cables (supply only). Tenders by May 17. Particulars in our advertisement columns.

London, S.E.—The Bermondsey Vestry invite tenders for erection of a chimney shaft, about 150ft. high, of brickwork, on the site of their new electric generating station in "Neckinger," Spa-road, at the rear of the public baths and wash-houses. Tenders by May 4.

London.—The Streets Committee of the Corporation of London invite proposals from firms or persons experienced in the manufacture and use of electric motorcars for the hire of an electrically-driven dustcart. Tenders by June 1. Full particulars in our advertisement columns.

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Paddington.—The Vestry invite tenders for the execution of sundry works required to be done in certain alterations to the existing electric lighting arrangements at the public baths, Queen's-road, Bayswater, W. Tenders by May 14. Particulars in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of (*a*) 150 car trucks, (*b*) tramway bonds, (*c*) special track work and points and crossings. Specifications, etc., may be obtained from Mr. J. M. M'Elroy, general manager, Tramways Department, Town Hall, Manchester. Tenders by May 7.

Heywood.—The Corporation invite tenders for the supply and erection of Lancashire boilers, economiser, pipe work, feed pumps, two steam dynamos, balancer booster, travelling crane, storage batteries, switchboard connections and station lighting, underground mains and feeders, and meters. Tenders by May 14. Particulars in our advertisement columns.

Rhyl.—The Urban District Council invite tenders for the supply and erection of—boiler-house plant: water-tube boiler, fittings, steam and exhaust pipes, etc.; engine-house plant: steam dynamos, pumps, etc.; switchboard, etc.; underground mains lamp-posts, etc.; accumulators, meters, crane, etc. Tenders by May 14. Details in our advertisement columns.

London, W.—The Central Electric Supply Company, Limited, invite tenders for the supply, delivery, and erection of two 1,200 i.h.p. Willans engines, each direct coupled to a three-phase H.T. generator; six three-phase H.T. motors, each direct coupled to a L.T. continuous-current generator; and switchboards and connections for above plant. Tenders by May 22. Details in our advertisement columns.

Perth.—The Commissioners invite tenders for the supply and erection of 45 enclosed arc lamps and ornamental cast-iron and steel pillars, with switch gear, etc., complete. Persons tendering are to tender for the complete section, but not for part of above section. Specification, etc., may be obtained from Mr. John Begg, clerk, City Chambers, Perth, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders by 12 noon on May 7.

Mariupol.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Taganrog stating that tenders are invited by the Municipality of Mariupol not later than May 16 (29) for the construction and exploitation of an electric tramway and the installation of electric light in that town. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Barking.—The Urban District Council invite tenders as follows: (Contract No. 1) for the supply, construction, and erection of about 365 tons of cast iron and 235 tons of steel in an opening bridge over Barking Creek, 45ft. in clear opening, and to carry a double line of railway, together with two shore spans of 45ft. each, and the embanked approaches, and with all the electrical and other machinery and appliances incidental thereto and required for opening and closing the bridge by electrical power supplied from the generating station of the Council; (No. 2.) the construction of 73 chains of 3ft. 6in. gauge single-line railway (83lb. tramway rails) and 38 chains of double-line railway, with granite sett paving on concrete, electrical rail bonding, etc. Tenders before 12 noon on May 7.

Inverness.—The Highland Railway Company invite tenders for the Wick and Lybster light railway, extending from Wick Station, Highland Railway, to the village of Lybster, a distance of about 13½ miles, divided into two contracts—viz.: (No. 1, or Wick, contract) 7 miles, or thereby; and (No. 2, or Lybster, contract) 6½ miles, or thereby. Plans may be seen with and specifications and schedule of quantities obtained from Mr. William Roberts, the company's engineer-in-chief, Inverness, on payment of 10s. 6d. for each contract. An assistant engineer will meet intending tenderers at Wick on 27th inst., at 9 a.m., and accompany them over the route of the new line. Tenders, addressed to Mr. Wm. Gowenlock, secretary, Inverness, and marked on outside "Tender for Wick and Lybster Railway," will be received on or before May 8.

RESULTS OF TENDERS.

Bangor.—The Lighting Committee have recommended that the contract with Messrs. Verity and Co. for a switchboard be accepted.

Hereford.—The Committee of Visitors have accepted the tender of Mr. A. H. Wood for the electric lighting of the asylum at a cost of £4,462.

Keighley.—The Corporation have accepted the tender of Messrs. G. H. Woods and Co., 77, Northgate, Blackburn, for wiring the new municipal offices now in course of erection, at £220.

Fulham.—With regard to the list of tenders received by the Vestry for the supply of 250 meters, referred to in our issue of the 13th inst., in which it was stated that Messrs. Johnson and Phillips tendered for the Hümmel meter, we are informed that it was Messrs. Hartmann and Braun's meter for which they quoted.

Cardiff.—The Corporation have received the following tenders for the wiring and fitting up for electric light the new fish market in the Hayes, Cardiff:

J. Bakewell and Co., 130, Queen Victoria-street, E.C.	£522	10	0
H. Lewis and Fletcher, St. Mary-street, Cardiff	366	0	0
Clay Bros. and Co., Custom House-street, Cardiff	352	10	0
W. A. Baker and Co., Commercial-street, Newport, Mon.	340	0	0
Edwards and Armstrong, Windsor-place, Cardiff	286	0	0

Colwyn Bay.—The Urban District Council have received the following tenders for the erection of buildings, etc., for electric lighting station to be established at Ivy-street, Colwyn Bay:

J. Biggs, 333, Farm-street, Hockley, Birmingham	£1,851	13	0
J. M. and R. Roberts, Colwyn Bay (accepted)	1,527	2	10
Tucker Bros., Colwyn Bay	1,718	7	0

London, W.C.—The following tenders have been received for electric light installation, King's College:

Alliance Electrical Company	£1,722	0	0
Alliance Electrical Company (alternative estimate)	1,644	10	0
Tamplin and Makovski	1,656	0	6
Tamplin and Makovski (alternative estimate) (accepted)	1 444	5	9
Drake and Gorham	1,343	0	0
Drake and Gorham (alternative estimate)	1,269	15	0
National Electric Wiring Company, Limited	1,173	8	4
J. O. Grant	1,160	0	0

BUSINESS NOTES.

TRACTION.

New General Traction Co.—The transfer books of this Company will be closed from 28th inst. to 12th prox., inclusive.

Ashton.—The District Council have decided to make another attempt to arrange with Pemberton with regard to the proposed tramways.

Norwich.—A trial run has been made on the Sprowston-road section of the Norwich Electric Tramways Company's line. It is expected that the system will be opened about Whitsuntide.

Rawtenstall.—The Electric Light and Tramways Committee are considering proposals from the Rossendale Valley Tramways Company and from the Accrington Corporation Steam Tramways Company.

Skene and Echt Light Railway.—The Tramways Committee of the Aberdeen Town Council have before them a letter from the District Committee with reference to the proposed light railway to Skene and Echt.

Cardiff.—The question whether a separate generating station should be erected for the tramways has been postponed till May 7. In the meantime it is stated that the Lighting Committee can supply energy for traction purposes at ·95d. per unit.

Sunderland.—It is reported that the agreement between the Corporation and the tramways company has been settled subject to certain details. It is proposed to use the premises adjoining the town hall for electric lighting purposes in connection with the tramway system.

Worsley.—The District Council have been authorised by a public meeting to oppose the South Lancashire Tramway Company's Bill and the Lancashire Electric Power Company's Bill now before Parliament, so far as the schemes of these companies affect the interests of the township.

Teddington.—The agenda for the last meeting of the District Council contained the following notice of motion: "That the resolution of Feb. 23, 1900, as to the purchase clause of the London United Tramways (Extension) Bill be rescinded." When called upon the same was withdrawn.

Paisley.—The Corporation on the 20th inst. received yet another offer from Mr. Murphy with regard to the proposed tramways. At a meeting of shopkeepers on Tuesday the measure was approved of, and it was agreed that a petition be prepared in support of the scheme to be signed by shopkeepers and presented to the Council at their special meeting this week.

Swansea.—At the last meeting of the Town Council the following resolution was discussed and defeated: "That no further expense or costs be incurred in respect of the proposed application on behalf of the Swansea Corporation to the Light Railway Commissioners for powers in relation to the construction and working of light railways or tramways until the opinion of some expert tramway engineer has been obtained as to the feasibility, cost, and probable revenue thereof."

Leamington.—A special committee of the Town Council sat on Tuesday to consider the present position of the tramways question arising out of the application of the company for a provisional order. It was proposed that the resolution to purchase the tramway, passed at a previous meeting, be rescinded, and that an agreement be entered into with the tramways company. Finally it was decided to refer the question back to the committee, the members of which were increased in number from five to eleven.

Hertfordshire.—The Commissioners have recommended an order in consequence of the enquiry recently held into the application made by the Hertfordshire County Council and the Metropolitan Tramways and Omnibus Company, Limited, for an order to authorise a light railway commencing at the Middlesex and Hertford county boundary in the Hertford-road at the termination of the proposed Waltham Cross and Enfield light railway, and running thence in a northerly direction along the Hertford road, the various portions of which are known as Crossbrook-street, Turner's-hill, New-road, Cheshunt-street, Cheshunt Wash, and Turnford.

New Companies.—The Adelaide Electric Tramways, Limited, has been registered with a capital of £3,000 in £1 shares, the object being to carry on the business of tramway, railway, and vehicle proprietors, locomotive, carriage, truck, and dynamo manufacturers, etc.—The Johnson-Lundell Electric Traction Com-

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pany, Limited, has been incorporated under the Companies Acts, 1862 to 1898, with a capital of £300,000, divided into 60,000 shares of £5 each, of which 20,000 shares, the largest number allowed by the rules of the Stock Exchange, are taken by the vendors in part payment. The balance—viz., 40,000 shares—was offered for subscription this week.

Leith.—The Special Tramways Committee of the Town Council on Wednesday resolved to recommend the Council to purchase the tramway undertaking in the burgh and lease it to the Edinburgh and District Tramways Company. The purchase price is £90,000. The Council is to receive 6 per cent. upon £62,500, the cost of the undertaking less the price of Morton-place property, which is not required by the proposed lessees (£18,000), and the price of horses and plant, which they have agreed to take over at £9,500. The Council is also to receive 6 per cent. upon the cost of cabling Leith walk (£15,000), and of adapting the other lines in the burgh to electrical traction (£42,000).

Light Railway Orders.—The Board of Trade on the 20th inst. confirmed the following orders made by the Light Railway Commissioners: (1) the Dudley and District Light Railway (Extensions) Order, 1900, authorising the construction of light railways in the borough of Dudley and in the urban districts of Stourbridge and of Lye and Wollescote in the county of Worcester; (2) the Mid-Suffolk Light Railway Order, 1900, authorising the construction of a light railway in the county of Suffolk from Haughley to Halesworth, with a branch to Debenham and Westerfield; and (3) the Rhyl and Prestatyn Light Railway Order, 1900, authorising the construction of a light railway in the county of Flint from Rhyl to Prestatyn.

London County Council Light Railways.—The Light Railway Commissioners commenced an enquiry on Wednesday into the application of the London County Council to construct under the Light Railways Act, 1896, for electrical traction, four lines of tramways—viz.: (1) from Clapham Common to Kingston; (2) from Deptford, by Shooter's Hill, to Woolwich; (3) from New Cross, by Lewisham, to Eltham; and (4) from Archway Tavern, Highgate, to the county boundary. The line from Deptford to Woolwich was first considered. It was stated that it was proposed to work the line by the slot or conduit system, which was the best suited to the district. The estimated cost, including the electrical equipment, was £178,637.

Wandsworth.—On the agenda of last week's meeting appeared a motion to the following effect: "That as the London County Council light railway scheme comes before the Railway Commissioners on April 27, and as the District Board has failed to come to terms with the Council as regards improving the High-street, and, in consequence, are now opposing the whole scheme, that this Vestry is of opinion that the Council's proposal would prove advantageous to the further development of the parish, and that the vestry clerk be instructed to appear before the Commissioners to represent this Vestry to support the scheme." It was ruled that the motion was out of order until the resolutions passed at the former meeting were rescinded.

Chester.—At a recent meeting of the Local Government Act Committee of Chester Town Council, a letter was read from the tramways company giving the information promised at the conference between the sub-committee and the directors of the tramways company, and a plan of the company's stables and land was submitted. The question of value was considered, and instructions were given to the town clerk to obtain professional valuations for the guidance of the committee and the Council. The questions of system of traction and extensions to be recommended were considered, and Mr. Thursfield's report was referred to. It was resolved, "That the surveyor and Mr. Thursfield be requested to report as to the best routes for extensions."

Wolverhampton.—The *Birmingham Daily Post* says there appears to be every likelihood of a hitch occurring in regard to the tramway service from Wolverhampton to the neighbouring towns after the Wolverhampton Corporation take over the control of the tramways within the borough boundaries on the 1st prox. The British Electric Traction Company have been for some time negotiating with the Corporation as to the working of the system locally, but up to the present we are informed that no arrangement has been arrived at whereby through services will be maintained with Bilston, Willenhall, and Sedgley, and it will be regrettable if the public should have to suffer inconvenience through the authorities not arriving at a mutual understanding. In all likelihood the electric traction company will run cars to meet those under the control of the Corporation.

Leeds.—The Board of Trade inspection into the electrical equipment of the York-road and Beckett-street section was held on Tuesday. It is expected that electric cars will commence running on these lines about three weeks hence, by which time the second large steam dynamo now being erected by Messrs. Fowler will be ready for use. The question of reduced fares has been referred back to the Traffic Sub-Committee. Orders have just been placed for overhead wires and cables for the Beeston and Elland road routes. Orders have also been given for wires and cables for the Meanwood-road and Woodhouse-street lines, upon which at present horse cars are being run. Two additional steam dynamos similar to the one ordered recently are also to be obtained. It is estimated that in about another year and a half the committee will command sufficient power to work the whole of the city tramways by electricity.

Gloucester.—At the meeting of the City Council on the 24th inst. a letter was received from the Gloucester Tramways Company with reference to the terms on which the Council would supply electric power for new trams which the company propose running. The Corporation offer to supply the company with 600,000 units at the following rates: 200,000 at 2d., 200,000 at 1½d., and 200,000 at 1d., giving a return of £4,375. From this £2 500 was deducted as the expenditure, leaving a profit of £1,875, or 75 per cent., further reductions to be made on any additional supply. The company objected to these proposed charges as exorbitant, and suggested that for 600,000 units they should pay at the rate of 1½d. per unit for 400,000 and 1d. for 200 000, giving a total of £3,333, and a profit, after deducting the estimated expenditure of £3,500, of £833, or 33⅓ per cent. The terms submitted by the Council were confirmed.

Middlesex.—The application of the Middlesex County Council and the North Metropolitan Tramways Company for an order to lay 15 miles of light railways, at a cost of £350,000 beyond the cost of lands and equipment, was before the Commissioners on Wednesday. It was stated that the contract between the parties had not been signed, and an adjournment was asked for. The Earl of Jersey said that they had agreed on their decision. On the agreement being concluded the three main lines would be sanctioned. As to Railway No. 1, the Commissioners proposed to recommend the order, and for so much of No. 2 as went to Station-road. The other portion of No. 2 had been dropped by the promoters. As to Railway No. 3, from Hornsey to Whetstone, they would recommend the whole of that. Railways Nos. 4, 5, 7, and 8 had been withdrawn. As to No. 6, the Commissioners proposed to recommend an order for such part of it as went to a point north of Church End at Edgware, leaving out the Cannon's Park Estate. No. 9, the line to the generating station, would be granted, and No. 10 was withdrawn.

LIGHTING AND GENERAL.

Lytham.—Some move may shortly be expected in regard to the electricity installation.

Eastern Extension Telegraph Co.—Sir John Wolfe Barry, K.C.B., has been elected a director.

St. Annes.—A start has been made of laying the cable for the electric lighting scheme in St. Annes-road East.

Ipswich.—Prof. Kennedy's report has been received, and will be laid before the Electric Lighting Committee in a few days.

Cleetherpes.—The Urban District Council have elected Mr. Mackrill as chairman of the Finance and Lighting Committee.

Maidenhead.—Application is to be made for sanction to borrow a sum not exceeding £25,000 for the purposes of electric lighting.

Grays.—Colonel A. C. Smith has held an enquiry into the Council's application to borrow £12,000 to carry out Mr. Preece's electric supply scheme.

Calais.—A powerful electric crane has been installed at the Gare Maritime, to expedite the landing of the cross-Channel mails and passengers' baggage.

Fleetwood.—The furnace at the new electric light works, which is so constructed as to consume all the refuse of the district, will, we learn, shortly be in operation.

Cupar.—The Lunacy Board will probably continue their present lighting arrangements for another year in order to have time to mature their plans for the electric light.

Cuba Submarine Telegraph Co.—The directors recommend a dividend on the ordinary shares at the rate of 6 per cent. per annum, tax free, for the half-year ended Dec. 31.

St. George's (East).—The Vestry have received a letter from the Board of Trade stating that they had decided to grant the Vestry an electric lighting provisional order.

Hornsey.—It is stated that the District Council, consequent upon receiving Mr. Hammond's report favourable to the erection of an electric lighting plant, intend to retain the provisional order in their own hands.

Sleaford.—The Bill for confirming the Board of Trade electric lighting provisional order to the Urban District Council has been published. The rates are 13s. 4d. per quarter for 20 units and 8d. for additional units.

Jarrow.—The Town Council have appointed a deputation to give evidence in favour of the Durham County Electrical Power Company's Bill and against the Tyneside Company's Bill if a certain clause asked for be not inserted.

Boilers.—The Vulcan Boiler and General Insurance Company, Limited, have issued a little pamphlet entitled "Notes for Boiler-Owners and Users of Steam Power," drawing attention to present and prospective legislation on the subject.

Hull.—The Chamber of Trades will again memorialise the Telephone Company with reference to the telephone breakdown at Hull, and particularly with respect to the question of a rebate for the time the service has been discontinued.

Bridgwater.—The Town Council last week, after some discussion, confirmed the minutes of the Electric Lighting Committee, part of which referred to the signing of the agreement with Mr. Trentham in relation to the electric lighting works.

Bridlington.—The Bill for confirming the Board of Trade electric lighting provisional order to the Corporation has been published. The rates proposed are for any amount per quarter up to 20 units 13s. 4d. and 8d. for each additional unit.

St. James and Pall Mall Electric Light Co.—The returns for the quarter ended 25th ult. show the amount of electricity sold as 1,599,768 units, estimated to produce £28,529, as against 1,161,987 units, which produced £20,964, for the corresponding period of last year.

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Barrow-in-Furness.—The returns for the first year's working, just issued, show the following figures: capital outlay, £32,000; revenue, about £2,600; expenditure, £1,900; profit, £750. The price of current is to be reduced as a result of the first year's working.

Tynemouth.—At Wednesday's meeting of the Town Council it was said that the Council were under an engagement to supply electric power to the tramway company by the end of June, and it was anticipated that it would also be available for street-lighting about the same time.

Long Eaton.—The Bill for confirming the electric lighting provisional order granted by the Board of Trade to the Urban District Council has been published. The proposed maximum rates per quarter are for any amount up to 20 units 13s. 4d., and for each unit over 20 units 8d.

Halifax.—At the last meeting of the Guardians the chairman said, referring to the recent installation of the electric light, that they ought to take steps for supplying the light themselves. By doing so they would, he believed, get the current at half the price they were now paying.

Brighton.—The amended report of the Lighting Committee having been adopted, Mr. Wright will now continue as manager and consulting engineer for the period of five years, at three months' notice on the side of the Corporation, and a resident engineer will be appointed at £600 per annum.

Worksop.—Mr. Mountain, electrical engineer of Huddersfield, estimates that the cost of an electric lighting system for Worksop would be about £15,779, and he has advised the Council to advertise for tenders in the electrical papers. This estimate is based on the prices of material precedent to the late rise.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in Crompton and Co., Limited, further issue of 7,562 ordinary shares of £3 each, fully paid, Nos. 46,419 to 54,000, and to allow to be quoted in the official list Commercial Cable Company's 3,333,300dol. additional capital stock.

Yarmouth.—The Harbour Commission have agreed to the application of the Corporation for permission to lay three electric cables in the bed of the river, near the Lower Ferry, for the transmission of the electric light from Yarmouth to Gorleston. The trench for the cables will be excavated to a depth of 21ft. below low water.

Farnworth.—The Local Government Board enquiry into the County Council's application for the loan of £22,000 has been held unopposed. It is proposed to erect a plant for lighting and traction purposes. Messrs. Lacey, Clirehugh, and Sillar's plans show that there will be three 120 kw. steam dynamos and two Lancashire boilers.

New Publication.—The already great number of Spanish technical papers has been added to by the issue at Venlencia of a small illustrated review called *La Pequena Industria*. Its aim is the popularising of the knowledge of scientific phenomena. At the same time it will defend the interests of those employed in electrical undertakings.

Bangor.—The surveyor is constructing a well for the electric light works and destructor at a cost of £15. 10s. A steam pump is to be set up, at a cost of £28, to pump the water into the overhead tank, and additional cables are to be laid from the Eagles Café to St. Winifred's School along High street, also to Victoria-avenue and Temple-road in Upper Bangor.

Accrington.—The great chimney at the electricity and destructor works was practically completed early last week. The destructors are about halfway finished. The boilers, to provide steam when necessary to drive the electric plant, have been put in, and the whole work reported to be progressing satisfactorily. The entire combination will probably be ready to commence operations about September.

Mackey Electric Lamps.—We are informed by the Mackey Electric Lamp Company that they have now completed their new factory, and hence are now able to supply large quantities of incandescent lamps from stock. These lamps, which are entirely of English make, are subjected to most careful tests before they are allowed to leave the makers' works. The firm make a speciality of high-voltage lamps, in which they claim to have secured great success.

Limerick.—A special committee of the Town Council have passed the following resolution: "That we recommend the Council to oppose the Shannon Water and Electric Power Bill on the lines set out in the petition against the Bill so as to safeguard our interests in the waterworks, and the Electric Lighting Order, 1892, and that we instruct our parliamentary agents without incurring unnecessary expense to maintain our position in opposition to the Bill."

London Gazette.—The discharge of Mr. E. L. Joseph, Brondesbury, has been suspended for three years from March 8, 1900. bankrupt to be discharged as from March 8, 1903; bankrupt's assets are not of a value equal to 10s. in the pound, etc.—The first meeting *re* E. Bates, Stockton Heath, Warrington, will be held on May 2 at 2.30 p.m. at Official Receiver's offices, Byrom-street, Manchester, and the public examination on May 28 at 11 a.m. at Court House, Quay-street, Manchester.

Croydon.—The Board of Trade having forwarded to the Council a copy of the provisional order applied for by the Surrey Electric Distribution Company under the Electric Lighting Acts, 1882 to 1890, stating that the Board proposed to make the order in the form in which it was now transmitted to the Council, the Council have decided to insist on the insertion of clauses in the order providing for the usual notices to be given in respect to disturbing the roads, paying for their reinstatement, etc.

Appointments Vacant. — The Bradford electricity works department require a chief assistant to the superintendent engineer.—The Shoreditch Vestry invite applications for the position of chief clerk and book-keeper in their electric lighting department. Particulars of these vacancies and others referring to appointments of a junior assistant, etc., will be found in our advertisement columns.—A shift engineer is also wanted at the Taunton and a second assistant at the York Corporations' electricity works.

Bradford.—The Postal Committee of the Chamber of Commerce have had referred to them a letter drawing the attention of the Chamber to the serious inconvenience which was caused by the inefficient telephone service in Bradford, and the impossibility of securing proper attention from the company or compensation for loss of the services of the telephone. It was mentioned that during the past two months the writers of the letter had been unable to communicate by telephone, and were in that position at the time of writing.

Kensington.—In the last issue of the *Citizen* appears an interview with Mr. Philip Monson, the lighting engineer of Kensington, from which we quote the following question and answer: "What about electric lighting?" "That must come some day. We are a very proud parish, you know, and people will want it done in the best style, but our Vestry cannot see their way to put down a good system, which in the main streets will cost something like £40 per lamp. Take a street as 10 lamps, and figure out our 90 miles of streets for yourself."

Grantham.—The Bill for confirming the electric lighting provisional order of the Board of Trade to the Urban Electric Supply Company, Limited, has been published. The following maximum rates par quarter are proposed: (*a*) for any quantity not exceeding the equivalent of 91 hours of supply, at the maximum power which has been demanded, at the rate of 7d. per unit; (*b*) for any further supply, not exceeding the equivalent of 91 hours of supply at such maximum power, at the rate of 4d. per unit; and (*c*) for any further quantity at the rate of 2½. per unit.

Dinner.—At the Hotel Metropôle, Swansea, last Saturday, a dinner was given in honour of Mr. Daniel F. Sagrue, who, after being for nearly 20 years the popular and efficient manager of the Swansea Tramway Company, and more recently the South Wales superintendent of the British Electric Traction Company, which has acquired the tramways of the town, is now leaving to take a more important position under the same company in London. He will still retain his seat as a director of the Swansea Tramway Company and of the Merthyr Electric and Lighting Company.

Bexhill.—A special committee is arranging for the placing of 50 electric incandescent lamps in the streets. Sanction has been obtained to the borrowing of £4,228 for lighting. The Local Government Board have excluded from the amount applied for the items of £456. 8s. 5d. paid to Messrs. Cope and Co in respect of the costs of the undertakers of the Bexhill Electric Lighting License, 1896 in obtaining such license, and £315. 9s., representing the costs of promoting the Bexhill Electric Lighting Order, 1897, as it did not appear to the Board that the District Council had any power to borrow money for such purposes.

Cardiff.—A special meeting of the Town Council was held on Monday for the purpose of again considering the question of a combined station for lighting and electrical traction, or a separate and distinct station on its own site for tramway traction purposes. The further consideration of the question was adjourned until May 7. The Tramway and Lighting Committees are in the meantime to supply additional information to the members. The Council have selected Messrs. H. D. B How (London), E. Jones (Cardiff Corporation Electric Lighting Station), and W. H. Illingworth (Halifax), out of 19 applicants, for the position of mains superintendent.

Newcastle.—The Corporation intend to oppose the Bill of the District Electric Supply Company on the grounds that their main lines would pass through the city for the supply of outside places. With regard to rental for telephone wires under the street utilised by city subscribers, the Town Improvement Committee have passed a resolution that no charge should be imposed on existing renters, but that in the case of all new subscribers the charge should be at the rate of 2s. 6d. per renter under both telephonic systems. This may work out all right with regard to the National Telephone Company, but the Corporation will find that they cannot collect their bill from the General Post Office.

Cleckheaton.—At the last meeting of the District Council it was reported that the Board of Trade had issued an electric lighting order upon the Council's application, and that the applications of the Bradford Corporation, the North Bierley Gas Company, and the British Electric Traction Company for special protective clauses had not been successful. An agreement has been completed with the British Electric Traction Company, whereby the company undertake to take electrical energy from the Council, and that the period of the purchase clause had been left to be fixed by the Light Railway Commissioners, with the proviso that the term should not exceed 28 years.

Newington.—The Roads and Depôt Committee recommended at the last meeting of the Vestry that 166 lamps in the side streets, along which it is proposed to extend the electric lighting cables, be changed over to the Vestry's undertaking at a charge of 2½d. per unit for lighting, and that the distance between the lamps be reduced to 120ft., the present space being 150ft. It was

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stated that the cost of lighting in these particular streets would be increased by £132, but the light provided would be nearly double. The thoroughfares would be Westmoreland-road, Alvey-street, Elsted-street, Rodney-road, Deacon-street, South-place, Doddington-grove, Manor-place, and one or two others, to be decided upon. The motion was agreed to.

Dundee.—Mr. Tittensor has presented his report on the question of lighting the streets on the tramway routes with electricity. He recommends that arc lamps be placed on poles in the middle of the street where these are wide enough, and side poles on the kerbs of each of the narrower streets. He recommends that the lamps be placed 20ft. from the ground and 60 yards apart. The posts for traction purposes are placed at an average distance apart of 40 yards, and in order to utilise them for the arc lamps he proposes that a lamp be attached to every third tramway post, and that a special arc lamp-post be erected on the opposite side of the street midway between these posts. The estimate of the total annual cost is £348. It is proposed that Nethergate and Murraygate should be lighted with electricity as a trial.

Mile End.—At the last meeting of the Vestry the Clerk read a letter from the Board of Trade stating that that authority had decided to grant an electric lighting provisional order to the Vestry. No. 1 Committee reported that the clerk and surveyor submitted amended plans and notices from the County of London and Brush Provincial Electric Lighting Company, Limited, giving notice of their intention at the expiration of one month to commence the execution of the works therein described. The committee reported that they saw no objection to the plans submitted. The Surveyor pointed out that the company now were not deprived of their rights to lay cables in the district. Parliament would also have to confirm the provisional order of the Vestry. The Vestry then decided to refer the report of the committee back.

Edinburgh.—At the Town Council on Wednesday a recommendation by the Cleansing and Lighting Committee that certain additional routes be lighted with electricity was discussed. It was stated that the total cost was £11. 17s. 6d. per lamp. Carbons cost £1. 3s. 6d.; coal, £3. 5s.; stores, 5s.; trimmer's wages, £3; maintenance, £1. 7s.; and interest on sinking fund, £2. 17s. According to the estimate recently accepted, coal would be £1 1s. and carbons 7s. 6d. more per lamp for the coming year, making the total increase up to £13. 5s. 6d. The Chairman of the Lighting Committee said if they reduced to £13 per lamp, as was proposed, that would be a loss of 6s. per lamp, which on 839 lamps would amount to £251. He believed, however, that from the committee's point of view this loss would be more than compensated for by the additional private lighting that would be got from the extension of the public lighting. The report was agreed to.

Hampstead.—At the meeting of the Vestry last week it was resolved that mains for the supply of electric current to private consumers be laid in Boundary-road, West Hampstead-avenue, and Goldhurst-terrace. A letter was received from the clerk of the London County Council, stating that the Council had considered the Vestry's application for a loan of £97,178 for electric lighting purposes, and were only able at present to sanction the borrowing of £90,740, and that, as the Vestry had elected to spread the repayment of the whole of the initial cost of the installation over 42 years, the Council would decline to give its sanction to the raising of any loan to replace any of the plant and machinery which might be necessary during the currency of the loan, and would expect the Vestry to provide for all replacements and renewals required during that period out of a sinking fund or from maintenance account; also stating that, on receipt of a certified copy of a resolution of the Vestry accepting and recording the terms on which the Council is prepared to allow so long a period as 42 years for repayment, the formal sanction to the borrowing would be issued.

Oriental Telephone and Electric Co.—At the ordinary general meeting, which was held on Wednesday at the Cannon-street Hotel, Sir Auckland Colvin, who presided, stated that increases had taken place both in the numbers of subscribers at the different centres and in the receipts, while the expenses were but in proportion to the heavier work entailed. After providing for the usual dividend of 5 per cent., there remained an available balance of £4,507, as compared with £3,344 in the previous year. The closing of the Shanghai exchange was regrettable, but the Municipal Council had imposed on the China Company conditions which would have involved an expenditure of fresh capital to the extent of £15 000 or £20 000. The Board considered that this amount could be better and more safely employed in their exchanges nearer home, especially in Egypt. The Hong Kong branch was prospering, and was sufficiently provided with funds for a considerable time to come. The directors hoped that that branch would be in a position next year to contribute to the annual dividend. The report was adopted, and a final dividend of 8d. per share, making, with the interim distribution, 5 per cent. for the whole year, was sanctioned.

Pryke and Palmer.—The May issue of the catalogue of the above firm reaches us in time to be noticed in April, which is a good indication of the promptitude with which the firm carries out its orders. In the present list we notice a further development in the interior conduit system patented by Mr. Russell, and that a number of accessories in connection with this system have been introduced by the firm. In this system of wiring the iron casing used is sufficiently strong to resist damage from nails and to withstand exceedingly rough usage. This is a good point in connection with the system, especially when it is to be used in engineering or other works. In every case we notice that the lids of the boxes with this system are arranged to be secured by means of a central pillar and nut. This pillar is found to be of assistance when drawing wires into the corner boxes. In this case a small roller is placed on the central pillar and the wire can be drawn round this without damage to the insulation. All the lids of this box are machined and arranged to fit on to the face surface of the box, so that a practically watertight joint is obtained. The firm also specialise the iron framework for distributing or fuse boxes, which can be made either with iron or wood lids to suit the taste of the purchaser.

Turbines.—The firm of Messrs. Brown, Boveri, and Co. and the Parsons Foreign Patents Company, Limited, have entered into a contract for the manufacture and sale for electrical purposes of Parsons steam-turbines in France, Germany, Russia, Switzerland, and Italy, and simultaneously the official registration of the company constituted to carry out this business has appeared in the Zürich Government *Gazette*. The style of the company is Aktien-Gesellschaft fuer Dampf Turbinen System Brown-Boveri-Parsons, with its head office at Baden, Switzerland. This combination is important in view of the position Messrs. Brown, Boveri, and Co. hold on the Continent as manufacturers of various types of dynamos. The firm evidently anticipate that the future of the sale of dynamos is dependent on a combined high-speed plant. The following figures, extracted from the official returns of the exports of Switzerland, show that the firm of Brown, Boveri, and Co. on a total export of 4,285 tons for 1898 contributed alone 1,917 tons, or 45 per cent., and in 1899 out of a total of 5,765 tons they contributed 2,949 tons, or 51 per cent. Taking the proportion of increase over the year 1898—*i.e.*, 1,500—we find that Brown, Boveri, and Co. participate in this increase to the extent of 1,000 tons, or about 67 per cent.

Non-Magnetic Watches.—We have received from Messrs. A. and J. Smith, watch and clock makers, Aberdeen, a copy of their catalogue and price-list of non-magnetic watches. It includes some interesting particulars of these watches. They are made to withstand all possibilities of being magnetised by employing an alloy for the hair-spring, consisting of about 75 per cent. palladium, copper, and other metals, which possesses the same density, dilation, and elasticity as tempered steel. The balance is made of the same alloy for inside metal, while the escapement parts are of hard aluminium bronze, and gold in the higher grades. Watches fitted with these springs and balances have secured first prizes in observatory trials in competition with watches having steel hair-springs and balances. In actual contact with powerful electromagnets we are told that these watches may be stopped, but immediately after removal from contact the watch will resume its rate, as the mainspring will soon have demagnetised itself, on account of the poles changing places and neutralising their effect by the uncoiling. The mutual attraction between pinions can be left entirely out of the question, on account of their small volume and respective distances. Hence, even with steel pinions and mainsprings the watches are fully protected against magnetic influence. The watches are made in various grades, from the nickel at 15s. 6d. to the gold at £15. 15s., a five years' guarantee being given with each. Chronographs manufactured on the same non-magnetic principle, and varying in price from £7. 7s. to £33, are also illustrated in the catalogue.

The Westinghouse Compensator.—The British Westinghouse Company have just issued a circular catalogue, No. 1,026, dealing with compensators for alternate-current circuits. These compensators are designed with a view to dispensing with pilot wires in connection with systems of distribution. With a direct-current circuit it is comparatively easy to arrange a series coil for a voltmeter so that the same may be made to give the voltage at the far end of a feeder. The advantage of this over pilot wires is great, as these wires, as a rule, give trouble in practice, and are costly to lay down. With an alternate current feeder, however, the problem is somewhat more difficult, as the drop due to ohmic resistance, which is proportional to the amount of current, is not the only drop which has to be allowed for. The Westinghouse Company have accordingly standardised two types of compensators for these circuits, which are employed, one when there is practically little induction on the line, and the other which is used with the apparatus at the station end. The general design of these compensators is as follows: A small transformer is provided, the primary of which is connected to the prime circuit. The number of turns in this primary is adjustable. The secondary of this transformer is also adjustable as to the number of turns, and is connected to the compensating coil on the voltmeter. By means of varying this number of turns, the compensator can be accurately adjusted to give the correct voltage corresponding to a given feeder with a varying load. In the catalogue, diagrams of the connections are given which clearly show the arrangement of the various parts. A second type of apparatus is also standardised by the company, so that inductive drop, as well as the drop due to ohmic resistance, can be compensated for. In this case there are two regulators on the small transformer, one of which varies the voltmeter reading to compensate for the ohmic drop, while the other influences the reading of the voltmeter in consequence of a different phase, so as to represent the effect of the inductive drop. These various pieces of apparatus have all been standardised by the company in accordance with the range of compensation required and the current in amperes carried by the main circuit. For instance, in an instrument for 200 amperes with a maximum drop of 24 per cent., the steps in the compensator are so arranged that it can be set to correspond with the resistance, etc., of the line within 1 per cent.

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Devonport.—The amended Corporation Bill is in many respects different from the original. With regard to the tramways portion, clauses have been introduced for the protection of the interests of the Great Western Railway Company where the lines are to be laid under or over the railway. The proposal to make a tramway beyond the boundary to Crownhill was withdrawn on threat of opposition from the Devon County Council. Clauses which would have given to the Corporation the right to exercise certain powers over the bridges and their approaches in the carrying out of the electric lighting scheme have been dropped. The Corporation, however, obtain the right to carry their lines over the bridges on making an annual payment. A period of three years is allowed for the construction of the tramways from Albert-road to the borough boundary in Tavistock-road. The line, which is to run along a proposed new road connecting St. Levan-road and Wolseley-road, is to be made within three years of the completion of the street work. Sanction is to be given to the proposal of the Corporation to take over and exercise the powers of the Stonehouse District Council in regard to the electric light. Stonehouse appears, however, to lose the protection afforded in the original Bill, by which the Corporation was to proceed to carry out the supply of that district and not charge higher rates than in the borough. The clause by which the Corporation was bound not to transfer the Stonehouse portion of the undertaking without the consent of Stonehouse has also been eliminated.

Perth.—Sheriff Syme has held an enquiry on behalf of the Secretary for Scotland into an application for a loan of £50,000 for electric lighting. Ex-Bailie Wright, convener of the Electric Lighting Committee, said, according to the *Dundee Advertiser*, that he had always taken a special interest in the proposal to introduce electric light. In the latter part of 1897 a number of companies wanted to introduce electricity into Perth and work it on their own behalf, but previous to agreeing to their proposals the Commissioners asked Mr. Hawtayne to give them a report on the subject, whether they should carry out the work themselves or do it by a company. Having considered Mr. Hawtayne's report, the Commissioners resolved to apply for the order, which was obtained in 1898. After tracing the various transactions which had taken place in connection with the scheme, the Bailie stated that the total amount of the tenders was £22,334. 13s. The Commissioners were in process of carrying out a number of extensions of mains, the cost of which was estimated at £6,500. Bailie Wright admitted they were asking authority to borrow money for certain particular works which they had not yet resolved upon. The scheme of public lighting was expected to cost £2,000, while for additions to plant £6,300 would be required. The various items brought out a total of £50,000. In answer to his lordship, the witness stated that the gas area and the electric lighting area were entirely different. The charges would be 7d. per unit for the first hour and 3d. per unit for the hours thereafter.

British Steam Specialities, Limited.—This firm, who have their offices at 14 and 15, Southampton-buildings, Chancery-lane, have sent us one of their catalogues, which shows that the steam specialities are British in name only and American in manufacture. They are, however, not to be deprecated on that account, as the list discloses several most valuable pieces of apparatus in connection with steam plant and heating apparatus generally. These specialities, which may ultimately be manufactured in this country, are to the design of Messrs. Keelly and Mueller, of the United States. A large number of different types of reducing valves for high and low pressure and of steam-traps are illustrated in the catalogue, and we are particularly interested in a view of an oil and grease extractor, which is of great service where the exhaust steam has to be discharged into a town drain, or where it is required for heating apparatus, in which oil and other impurities would play havoc with the efficiency of the heating system. This oil and grease extractor exposes a considerable surface to the exhaust steam in order to collect the foreign matter, and at the same time the arrangements are such that no considerable back pressure is introduced into the engine exhaust. In connection with heating apparatus, the firm also specialise temperature controllers, which automatically vary the circulation in a heating system in accordance with the temperature required to be maintained. The catalogue in question contains at the end some useful details and tables of the engineers' pocket-book order.

COMPANIES' MEETINGS AND REPORTS.

EASTERN EXTENSION, AUSTRALASIA, AND CHINA TELEGRAPH.

The ordinary general meeting was held at Winchester House on Wednesday.

The **Marquis of Tweeddale**, who presided, stated that for the half-year ended Dec. 31 last the gross receipts had amounted to £339,450, against £290,431 for the corresponding period of 1898. After deducting all expenses, the available balance was £199,082. The gross revenue showed an increase of £49,019, about one half of which was derived from Australian traffic. In the expenses there was an increase of £16,850, which was almost entirely due to maintenance of cable. It was proposed to pay a quarterly dividend of 1½ per cent., making, with the interim dividends paid for the first half-year, a total dividend of 5 per cent. It was also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1899. The balance of £86,582 had been transferred to the general reserve fund. The traffic guarantees entered into some years ago with the Australian Governments would come to an end in the course of the next few days, but a new agreement had been entered into with the Governments of South Australia, Western Australia, and Tasmania for the establishment by this Company, in conjunction with the Eastern Telegraph Company, of direct cable communication between South Africa, Perth, and Adelaide, which, with the third route recently opened between Great Britain and the Cape, would provide Australia with an alternative line to the existing service. The arrangement also provided for an immediate reduction of the tariffs between Great Britain and the contracting colonies to 4s. per word, with proportionate reductions for Government and Press telegrams; and, as the traffic responded, for the further lowering of the tariffs on a "standard revenue" basis down to 2s. 6d. per word. The tariff between the contracting colonies and South Africa would also be reduced from 7s. 1d. per word to about 3s. 6d. per word on the opening for traffic of the new cable.

The report was adopted without discussion.

BUENOS AYRES AND BELGRANO ELECTRIC TRAMWAYS.

The ordinary half-yearly general meeting of this Company was held last week, Mr. Frank Parish presiding.

At the outset of the proceedings, the **Secretary** read a telegram, dated the 17th inst., from Buenos Ayres, which gave the following information: Traffic from main line for the week ended April 15 was £40,858, being an increase of £1,840; the aggregate for 41 weeks to date £1,646 460, or an increase of £202,787. Traffic from Ensenada section for week ended April 15 £4,065, being an increase of £401; aggregate for 41 weeks to date £177,646, an increase of £31,917. Results of working from the main line for the nine months to March 31 – gross receipts £1,560 506, an increase of £199,867; working expenses, £672 067, or 43 07 per cent.; net receipts, £888,439 an increase of £97,260. Results of working of the Ensenada section for the nine months to March 31—gross receipts, £169,490; working expenses, at 55 per cent., £93,219; and net receipts, £76,271.

The **Chairman** stated that comparative statements showed only a few instances in the last six months where there had been any decreases in receipts. The receipts per mile of line had fallen from £509 to £466, or a decrease of only £43 per mile, or 8·39 per cent., whereas the Company had opened up 350 more miles to Bahia Blanca. The working expenses of the half-year showed an increase of £87,000, which at first might appear rather heavy, but a large portion of it arose from increased contributions to the reserves for maintenance and renewals. The lower premium, which increased their wages, accounted for £14,000 more; and, in addition, the expenses of the refreshment department had had to be borne, amounting to £8,000, against which the Company had secured a net profit of £6,300 for the half-year. If the proprietors added these three items together it would be found that they amounted to £71,000, leaving only £15 000 as the cost of working 532 additional miles of line with 23 new stations. In June, 1902, the interest or dividend on the last issue of capital of £2 250,000 would come as a charge on revenue. The interest up to the present time had been paid out of the premiums received on the issue, but by the time it came to be a revenue charge they might, he thought, confidently anticipate that the increased earnings would be equal to the additional charge. The many works which had been described from time to time were all making progress. The undertaking was growing every year to such an extent that the directors had to increase the means of meeting the traffic and satisfying the public. Engines and rolling-stock were under order, and being shipped as fast as possible, and represented an aggregate cost of £607,000. The directors proposed to pay an interim dividend on the ordinary stock for the half-year at the rate of 7 per cent. per annum.

Mr. R. J. Neild seconded the adoption of the report, which was carried unanimously.

DUDLEY, STOURBRIDGE, AND DISTRICT ELECTRIC TRACTION.

The eighteenth ordinary general meeting of this Company was held at Donington House, Norfolk-street, W.C., on Tuesday last. **Mr. Emile Garcke**, who presided, submitted the following report to the shareholders. The report was seconded by **Mr. Woodward**, and carried unanimously.

The electrical equipment of the lines was inspected by the Board of Trade on July 25, 1899, and the lines have been worked electrically since July 26 last. The Board of Trade have granted the usual certificate for seven years from Feb. 2, 1900. During the year £53,968. 8s. 11d. has been expended in respect of the electrical equipment, and this account now amounts to £83,308. 8s. 11d., of which £71,173. 0s. 4d. is owing to the British Electric Traction Company. The directors propose to issue the balance of the unissued 8,211 ordinary and 19,375 preference shares of £5 each in order to discharge this amount, and to provide capital for the completion of the Dudley light railways which are now in course of construction, and will, it is hoped be opened for traffic during the summer. The total revenue for the year amounted to £11,504. 16s. 2d., and the expenditure to £7,195. 15s. 3d., leaving a net profit of £4,309. 0s. 11d., which, added to the amount of £919. 8s. 8d. brought forward from last account, makes a total sum of £5,228. 9s. 7d. available for distribution. The directors propose that this amount should be applied as follows: dividend at the

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rate of 5 per cent. on the cumulative preference shares to Dec. 31, 1899, £146. 5s.; dividend at the rate of 3 per cent. per annum on the ordinary shares for the past year, £1,768 7s.; amount to be placed to depreciation fund, £1,000; balance to be carried forward to next account, £2 313. 17s. 7d. The depreciation fund will then amount to £6,079 0s. 8d. An agreement has been entered into with the British Electric Traction Company whereby that company agrees to transfer to this Company the whole of the lines to be authorised by the Dudley Light Railways (Extensions) Order, 1899, when constructed, for the sum of £28,500. The above agreement also secures to this Company the right to work the Kinver light railways for a period of two years on the basis of actual cost, plus a clear profit of 10 per cent. Mr. H. F. Woodward, late secretary of the Company, has been appointed a director of the Company. Mr. C. S. Drummond has resigned his seat at the Board, and the directors have appointed Mr. C. Shirreff B. Hilton to fill the vacancy thereby created. Messrs. C. A. Edge and C. Shirreff B. Hilton are the directors who retire by rotation, and they are eligible for re-election. Messrs. W. J. Kershaw and Co., the auditors, retire, and they offer themselves for re-election.

Dr. BALANCE SHEET.	£	s.	d.
Capital authorised—20,000 ordinary shares of £5 each	100,000	0	0
20,000 preference shares of £5 each	100,000	0	0
	200,000	0	0
Capital issued—11,789 ordinary shares of £5 each	58,945	0	0
585 preference shares of £5 each	2,925	0	0
	61,870	0	0
Amount payable on electric traction account to the British Electric Traction Company	71,173	0	4
Sundry creditors	1,602	10	6
Depreciation fund	5,079	0	8
Profit and loss account—amount brought forward from last account, £919. 8s. 8d.; profit for the year 1899, £4,309. 0s. 11d.; less dividends on preference shares, £146. 5s.	5,082	4	7
	£144,806	16	1
Cr.	£	s.	d.
Capital outlay—as per last balance-sheet	59,555	4	9
Deduct engine and materials sold	429	16	4
	59,125	8	5
Add office furniture purchased	11	3	6
	59,136	11	11
Electric traction account—amount paid and accrued under agreement with British Electric Traction Company, Limited	83,308	8	11
Stores and material	523	0	4
Sundry debtors	369	3	7
Cash at bankers and in hand	1,469	11	4
	£144,806	16	1

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
Power and running expenses	4,493	9	1
Maintenance and repairs	1,484	13	11
Administration and general expenses	1,217	12	3
Balance carried to balance sheet	4,309	0	11
	£11,504	16	2
Cr.	£	s.	d.
Traffic receipts	11,162	10	3
Advertising receipts	230	17	2
Sundry receipts	111	8	9
	£11,504	16	2

KIDDERMINSTER AND DISTRICT ELECTRIC LIGHTING AND TRACTION.

The second annual meeting of this Company was held on Wednesday last at Donington House, W.C., **Mr. J. S. Raworth** presiding. At the meeting the following report was presented to the shareholders, and on **Mr. C. S. B. Hilton** seconding was unanimously adopted.

The prospectus of the Company was issued in July, 1899, and 3,000 ordinary shares and 3,000 5 per cent. cumulative preference shares of £10 each were allotted. The total capital expenditure at Dec. 31, 1899, on account of buildings and plant for electric lighting amounted to £6,676. 15s. 1d., and the Company hold 5,600 shares of £10 each of the Kidderminster and Stourport Electric Tramway Company out of 5,720 shares issued, and had paid £22,400 on account of calls at Dec. 31, 1899. The gross profits, including the amount receivable from the Kidderminster and Stourport Electric Tramway Company for dividend on the shares held by this Company, amount to £1,558. 14s. 11d., and after deducting the expenses there remains a net profit of £1,458. 9s. 4d. The directors propose that this amount should be applied as follows—viz.: to dividend on cumulative preference shares from July 27 to Dec. 31, 1899, £312. 10s.; to be carried forward to next account, £1.145. 19s. 4d. The net profits for the year in respect of the Kidderminster and Stourport electric tramways amounted to £2,165. 14s. 11d., and this amount has been applied as follows—viz.: to dividend of 5s. 6d. per share on 5,720 shares, £1,573; to depreciation fund, £500; to be carried forward to next account, £92. 14s. 11d. The work of installing the plant is well in hand, and the directors hope to be able to commence a supply of current during the summer. Mr. J. S. Raworth has been elected chairman of the Company in the place of Mr. Emile Garcke. Mr. W. L. Madgen has been appointed a director of the Company. Mr. C. S. Drummond has resigned his seat on the Board, and the vacancy thereby created has been filled by the appointment of Mr. C. Shirreff B. Hilton. Messrs. Emile Garcke and C. Shirreff B. Hilton are the directors who retire by rotation, and they are eligible for re-election. Messrs. Walter J. Kershaw and Co., the auditors, retire, and they offer themselves for re-election.

Miles open— *Tramways.*	M.	F.	Ch.
Route miles	4	4	7
Single line	4	2	4
Double line	0	2	3
Number of passengers carried		753,500	
Average receipts per passenger		1·69	
Average expenditure per passenger		1·07	
Proportion of expenses to receipts		63·19	
Number of cars in stock		13	

Dr. REVENUE ACCOUNT.	£	s.	d.
Management expenses—stationery and printing	32	2	11
General establishment charges	52	4	0
	84	6	11
Special charges—cost of obtaining Stock Exchange quotation, etc.	15	18	8
	100	5	7
Balance carried to net revenue	1,448	1	1
	£1,548	6	8
Cr.	£	s.	d.
Dividend receivable from the Kidderminster and Stourport Electric Tramway Company	1,540	0	0
Discounts	5	19	8
Transfer fees	2	0	0
Lists of shareholders	0	7	0
	£1,548	6	8

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount received	34,686	0	0
Sundry tradesmen and others, due on construction of plant, machinery, etc.	3,651	17	2
Sundry creditors on open accounts	864	9	6
Balance at credit of net revenue account	1,145	19	4
	£40,348	6	0
Cr.	£	s.	d.
Capital account—amount expended for works as per account	6,676	15	1
Amount paid on account of 5,600 shares of the Kidderminster and Stourport Electric Tramway Company	22,400	0	0
	29,076	15	1
Sundry debtors	1,560	17	8
Cash at bankers and in hand	9,710	13	3
	£40,348	6	0

CHARING CROSS AND STRAND ELECTRICITY SUPPLY.

At an extraordinary general meeting on the 24th inst. it was decided to increase the capital of the Company to £800,000, by the creation of 30,000 new ordinary shares of £5 each and 60,000 new preference shares of £5 each. It was pointed out that owing to the demand it became absolutely necessary for the Company to build one new station, and possibly two.

LEGAL INTELLIGENCE.

F. KIRBY v. H. J. LAWSON.

This case came before Mr. Justice Grantham and a special jury on Tuesday, and was an action brought to recover £2,000 commission, alleged to be due from Mr. Harry J. Lawson, the defendant, a company promoter.

Mr. Rufus Isaacs, Q.C., said the plaintiff, Mr. Frederick Kirby, was a civil engineer practising in Cannon-street, E.C., and was associated in business with a Mr. Wells. In June last year Mr. Lawson had some business in hand in connection with a then projected company to be floated by the Electrical Tramways Construction Company, and he desired an introduction to an engineer of considerable eminence in the electrical world whose name could appear on the prospectus. The subject was introduced to plaintiff and Mr. Wells, and as a result, after some negotiations, the defendant promised verbally to pay £2,000 commission for the introduction of Mr. Thomas Parker. The introduction was duly effected. Mr. Lawson now denied having given any undertaking to pay commission.

Mr. Marshall Hall, for the defence, said that Mr. Lawson was most anxious to get a first-class scientific man at the head of it

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like Mr. Thomas Parker, and, on the terms that Parker should come in at £1,000 salary and bring his influence, he offered the present claimants £2,000 commission as and when the company was formed. However, Mr. Parker had always refused the appointment with the Electrical Tramways Construction Company unless his businesses were taken over, and in consequence the agreement had never been completed.

The jury found a verdict for the defendant, and there was judgment accordingly, with costs.

FAILURE OF SUPPLY, ETC.

At the Greenwich Police Court on the 24th inst. the London Electric Supply Corporation, Limited, appeared to seven adjourned summonses at the instance of Thomas Allen Shaddick, the occupier of the Dover Castle public-house, Broadway, Deptford, for making default in supplying electrical energy to the premises. The defence was that the default was due to *force majeure*, and was caused by the failure of a contractor to supply boilers, and also to difficulties about coal supply. The magistrate reserved his decision.

A similar prosecution was heard at Southwark Police Court, before Mr. Paul Taylor, against the same company, at the suit of the London County Council, in respect of failures in the electric light supply in the parish of St. George-the Martyr. The defence was the same as submitted in the Greenwich case. Mr. Taylor dismissed the summonses, with five guineas costs.

At the Marylebone Police Court, on Tuesday, the Metropolitan Electric Supply Company, Limited, answered before Mr. Plowden six adjourned summonses issued at the instance of the Marylebone Vestry and the Marylebone Board of Guardians, for in the month of December making default in the supply of electrical energy.

When the case was originally before the Court Mr. Muir pleaded guilty, and assured the Court that measures had been taken to prevent a recurrence of the cause of complaint, and asked as a test that the case should stand adjourned for three months. He now contended that there had been no repetition of the original defaults, and that the failures since had been beyond human foresight, and were not preventable. They were inevitable accidents.

Mr. Plowden thought the explanation of the company as to the failures during the present year exculpated it from blame, and he should not, therefore, take them into account. On the original summonses the company would have to pay 5s. for each date (total £1. 5s.), with 10 guineas cost.

PROVISIONAL PATENTS, 1900.

APRIL 11.

6774. **Improvements in or connected with direct-current transformers.** Wilfrid L Spence, Oakleigh, Alloa, N.B.

6780. **Improved electrical measuring instruments.** Harold Henry Lindon and Robert Foster Collinge, 54, Jolliffe-street, High Park-street, Liverpool.

6794. **An improved electrical combined switch and cut-out.** August Eckstein and Albert Julius David Krause, Peel Works, Adelphi, Salford, Manchester.

6798. **Double and single pole maximum and minimum automatic electrical cut-out.** Stephen Mason Johnstone, 142 Cambridge Drive, Kelvinside North, Glasgow West.

6826 **Improvements in switches for electric currents.** Joseph Charles de Janisch, 45, Southampton-buildings, Chancery-lane, London.

6828. **Improvements in the manufacture of electric cables more particularly intended for conducting currents of high tension or voltage.** Max Mildner, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 12.

6866. **Improvements in or connected with electricity distribution on the multip e voltage system.** Wilfrid L Spence, Oakleigh, Alloa, N.B.

6878. **Improvements in electric arc lamps.** Henry Vincent James, 62 Market-street, Manchester. (Complete specification.)

6913. **Improvements in electrical speed indicators** The British Thomson-Houston Company, Limited, and Frank Holden, 83, Cannon-street, London.

6918. **An improved electric typewriter.** Wilhelm Carl Emil Faber, 53, Chancery-lane, London.

6923. **Improvements in loud speaking telephones.** Charles François Dussaud, 45, Southampton-buildings, Chancery-lane, London.

6931. **Improvements in or connected with the transmission and distribution of electricity.** James Grieve Lorrain, Norfolk House, Victoria-embankment, London. (Frederick Bedell, United States.)

6936. **Improvements in switches for electrical circuits** Ernest Francis Moy and Ernest F. Moy, Limited, 37, Essex-street, Strand, London.

6947. **Improvements in dynamo electric machines.** Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Feb. 24, 1900, being date of application in United States.)

6948. **Improvement in polyphase induction motors.** Benjamin Garver Lamme, 322, High Holborn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Sept. 14, 1899, being date of application in United States.)

6951. **An improved instrument for measuring electric currents.** Louis John Steele, 11, Burlington-chambers, New-street, Birmingham. (Complete specification.)

APRIL 14.

6974. **An improved system or means for controlling or regulating electrical installations.** William Phillips Thompson, 6, Lord-street, Liverpool. (Carl Coerper, Germany.)

7031. **Improvements in electric clocks.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Walter Jenkins Dudley, United States.) (Complete specification.)

APRIL 17.

7062. **Variable-speed gear for mechanically or electrically-propelled vehicles.** Colombo Ricci, 68, Sharrolds-road, Fulham, London.

7070. **Improvements relating to telephones.** James Coole Kneale and Henry Hartley, 18, Southampton-buildings Chancery-lane, London.

7082. **Improvements in printing telegraphs.** Luigi Cerebotani and Carl Moradelli, 111, Hatton-garden, London. (Complete specification.)

7084. **Improvements in or relating to electric motors.** Alfred Julius Boult, 111, Hatton-garden, London. (Oscar H. and Alphonse F. Pieper, United States. (Complete specification.)

7095. **Improvements in or relating to multipolar electric machines.** Sidney Howe Short, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7100. **A new or improved device to fixing incandescence electric lamps.** Louis Jean Paul Hollub and Henri Mignal, 45, Southampton-buildings, Chancery-lane, London.

7106. **Improvements in electric railway systems.** John McLeod Murphy, 40, Chancery-lane, London. (Complete specification.)

7108. **Improvements in or connected with magneto-electric machines.** Frederick Richard Simms and Robert Bosch, 4, South-street, Finsbury, London. (Complete specification.)

7109. **Improvements in electromagnetic coils.** Richard Varley, 322, High Holborn, London. (Complete specification.)

7133. **Improvements in incandescence electric lamps.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Samuel D. Washburn and Clarence H. Tinkham, United States.) (Complete specification.)

APRIL 18.

7155. **Improvements in overhead electric tram and railway conductor junctions and crossings.** Joseph Newns, 15, Water-street, Liverpool.

7157. **Improvements in and relating to telegraphic transmitting devices.** Alexander Marr, 70, Market-street, Manchester.

7198. **Improvements in the method of producing complex chemical compounds by electrolysis with alternating currents.** William Phillips Thompson, 322, High Holborn, London. (Alf Sinding-Larsen, Norway.) (Complete specification.)

APRIL 19.

7218. **Improvements in and relating to the application of electricity and/or magnetism to fibrous substances and fabrics and/or to machinery and apparatus or parts thereof employed in the preparation, manufacture, and treatment of such substances and fabrics.** James Townsley Pearson, 8, St. James's Hall, Burnley.

7239. **Improvements relating to fusible cut-outs for electric circuits.** Victor Jacques Delebecque, 18, Southampton-buildings, Chancery-lane, London.

7245. **Improvements in the production of plates for secondary batteries.** Henry Leitner, 37, Chancery-lane, London.

7246. **An improved secondary battery.** Henry Leitner, 37, Chancery-lane, London.

7272. **Improved connections for carbon electrodes.** Harry Baker, 55, Chancery-lane, London.

7285. **Improvements in or relating to electric railways operated on the conduit system.** Richard Clere Parsons, Reginald Belfield, and William Chapman, 322, High Holborn, London.

7287. **Improvements in electric railways with underground conductors.** Ludwig Henne and Georg Schönfelder, 6, Lord-street, Liverpool.

APRIL 20.

7314. **Improvements in boiling and vaporising fluids by electricity.** Robert Cooke Sayer, 11, Clyde-road, Redland, Bristol. (Complete specification.)

7320. **Improved sound deadener for overhead conductors of electric railways and the like.** Albert Thode and Co., 17, Devonshire-square, London.

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7321. Improved electric rotating insulator. Albert Thode and Co., 17, Devonshire-square, London.

7322. Incandescent electric lamp. William Edwin Irish, 77, Calabria-road, Highbury, London.

7356. Improvements in electrical incandescence lamps. Ernest Schattner and Frederic William Harmer, 55, Chancery-lane, London.

7372. An improved manufacture of electrodes. Alberto Tribelhorn, 11, Southampton-buildings, Chancery-lane, London.

7373. Improvements in the formation of drum windings for dynamo-electric machines. Walter Langdon-Davies and Alfred Soames, 24, Southampton-buildings, Chancery-lane, London.

APRIL 21.

7392. Electrometer of varying revolutions. August Lehner and Albert von Däuber, 17, Potsdamerstrasse, Berlin. (Complete specification.)

7410. Improvements in regulators for electric arc lamps. Paul Käsbauer, Michael Haberfellner, and Oskar Lenck, 55, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published May 12, 1900.

1899.

7776. Method of adapting candelabra for the electric light. Drake and Gorham.

10133. Systems of control for electrically-propelled vehicles. British Thomson-Houston Company, Limited. (Potter.)

10468. Party telephone line systems. Aitken.

10536. Electrical contact devices for explosion engines fired by electricity. Acciee.

11447. Electric cables. Heyl-Dia.

11795. Gear-changing mechanism. Du Bois and Mutual Electric Trust, Limited.

12294. Magneto-generators. Oppenheimer. (Actien Gesellschaft Mix und Genest.)

12668. Earthed coverings or electrical tubular conductors. Johnson. (Firm of Hartmann and Braun.)

12874. Glass globes, screens, covers, or the like for electrical incandescence and other lamps, and in means for manufacturing the same. Applegarth.

15525. Electric switches. Hofstede-Crull.

16739. Road contact and like systems for electric railways. Grunow.

25749. Systems of electric train control. British Thomson-Houston Company, Limited. (Potter.)

1900.

4122. Switch contacts for use in electrical ignition devices for multi-cylinder explosion motors. Kühlstein and Vollmer.

4193. Signalling devices for telephone systems. Justice. (Williams.)

4268. Tools for use in the laying of tile conduits for electrical conductors. Lake. (American Vitrified Conduit Company.)

4586. Telegraph receivers. Cerebotani and Silbermann.

4785. Alternating-current motor. Déri.

4933. Register dials for meters and the like. British Thomson-Houston Company, Limited. (Alton.)

5167. Alternating-current electrometers. Yates, Yates, and Bent.

5232. Storage batteries. Kennedy.

5274. Process of, and apparatus for, the electro-deposition of metals. Buck.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Apl. 21	5 000	4,118	+ 882	64,769	61,295
Blackpool-Fleetwood	,, 21	757	301	+ 456	3,525	3,647
Bradford City Trams	,, 22	532	290	+ 242	1,458*a*	1,112
Bristol Tramways Co.	,, 20	3,900	2,619	+1,281	—	—
City & South London	,, 22	1,211	1,025	+ 186	—	—
Dover Tramways	,, 21	247	160	+ 87	2,487	2,421
Dublin U.T., elec. cars	,, 20	4.239	1.064	+3,175	—	—
Dublin S.D. Electric	,, 20	1,505	868	+ 637	—	—
Halifax Corporation	,, 8	593	499	+ 94	—	—
Hull Corporat'n E.S.	,, 21	1,321	—	—	—	3 262*a*
Liverpool Corporat'n	,, 14	7.520	5,862	+1,658	101.326	88 907
Liverpool Overhead	,, 22	1,665	1,352	− 413	22,470	21,455
Sheffield Corporation	,, 22	2,548	—	—	—	—
South Staffordshire	,, 20	1,066	606	+ 460	10,243	9,810

a Since April 1. *b* Partly electrical.

NOTE.—Other returns, received too late for classification, will be found amongst our "Business Notes."

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Monday.
Commercial and Industrial.—		
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1 ..	¾-⅞
British Insulated Wire, Ord., 1-40,000	5 ..	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5 ..	6 6¼
—— 5 per cent. Mortgage Debentures	100 ..	98-103
British Electric Works, Ordinary, 50,001-95,000	1 ..	⅞-1
—— 6 per cent. Cum. Pref., 1-50,000	1 ..	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	103 ..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5 ..	4¾-5¼
Brush Electrical Engineering, Ordinary	2 ..	1¾-2
—— Non. Cum., 6 per cent. Pref.	2 ..	2¼-2⅜
—— 4½ per cent. Debenture Stock	100 ..	108-113
—— 4½ per cent. 2nd Debenture Stock	100 ..	108-105
Callender's Cable, Debentures	100 ..	112-116
—— Ordinary	5 ..	14½-15½
—— 5 per cent. Pref.	5 ..	5¾-6
Crompton and Co.	3 ..	3¾ 4
—— 5 per cent. Debentures	— ..	99-102
Edison and Swan United, Ordinary	3 ..	2-2¼
—— 5 per cent. Debentures	5 ..	3¼-4¼
—— 4 per cent. Deb. Stock, Red.	100 ..	93-95
Electric Construction	2 ..	2¼-2⅜
—— 7 per cent. Cumulative Pref.	2 ..	3⅜-3½
—— 4 per cent. Perp. 1st Mort. Deb.	100 ..	103-106
W. T. Henley's Telegraph Works, Ordinary	5 ..	13½-14½
—— 4½ per cent. Preference	5 ..	5¼-5¾
—— 4½ per cent. Debentures	100 ..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10 ..	21-23
—— 4 per cent. Debentures	100 ..	100-103
Telegraph Construction and Maintenance	12 ..	36-40
—— 5 per cent. Bonds	100 ..	102-105
Telegraph Manufacturing, Ordinary	5 ..	10-11
—— 5 per cent. Cum. Pref.	5 ..	5½-6
Willans and Robinson, Ordinary, 1-30,000	5 ..	12-13
—— 6 per cent. Cum. Pref., 30,001-60,000	5 ..	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100 ..	104-106
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1 ..	⅜-½
Bournemouth and Poole, Ordinary	10 ..	11½-12½
—— 4½ per cent. Cum. Pref.	10 ..	10-11
Brompton and Kensington, Ordinary	5 ..	7-8
—— 7 per cent. Preference	5 ..	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5 ..	7-7½
Charing Cross and Strand	5 ..	9-10
—— 4½ per cent. Cum. Pref.	5 ..	5½-5¾
Chelsea Electricity Supply	5 ..	6¼-7½
—— 4½ per cent. Debentures	100 ..	108-111
City of London, Ordinary	10 ..	9½-10½
—— 6 per cent. Cumulative Pref.	10 ..	13-15
—— 5 per cent. Debenture Stock	100 ..	122-127
County of London and Brush Provincial, Ordinary	10 ..	9½-10½
—— 6 per cent. Cum. Pref.	10 ..	12½-13½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	— ..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5 ..	4½-5
—— 4½ per cent. First Mort. Deb.	100 ..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10 ..	9½-10½
London Electric, Ordinary	3 ..	1½-2
—— 6 per cent. Pref.	5 ..	4¼-4
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100 ..	100-102
Metropolitan, Ordinary	10 ..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100 ..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100 ..	96-98
Notting Hill Electric Lighting	10 ..	15½-16½
Oriental, 1879	1 ..	1⅜-1⅝
—— £5 Shares	5 ..	7-7½
—— £4½ Shares, New	4½ ..	6¼-6⅝
Oxford Electric, Ordinary, 1-96 and 407-10,310	5 ..	6½-7
River Plate Electric Light and Traction, Deb.	100 ..	75-85
Royal Electrical Company of Montreal	1½ ..	170-19
—— 4½ per cent. First Shares Mortgage Debentures	100 ..	103-105
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5 ..	2½-2
—— 4 per cent. Debenture Stock	100 ..	85-95
South London, Ordinary	3 ..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5 ..	14½-15
—— 7 per cent. Pref.	5 ..	8½-9½
Westminster, Ordinary	5 ..	15-1
Electric Railways.—		
Central London, Ordinary	10 ..	10½-10
—— Pref. Half-Shares	5 ..	4½-5
—— ,, ,, deferred	5 ..	5-5½
City and South London, Consolidated Ordinary	100 ..	67-
—— Ordinary	10 ..	6-7
—— 4 per cent. Debenture Stock	100 ..	125-1
—— 5 per cent. Pref. Stock '91	10 ..	140-1
—— ,, ,, ,, '96	100 ..	132-1
Liverpool Overhead, 5 per cent. Pref.	— ..	13½-13⅝
Waterloo and City, Ordinary	100 ..	101-103
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10 ..	17-18
Brisbane Tramway	100 ..	102-104 xd
British Columbia Electric Railway Co., 5 per cent. Pref.	10 ..	10-10½
British Electric Traction, Ordinary, 1-80,000	10 ..	17-18
—— 60,001-75,000	10 ..	16½-17½
—— 6 per cent. Cm. Pf. 30,001-60,000	10 ..	12½-13½
—— 5 per cent. Perpetual Debenture Stock	100 ..	124-127
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5 ..	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5 ..	4-4½
—— 5 per cent. Deb. Stock, Red.	100 ..	105-108
Isle of Man Electric Power, 1-95,000	1 ..	⅝-11/16
—— 6 per cent. Preference, 100,001-170,000	1 ..	⅝-13/16
Kidderminster and District Lighting and Traction, Pref.	10 ..	9½-10½
New General Traction, Ordinary	5 ..	3¾-4½
—— 6 per cent. Cum. Pref.	5 ..	5-5¾
North Staffordshire Trams	6 ..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10 ..	16-18
—— Preference	10 ..	10½-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10 ..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10 ..	9½-10½
Telephones.—		
Consolidated Telephone Construction and Maintenance	½ ..	½-¼
National Telephone, Ordinary	*a* ..	5-5½
—— 6 per cent. Cum. First Pref.	10 ..	14-15
—— 6 per cent. Cum. Second Pref.	10 ..	14-15
—— 5 per cent. Non. Cum. Third Pref.	5 ..	5¼-5½
—— 3½ per cent. Deb. Stock, Red.	100 ..	97-100
Oriental Telephone and Electric Company	1 ..	¾-1

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NOTES.

Automobiles in War.—The German Emperor has offered a prize of £4,000 for the best automobile for military purposes.

Society of Engineers.—At the meeting next Monday a paper will be read, entitled "The Economical Disposal of Town Refuse," by Mr. Brierley Denham Healey. The paper will deal to some extent with the utilisation of the destructor for power.

Electric Power in India.—We learn from *Indian Engineering* that the Government of India has called for proposals for lighting Wellington by electricity from the Kartari Falls, in connection with the scheme for the utilisation of the water power from these falls for the cordite factory now building in the Arvenghat Valley, Nilgiris.

Braun's Wireless Telegraphy.—We gather from the *Financial Times* that a company has just been formed in Hamburg, under the title of Prof. Braun's Telegraph Company, for the purpose of continuing the experiments of Prof. Braun, of Strassburg, in the direction of wireless telegraphy. The capital for this company has been fixed at about £100,000, and an agreement made between the Schuckert Company and the syndicate hitherto dealing with the Braun patents is to be taken over.

Hull Tramways.—We gather from the daily Press that a serious stoppage occurred on the Hull electric tramways owing to a machine breaking down in the power station. The machines are practically on trial, being yet under the contractors' 12 months' guarantee, and apparently the one on which the whole burden of the line was thrown worked very well until the load became too great. The accident occurred in the early morning, the service stopping entirely at 9.30 a.m., traffic being resumed the next day. The loss caused by the stoppage is estimated at from £150 to £160, which would tend to show that the tramways are a rather popular mode of conveyance in Hull.

Telephonography.—The Berlin correspondent of the *Daily Mail* states that the German Postmaster-General recently witnessed some experiments with this new instrument. He states that the telephonograph is a combination of the telephone with a newly-constructed phonograph, which makes it possible to fix and preserve conversations in the absence of the intended hearer, so that he can listen to the message after his return. It is also stated that with this instrument it is possible to multiply the effect of the sound and to give the sound greater force. Another advantage claimed for the invention is the use of the same wire for several conversations at the same time.

Modern Motorcars.—A paper on "Modern Motor Vehicles" was read at the monthly meeting of the Leeds Association of Engineers by Mr. R. Winn. These, he stated, were a great improvement on the machines of three years ago. The price was high, but this could be reduced when the demand increased. He described in detail the various kinds of motor vehicles made in England, France, and America, and pointed out the more salient features of each. He preferred the smaller sizes of cars, driven by spirit motors. Electricity, he thought, was an ideal power, there being no connecting rods or gear for producing different speeds required, but up to the present satisfactory accumulators had not been invented.

A Glasgow Engine.—We notice in an issue of the *Engineer* of Cleveland, U.S.A., an illustration of a hollow steel shaft which has been dispatched to Glasgow for one of the large Allis engines to be used in the power station in that town. This steel shaft was manufactured by the Cleveland City Forge and Iron Company, and weighs complete 66,105lb. Its length over all is 24ft. 1½in., and its greatest diameter 36in. The boring through the centre of the shaft is in most places 8in. in diameter, but in one part this is increased to 10in. The size of this shaft as compared with the workman who stands behind it in the illustration gives one a good idea of the magnitude of the electric traction scheme at Glasgow.

King's College.—We are informed that the fortieth annual dinner of old students of King's College, London, will be held at the Holborn Restaurant on Monday, June 18. The Hon. Sir John Alexander Cockburn, K.C.M.G., F. and A.K.C., M.D., Agent-General for, and formerly Premier of, South Australia, has kindly consented to preside on this occasion, and his Royal Highness the Duke of Cambridge, K.G., has also signified his intention of being present. The stewards and committee would alone form a very distinguished gathering, as the list includes a large number of eminent scientists, etc. Any information respecting tickets, etc., may be obtained from Mr. W. Vincen, hon. secretary to the Dinner Committee, at King's College.

Central Trolley Poles.—The lamentable death of an electrical engineer near Blackpool emphasises the need of carefully considering the spacing of the tramway tracks when central poles to support the trolley wires are used. The accident occurred at Lytham-road, the deceased being crushed between the tramcar and the pole and killed. It was proved at the inquest that there was only 5in. space between the pole and the tramcar. The deceased was trying to board the car, and he had his back to the pole against which he was crushed. We understand that ordinary passengers are forbidden to enter the car from the front If, however, the space between the tracks was limited, the car should have been so constructed that it was impossible for anyone to enter it except at the proper side, away from the pole. Cars of this type are, we understand, now being adopted.

Continental Telegrams.—The Postmaster-General has, we understand, issued to the Chambers of Commerce a letter stating that the Post Office Department have from time to time given much consideration to the question of strengthening communication with the Continent generally, and a number of new lines have been laid. The policy of opening up direct communication with the principal centres on the Continent is still being steadily pursued, and further projects for direct wires are under consideration. He has also, after careful consideration, arrived at the conclusion that the circumstances justify an actual addition not merely to the land lines, but to the existing cables, and is therefore arranging with the respective telegraph administrations to provide new cables to Germany, Belgium, and the Netherlands, which he hopes will be laid during the current financial year.

Midland Institute of Engineers.—A meeting in connection with this body was held on Saturday, in the Queen Hotel, Leeds, when Prof. Goodman gave an address on "Economy in Steam-Engine Practice." He showed that the difference between efficiency and inefficiency was largely a matter of attention to details, and that by attention to the initial condensation of steam in the engines, by jacketing in cases where the cut-off was at half-stroke or less, by superheating, etc., great economies might be effected. There was a difference of 25 to 30 per cent. in the efficiency of the use of steam in the worst and in the best engines. The engineers of the country were awakening to the importance of these details, and he believed that in a year or two England would again take her proper

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position as leading the world in the construction of the most efficient and economical steam-engines.

Electric Traction in Italy.—We have at different times referred to the various electric power schemes which are being developed in Italy. A *résumé* of the application of electric power to railway working in the same country now appears in the issue of the *Electrical World* for April 21, and is by Mr. G. Giorgi. From this one gathers that 83 miles of track are now being transformed from steam to electric traction. In small lines running into the mountains electric traction is being even more used, and proposals for the construction of several hundred miles of these lines are now being considered. In all these cases water power, which is so abundant in Italy, is being used as the prime mover in the generating station. The author gives actual details of the different schemes, which will be of great interest to contractors.

Electromagnets and Well-Boring.—An instance of the utility of the electromagnet for removing pieces of iron and steel when in very awkward places is instanced in a German mine. A bore was being sunk, and at a depth of almost 1,000ft. the hardened end of the steel bit broke off. This obstruction naturally prevented any further boring. In order to get the broken piece of steel out, therefore, a soft-iron bar 5ft. long and 2·7in. diameter was surrounded by a single winding of indiarubber-covered wire. It was then magnetised by means of a small dynamo and let down the hole. When at the bottom, current was switched on through the wire turns, and in this way a fairly powerful magnet was obtained, which raised the steel to the surface without further trouble. This method was very successful in this instance, as was natural with no very large piece of metal to hold. It would perhaps not answer if a large section of the boring bar were to be pulled out, as the magnet would have to be a much more powerful one than could conveniently be constructed in the limited space.

Electroplating Baths Without Water.—In a paper read at the March meeting of the Chicago Electrical Association by Mr. C. F. Burgess, we learn from the *Electrical World* of New York that reference was made to the desirability of an electroplating bath containing no water, which would obviate difficulties encountered in working with certain metals, owing to the presence of hydrogen released from the water. Recent experimental research had shown, he said, that it was possible to dissolve certain metallic compounds in certain organic substances, and that such solutions might be electrolytes. Some notable work along this line had been carried on very recently by Dr. L. Kahlenberg, of the University of Wisconsin. He had succeeded in obtaining very good deposits of lithium, a metal which under ordinary circumstances would be considered even more difficult to deposit than aluminium or magnesium. His method consisted in dissolving lithium chloride in pyridine, a somewhat volatile organic compound, and passing the current through the solution, as in the ordinary plating operation.

Engineers' Wages.—There again appears to be trouble brewing between the engineers and employers on the North-East Coast. This is owing to a demand recently made by the Amalgamated Society of Engineers for an advance of 2s. per week on time wages, and 7½ per cent. on piecework, to commence from May 1. We gather from the journal of this association, however, that the employers do not appear to treat this demand favourably. It is stated in this journal that "unanimity of resolve seems prevalent that this time the employers must concede an advance. Last year, when asked, it was argued that trade was falling off. Experience has since shown this view to be wrong. It is felt strongly that the present demand is moderate, inasmuch that the advance last sought was not pressed, although justly entitled to same. The associated firms, however, at the moment of writing, are not, apparently, willing to grant an advance, as they say they are 'unable to accede thereto.'" It is to be hoped that some amicable arrangement will soon be come to, and that no further disorganisation of trade, which has already been much upset this year, will take place.

Telephones.—On Saturday last, in the House of Commons, it was stated by Mr. Hanbury that it was of public interest that the National Telephone Company's system should be made to work in intercommunication with the Post Office system. This was specially desirable in London, where the County Council had promised to give facilities for opening the roads for purposes of underground wires if the National Telephone Company would make arrangements in the public interests. Amongst such arrangements intercommunication with the Post Office system was to be included. He praised the administration of the Glasgow Corporation, but could not admit the charge that the Government had acted prejudicially to the Corporation by giving undue facilities to the National Telephone Company. The fact was that the conditions which had been complained of were largely the outcome of the agreement made between the Post Office and the company long before competition was intended. This agreement must be carried out, but he did not think it would be found to operate to the disadvantage of Glasgow. A motion to reduce the vote to the Post Office was afterwards negatived.

Electrically-Heated Soldering Irons.—*L'Eclairage Electrique* recently contained an article describing the various types of electrically-heated soldering irons and plates for soldering tin canisters, etc., hitherto in vogue. Most of these devices obtain their heat from resistances embedded in some insulating material, such as porcelain, but the Allgemeine Elektricitäts-Gesellschaft have introduced a soldering iron which is heated in a novel manner by means of an electric arc in a closed cylinder. The same firm have applied the principle to a number of different heating devices, including flatirons. The method was patented some years ago by Rudolf Wieczoreck. In its application to a soldering iron a cylinder of wood is employed, which carries the soldering iron at one end, while at the opposite end a carbon receptacle is attached. The arc is formed between the carbon and the copper of the iron, the consumption of carbon being small in consequence of its being enclosed. When the iron is not in use the copper is moved back away from the carbon. To form the arc an eccentric is turned, by which means the carbon is brought in contact with the copper, a further slight turn of the eccentric separating the carbon from the copper again and so forming the arc. From four to five amperes of current at a pressure of from 25 to 35 volts are consumed by such a soldering iron, according to the length of the arc. We are not told how long the copper stands the treatment.

Wireless Telegraphy.—It is interesting to see how strongly some of the daily papers support the system of wireless telegraphy which has been the cause of so many sensational paragraphs in their columns during the past year or two. The *Globe*, for instance, in its "Echoes of Science" column last Friday, accuses the electricians connected with the older form of telegraphy of refusing to believe in the possibilities of wireless telegraphy, just as the gas engineers would at first not believe in the electric light. Our contemporary goes on to say that while these electricians are unable to deny that Marconi has been

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successful to some extent, they say that his system is only of use for short-distance work, and that it will only be useful for communication between the shore and lightships. It then proceeds to quote Prof. Fessenden to the effect that the Marconi law as to the range of signals would show that, with high enough sending and receiving wires, messages could conveniently be sent to 1,000 miles or more. If our contemporary's condemnation of the action of electrical engineers with respect to wireless telegraphy is to be justified, Sir W. H. Preece must be included amongst those who are to be blamed, as in his "James Forrest" lecture he practically re-echoes the statement which has appeared many times in our columns—*i.e.*, that the commercial possibilities of wireless telegraphy are wanting.

A High-Temperature Thermometer.—It is often convenient to have a thermometer which should give accurate readings from, say, zero up to about 500deg. C., and the ordinary mercury thermometer cannot be used at the higher temperatures. We see described in *L'Industrie Electrique* a mercury thermometer which can be used for these temperatures, designed by Mr. Steinle. Its operation is based on the expansion of mercury with a rise of temperature. It consists of a small cylindrical receiver of steel, which is closed at one end. At this end a capillary tube of steel, the internal diameter of which is ½mm., is connected. This thin tube of steel can be made of any length up to 50 yards, so that the indications of the instrument can be seen at a considerable distance from the place of which the temperature is required to be known. The capillary tube of steel is connected to another small tube which is wound in the form of a spiral. The whole of these tubes and the cavity are completely filled with mercury. The heating of the small cylindrical receiver then causes the spiral to dilate and to untwist. One end of the spiral being held and the other fixed to a suitable gearing, the indication of the temperature can be given on a dial which can be seen for a considerable distance. We have seen a somewhat similar principle used with an apparatus in which the pressure of the expanding liquid is indicated on an ordinary pressure gauge.

The Coming Solar Eclipse.—At the monthly meeting of the British Astronomical Association, held at Sion College, some interesting statements were made regarding the arrangements for observing the total solar eclipse of May 28 next. One party will go to Wadesborough, in North Carolina, U.S.A.; another will go to Algiers; and yet another to Portugal. We are glad to find that the United States Naval Department have intimated that the instruments will be admitted into the country free of charge and of examination, the Canadian Government having also granted similar facilities should the expedition pass into Canada. The British Government have done the same in respect of the return to England, so that much inconvenience and risk to photographic material and instruments generally which would otherwise be experienced will be avoided. It was mentioned, also, that the Foreign Office had intimated that they would give certain facilities to British observers going to Portugal, and that the Portuguese Customs authorities had granted facilities for the passing of instruments through. The railway companies in Portugal proposed to grant to duly-authenticated astronomers tickets at half price, and between certain points on the State railways astronomers possessing a certificate that would be issued would be carried free. In the United States, also, the railway companies have promised special concessions for the occasion. It is very pleasing to find that scientific research is in this way to be helped forward by the various countries in which the observations are to be taken.

Accumulator Traction.—What we believe to be the last English tramway using accumulator traction is apparently within a measurable distance of having this method superseded by the overhead trolley system. The line we refer to is at Birmingham, where the Bristol-road section is worked by accumulators. Some time ago the company proposed to the Corporation that they should convert the present system into overhead trolley, and the Corporation instructed their Public Works Committee to report upon the subject. In this report, which has just been presented, they state that the lease of the tramways by the company will expire on June 30, 1911. Since their opening they have been worked on the accumulator system, but this has never worked properly, and a very inefficient service has been given. The company do not wish for an extension of the lease, and only require that the Corporation, on the conclusion of it, shall purchase the tramways at a price to be settled by valuation. If the Corporation also decide at the end of the 11 years of the lease now remaining to continue the overhead system, they are to purchase the overhead work, or if they do not so decide, to allow the company to remove the overhead equipment and the copper rail bonds. The whole of the construction is to be carried out under the superintendence of the Corporation officer. The Public Works Committee are of the opinion that the proposals are reasonable, and that they would benefit the city. It therefore recommends the Council to accept the company's offer. We are glad to know that this has been done, and that the public will get a share of the resulting saving in the shape of reduced fares.

Electricity at Sarajevo.—The April number of the *Revue Générale des Sciences* is devoted largely to a description of the country of Bosnia-Herzegovina. Information is given as to the agricultural industry, mining industry, education, legislation, commerce, finance, etc, of the country, while the public works come in for no inconsiderable notice. Amongst the electrical installations mentioned is the plant of the capital of the country, Sarajevo. This installation was equipped by Messrs. Siemens and Halske, of Vienna, and is used to supply electrical energy for both lighting and traction, the electric tramways giving a rapid and frequent service through certain of the main streets. Two stations are used, one being the generating station and the other an accumulator sub-station. The positions of these are said to be the foci of an ellipse formed by the electric tramways. The supply is given on the direct-current three-wire system at 110 volts for lighting, while the tramways are supplied on the trolley system, at 300 volts between the trolley wire and earth. We understand that the same plant is used for both purposes. The steam-engines are of the horizontal type, and drive the dynamos by means of ropes. In the lower part of the town the electricity is transmitted by underground cables, which have a steel armouring. In other parts of the capital bare overhead wires are used. The street-lighting is effected by means of 140 arc lamps, which for some reason our contemporary classes as going on the tramway network. This network is also said to supply 9,100 incandescent lamps, equivalent to 12,000 lamps of 16 c.p.; but it is not clear from the description before us quite how this is done.

'Bus Bars.—It is interesting to note the development of the use of omnibus bars in connection with alternate-current stations, working both for the distribution of lighting and power. In the earlier stations laid down in this country 'bus bars were conspicuous by their absence, as the alternators were not worked in parallel. Instead

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of these bars, ingenious connections were arranged by which any machine could be switched on to a fair number of the circuits which had to be supplied. With the introduction of parallel running, 'bus bars became necessary, and in several instances a duplicate set was provided in order to run up on artificial load before the machines were switched on to the supply. These auxiliary bars in connection with the artificial load are exceedingly useful for testing purposes. As the number of lights supplied from the station and the size of the generating units became larger, it was soon recognised that it was not quite safe to have all the station working in parallel with the mains. If this is done, a comparatively small fault in one part of the mains is apt to interfere with the whole supply. Arrangements have accordingly been made in the latest types of switchboards for the dividing up of the 'bus bars into sections, which can be used to supply a certain part of the feeders. In this way the whole of the machinery in the station is not worked in parallel, and the whole of the feeders are only grouped together on to one machine at times of light load. We note that in the new generating station of the Metropolitan Street Railway Company of New York this system of dividing up the 'bus bars into sections has been adopted, which is a confirmation of the advantages of this English practice.

Street Alterations.—On Thursday week Mr. Ritchie received at the Board of Trade a deputation from the County Councils' Association, the London County Council, the Scottish County Councils' Association, and various county councils, which was introduced by Sir John Hibbert. The object of the deputation was to ask that the county councils should be relieved of having to pay heavy compensation to electric lighting companies when altering, widening, or rebuilding county bridges, which had been put upon them by the Consolidation Act of last year, and from which they were entirely free with tramways and gas and water companies. The county councils asked that their powers for widening and altering bridges should not be interfered with, that no new burden should be thrown upon the county ratepayers for the purpose of assisting electric lighting companies, and that if in widening or altering a bridge it became necessary to move a main, the work should be done by the electrical undertakers at their own expense and risk. We are glad to note that, in reply, Mr. Ritchie, while he expressed himself not unfriendly to what the deputation asked, said that new legislation on the subject should not be retrospective. In the county of London, if the County Council were not made responsible for the cost of altering the electric conduits entailed by changes in the street line, there would be a great expense put upon the various electric lighting companies. In fact, the present tendency of local authorities to make the electrical undertakers pay more than their fair share of the cost of making good the street surfaces is a tax on the electric light consumer, and this tax would be greatly increased if the local authorities could continually order changes to be made in the line of cables without bearing the cost of the alterations.

Electromobile Competition in Germany.—A competition instituted by the Mitteleuropäischen Motorwagen Verein between various types of electromobile cars has just been concluded in Berlin. The results are not yet to hand, but may be expected shortly, and judging from the names comprised among the jury—Gisbert Kapp and Dr. Kallmann, amongst others—an impartial and instructive report on the trials may be anticipated. On the first day of the competition the weights, dimensions, and other particulars of the competing cars were ascertained. Subsequently the batteries of the cars were discharged to the permissible minimum potential of about 1·83 volts per cell, and then recharged in order to determine their respective capacities. They were thereupon left in a charged condition until the following day in order to ascertain if any loss of charge had occurred during the rest. Numerous firms entered the competition, all sorts of vehicles being represented. On the second day, after due inspection of the cars, a trial run at an average speed of 9½ miles per hour was entered upon over a given course in order to ascertain the consumption of energy. After about threequarters of the predetermined capacity of each car battery had been discharged, the return journey was made to the starting point, where the remaining charge in the batteries was discharged through resistances, the potential of the cells being observed during the operation. Hereupon followed a recharging of the batteries under precisely similar conditions to those observed on the first day. From the above it will be gathered that the tests were conducted with considerable care, and although the trials were of too short a duration to indicate the ultimate endurance of the competing accumulators, some interesting results should nevertheless have been obtained as to the carrying capacity and range of the electromobiles.

Ultra-Violet Rays.—With regard to cathode rays and certain other rays, it is already known, says Mr. P. Lenard in the *Elektrotechnische Zeitschrift*, that they make the air, in which they diffuse themselves, conductive of electricity, by the oxygen being partially transformed into ozone and the formation of the nuclei of condensed moisture so effected. The author points out that a ray bearing close relationship to visible light is also capable of producing similar effects—namely, the ultra-violet rays of short wave-length (n = from 0·00014mm. to 0·00019mm.), to which V. Schumann first called attention in the year 1893. These rays are subject to an extraordinarily high degree of absorption in almost all mediums, including the atmosphere, while isolated bodies only, such as fluorspar, gypsum, or hydrogen gas, were discovered to afford a good passage to the rays. Convenient as sources of such ultra-violet rays are a spark-gap of an induction machine composed of aluminium wires and an electric arc, particularly if the positive carbon is substituted by a rod of aluminium, and also sunlight, but this only in the upper strata of the earth's atmosphere—*i.e.*, upon high mountains. The author shows the process of the formation of the nuclei of fog by reflecting the light from electrical discharges upon a jet of steam through a window of quartz placed within a shield of zinc connected to earth. Upon setting up the discharges, the hitherto misty and undefined form of the jet became cloudy and better defined, while its usually uniform grey tint was succeeded by glistening colours or a brilliant white. This is an indication that the rays created nuclei of condensed particles of moisture. It was not found necessary that the jet of steam should be placed direct in the beam of light proceeding from the window so long as it was situated near the window. Conductors charged with electricity are discharged when subjected to the influence of ultra-violet rays of short wave length, and in this case positive charges are as rapidly lost as negative charges, the nature of the conductor exerting no influence upon the result.

Road Locomotion.—A paper on "Road Locomotion" was read by Prof. H. S. Hele-Shaw at a meeting of the Institution of Mechanical Engineers held last week. The author made an introductory statement concerning the revival of road locomotion by motor vehicles, and then dealt with the problem of the behaviour of the wheel on

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the road, the question of steering and turning, and, lastly, with the subject of motive power, which was divided into internal-combustion motors or oil-engines, external-combustion motors (steam), and electrical motors. He compared the advantages and disadvantages of these three kinds of motive power, and observed that, though at present oil-engines were used for light motor vehicles and steam for heavy traffic, there were very ingenious steam motor-cars both in this country and abroad, while light oil-engines had been applied in France and also in this country in connection with heavy traffic. Moreover, there were other kinds of motive power, such, for instance, as compressed air, which was being tried in America. Oil-engines had been found so far best suited for light motors or pleasure vehicles. Electrical motors were clean, extremely convenient and simple, and altogether an ideal type of motor, but the difficulty of getting an accumulator which was in all ways suitable was very great. The whole problem of the use of electricity was determined by the life and capacity of the battery, and the merits of any accumulator should really be judged to a great extent by the condition of its batteries after six months' daily use in a motor vehicle. So long as a range of 40 miles per charge at speeds not exceeding 10 miles per hour were only required, electricity at a cost of not more than 2d. per unit was, at least, on a par with steam or oil, even for heavy traffic. Above these limits, however, electricity was impracticable. Better results had been obtained by electric vehicles in individual cases on long runs, but the batteries had been quite destroyed and were useless afterwards. Looking at the whole question, the author remarked that it might be safely said that the motor vehicle had come to stay, and that its uses, both in peace and war, would rapidly develop.

The Royal Institution.—At the Royal Institution on Friday evening last Lord Kelvin delivered a lecture, entitled "Nineteenth-Century Clouds over the Dynamical Theory of Heat and Light." Sir Frederick Bramwell was in the chair. The gist of the lecturer's remarks was ably summed up in the *Times* as follows: Lord Kelvin said that there were only two clouds to obscure the beauty and clearness of the dynamical theory, which might be briefly expressed by saying that heat and light were modes of motion. The first came into existence with the undulatory theory of light, and was dealt with by Fresnel and by Dr. Thomas Young. It involved the question, How could the earth move through an elastic solid, such as the luminiferous ether was supposed to be, far more easily and freely than the "wind through a grove of trees"? This cloud hung heavy and undispersed. Some years ago Michelson made a beautiful experiment to discover whether the ether passed freely through the earth, and *vice versâ*. Lord Kelvin still hoped that it did, but from the results of that experiment, which proved it did not, he could see no way of escape. The second cloud over the dynamical theory was the Maxwell-Boltzmann doctrine of the partition of energy. Here the outlook was less sombre. He held that mathematics had not proved the doctrine, and that the doctrine was not true. Still, he did not know anyone but himself that attacked it, and his own views had been attacked by Poincaré, Lord Rayleigh, and other distinguished mathematicians, though none of his assailants had proved the proposition. Lord Kelvin proceeded to give some illustrations of the doctrine, and emphasised the labour and difficulty of putting it to experimental tests. Its mathematical consequences, indeed, sometimes appeared to be contrary to common sense, but that was not conclusive, for mathematics must never be judged by common sense. Still, within the last few months he had worked out a large number of cases and had obtained results that did not agree with the doctrine. The simple way, therefore, to destroy this second cloud on the dynamical theory was to drop the destructive general conclusion of the Maxwell-Boltzmann distribution. In conclusion, Lord Kelvin brought forward some considerations respecting the structure of the atom and the nature of the ether, regarded as a true imponderable outside the law of universal gravitation.

Illumination.—The second of a series of articles in the *Electrical World* on "The Elements of Illumination," by Dr. Louis Bell, deals with the most interesting subject of the effect of the brilliancy of illumination on the general effect produced. The author commences the article by a comparative table of the intrinsic brilliancies in candle-power per square inch of surface of sources of light. These figures are as follows: the sun in zenith has a brilliancy of 600,000, the sun at 30deg. elevation 500,000, the sun on horizon 2,000 (the author states that these are rough equivalent values, taking account of absorption), the arc light 10,000 to 100,000 (the maximum being about 200,000 in the crater), calcium light 5,000, incandescent lamp 200 to 300 (this depending on efficiency), melting platinum 130 (taking it that one square centimetre = 20 c.p.), enclosed arc 75 to 100 (this being within the opalescent globe), Welsbach light 20 to 25, kerosene lamp 4 to 8, gas flame 3 to 8 (these two both being very variable), candle 3 to 4, incandescent (frosted) 2 to 5, opal-shaded lamps, etc., 0·5 to 1. A noteworthy feature in the above list is the enormous discrepancy between the intrinsic brilliancy of incandescent electric lamps and the other sources of light which follow. This great intrinsic brilliancy of the incandescent lamp is apt to produce bad effects from the oculist's point of view. The author proceeds to show that while the eye adapts itself automatically to the illumination of the surroundings, it takes a short time for the retina to adjust itself to different illuminations. In consequence of this a brilliant light, after having been in a dark place, is exceedingly trying. Also to have a brilliant spot of light like the incandescent filament of an incandescent lamp always acting on the retina, is apt to cause trouble. An experiment in the advantage of not having too great a contrast between the illumination on the walls of the room and the source of light, is to place a brilliant lamp unshaded in a good-sized room and then observe the effect of placing an opal shade over the light. It will be found that the apparent illumination of the room has been increased by the addition of the shade, although the actual light given off by the bright lamp has been decreased. The conclusion of the matter is that it is well to have a distributed light, and to place the lamps in such a way that their filaments do not come in the line of the ordinary range of vision. Dealing with the bad effect produced by a fluctuating light, Dr. Bell points out that an ordinary 16-c.p. lamp commences to show flickering when the frequency is about 30 per second. At a frequency of 25 the light is most troublesome to the eyes, and at 20 and below it becomes intolerable. Naturally, the flickering effect is dependent on the thickness of the carbon filament. Arc lamps, on the other hand, show fluctuations at rather higher frequencies. For instance, at a frequency of from 40 to 45 a distinct flickering is evident. Dr. Bell suggests that where polyphase currents are available the fluctuation of the individual arcs can be partially nullified by connecting them to different phases, so that the fluctuations do not synchronise. He concludes that if in artificial lighting it is essential to have a very strong illumination at a certain point, the most satisfactory way from a hygienic standpoint is to superimpose it upon a well-distributed moderate illumination. In this way strong contrasts are avoided, which tend to cause damage to the eyesight.

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ROTARY CONVERTERS.

BY HANS SIGISMUND MEYER.

The following is a translation of an article which recently appeared in the *Elektrotechnische Zeitschrift*. The rotary converter, although it has found but very limited employment in Europe, has long since emerged from the experimental stage, and has been adopted in America to the extent of many thousands of horse-power. No large installations, whether for lighting, traction, or electrolytic purposes, are to be found there where this link between continuous current and alternating current does not find employment. Much has been written of recent years upon the theory of the rotary converter, but mention need be made of the articles by Steinmetz, Kapp, and Thompson only. It will be as well to assume the reader's acquaintance with these articles and touch here only upon the practical application of the machines. The rotary converter may take three different forms—that is to say, it may, firstly, be employed to convert alternating currents or multiphase currents into continuous current, to which use it is chiefly put when the generating station is situated so far from the centre of supply that transmission of the current at high pressure enables a saving in copper; also when a supply of continuous current for traction or electrolytic purposes is absolutely necessary. Of such cases there are numerous examples in America, but it will suffice to mention the system of the Metropolitan Street Railway, New York, where multiphase current of 6,000 volts pressure is

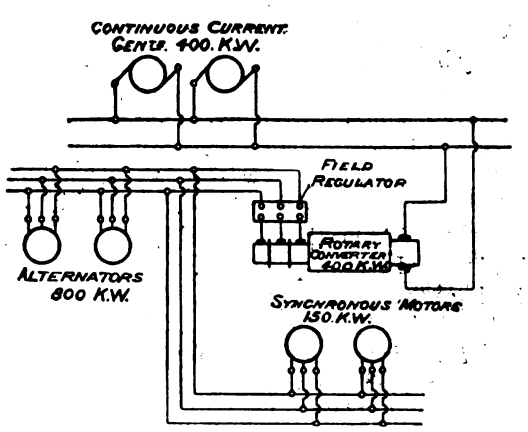

FIG. 1.

generated in a favourably situated station, and thence conducted to sub-stations, where it is used to drive rotary converters of 1,000 kw. capacity each, which furnish the necessary current for working the street railways of the company; further, the large converters of 700 kw. capacity each employed in connection with the Niagara Falls power transmission works for the winning of metals by the electrolytic process, etc. Secondly, the rotary converter is employed for the conversion of continuous current into alternating currents or multiphase currents. This application occurs in connection with large continuous-current stations, from which outlying districts are to be supplied with alternating or multiphase currents. In this manner a saving in copper is effected, and at the same time the building of a second central station avoided, since the converter transforms a portion of the continuous current generated in the main station into alternating currents, whose pressure may be raised as required by transformers. As examples of this application, the Edison stations in New York and of other towns in the United States may be instanced. Lastly, the double-current machine should be considered, although this type does not, strictly speaking, convert, but rather generates multiphase current and continuous current simultaneously. As it, however, likewise finds employment as a link between the two kinds of current, we will include it within the scope of this article. A good example of its employment is to be found in the Edison central station in Chicago, where this type of machine is used as required either to furnish continuous current for the immediate surroundings or multiphase current to the outlying districts, or both simultaneously.

Examples 1 and 2 also occur, so combined that the machine may convert continuous current into multiphase current or multiphase current into continuous current alternately as desired. The accompanying diagram (Fig. 1) shows the connections at the Cleveland electric light and power station. It will be seen how the rotary converter connects the continuous-current side with the alternating-current side—that is to say, the manner in which it is connected up on both sides in parallel with the generators. By regulating the self-induction outside the machine it is possible to so modify the pressure that the converter is either energised with multiphase current, and hence made to feed the continuous-current network, or fed with continuous current, and so made to feed the multiphase-current network.

We will now consider the converter proper, employed to convert multiphase current into continuous current, more closely. According to the field excitation the machine may be divided into three types. Firstly, converters with shunt excitation. This type is best adapted for lighting installations, where the pressure of the converter must be varied independently of the load, and where special regulating arrangements for the individual branch circuits are employed. By this method of excitation the rotary converter maintains the same wattless current on all loads—that is to say, if the excitation be so regulated to give minimum current for a certain load, this will also hold good for approximately all load. This will be the case if a multiphase current of constant pressure is induced in the converter—that is, if the generator is compounded. Since, however, the pressure of the continuous current falls with the load in consequence of the ohmic loss, and the variation of the wave form of the alternating currents, resource is frequently had to the second form with compound excitation, a series winding being wound over the shunt winding of the field coils. In this

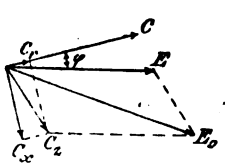

FIG. 2.

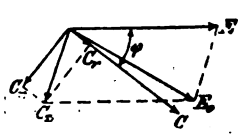

FIG. 3.

manner the pressure on the continuous-current side may not only be maintained constant, but also made to increase with the load, just as with over-compounded continuous-current machines. This compounding or automatic control of the pressure is obtained by modifying the distortion of phase between the current and the pressure in the converter. A leading current in passing the self-induction which occurs between the converter and the point of constant pressure raises the pressure at the terminals of the converter, while a lagging current diminishes the same. Speaking generally, the current for the compounding of converters should therefore lag on light loads, and lead on heavy loads. Further, in order to obtain sufficient effect, the reactance in the system should be amply large. We have here, therefore, the noteworthy fact that self-induction, which is generally considered one of the disadvantages of the alternate-current system, since a fall of pressure thereby results, is, on the contrary, in connection with the running of converters not only desirable, but absolutely necessary in order to prevent a fall of pressure, or, in other words, to raise the pressure in accordance with the load.

This will be rendered clearer with the aid of Diagrams 2 and 3. Fig. 2 shows how a current, C, induced by under-excitation produces a considerable fall of pressure between the generator and converter through the self-induction, X; while Fig. 3 shows the equivalent current and the equivalent self-induction produced by a leading current generated by over-excitation. It will be seen that the pressure at the generator is lower than at the converter—that is to say, the latter acts as a condenser and raises the pressure. The diagram shows further that the pressure is raised the more, the greater the reactance, and the lower the resistance, but naturally this only holds within certain limits. In the diagrams, whose construction needs no further explanation, C represents the current, r the resistance, x the reactance, E the E.M.F. at the converter, and E_0 the E.M.F. at the generator; while C_r represents the resistance loss, C_x the

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loss through reactance, and C_z the impedance loss. These losses are represented as back E.M.F. The diagrams must be read in the direction of the hands of a watch.

It may be as well to mention that the pressure of the continuous-current side cannot be independently varied by a change in the strength of the field excitation. As the converter is in principle a transformer, the voltages of the alternating or multiphase currents and the continuous current bear a definite ratio, which, indeed, varies somewhat with the load, but which is not influenced by the field excitation. The field excitation governs the back E.M.F. in the converter, and this is therefore modified by varying the field excitation. According as this is greater or smaller than the E.M.F. of the input current at the terminals of the machine, the converter will take leading or lagging current, and then, as above shown, change the pressure of the alternating current, and thereby also that of the continuous current with the help of the self-induction.

The requisite reactance is generally provided by impedance coils, connected in circuit with the low-tension leads between the converter and the transformer. Frequently, however, the necessary modification in the pressure is so small that the reactance of the leads suffices, especially if a generator provided with constant field excitation be employed, so that its reactance is employed in assisting in the control of the phases. In order to maintain the correct pressure both on light load and on full load, the regulator in the shunt should be so connected that the correct pressure is obtained on light load. The main resistance, in fact, usually consisting of a German-silver strip, should be so regulated as to ensure the required pressure likewise on full load. Under ordinary conditions the light-load current would then amount to some 30 per cent. of the full load current. But should it be found that the light-load current amounts to more than 40 per cent. in order to maintain the correct light-load pressure, this would indicate either that the ratio of conversion in the converter was not the most advantageous one—that a greater fall of pressure occurred in the leads than assumed—or that the generator yielded a somewhat higher pressure than had been provided for. To remedy matters, more reactance should be switched in. The necessary main exciting current is determined by regulating the converter to take the least possible amount of current on full load. But, in practice, it is certainly in most cases more advantageous to adjust for this minimum current on about three-quarters of the full load. In order to illustrate the automatic control of the phases considered above an example may be given.

Let us assume that we have two high-tension generators of 450 kw. capacity each, which deliver current at a pressure of 6,500 volts to rotary converters each of 400 kw. capacity, and employed for traction work. The generators run with constant field excitation, corresponding to an E.M.F. of 6,500 volts on light load. Let the distance of transmission be about 14 miles, the loss in the leads and in the low-tension transformers 10 per cent., and the loss of E.M.F. in consequence of the ohmic resistance in the trolley wires 20 per cent. on full load. If, now, the generators with constant field excitation feed direct into the line, the light-load E.M.F. without phase control will amount to 600 volts, but the full-load E.M.F., on the contrary, to less than 500 volts on the continuous-current side of the converters. If we energise the converters with a weak shunt and a strong main coil excitation, they will be under-excited to a high degree on light loads—that is to say, they would in the first case take lagging current, and in the second case leading current.

The E.M.F. of the self-induction in the generator and in the conductor is 90deg. behind the current, and, as the current lags considerably behind the terminal potential of the generator, the E.M.F. of the self-induction will therefore subtract itself from the E.M.F. of the generator, so that the E.M.F. at the brushes of the converter is reduced to 500 volts on light load. With an increasing load, the exciting current also increases in consequence of the considerable amount of series winding, and the current acquires a lead. With a leading current the E.M.F. of the self-induction is more approximately in phase with the E.M.F. of the generator, and a component has to be added to this. We obtain therefore, in spite of the greater fall of pressure in consequence of the ohmic resistance on load, a total fall of pressure between the generator and converter, which is considerably smaller, since the resistance loss is partially equalised by the increase of E.M.F., owing to the leading current which flows through the self-induction. In our example, for instance, the E.M.F. on full load might easily be raised to 550 volts with sufficient reactance, a condition which is frequently desirable in traction work.

The third form of rotary converter is that without field coils. Since in this form the excitation is maintained entirely by the armature current, it is apparent that the machine will run with lagging current on all loads. The factor of efficiency is therefore even on full load relatively low, and consequently at the generator, owing to the reactance in the conductors, still worse. Even with a very small air-gap the lagging current amounts to at least 40 per cent. of the full-load current, whence the factor of efficiency at the converter on full load

$$= \frac{1}{\sqrt{1+0{\cdot}4^2}} = 93 \text{ per cent.},$$

$$\text{on half load} = \frac{0\,5}{\sqrt{0\,5^2+0{\cdot}4^2}} = 78 \text{ per cent.},$$

$$\text{and on quarter load} = \frac{0{\cdot}25}{\sqrt{0{\cdot}25^2+0{\cdot}4^2}} = 53 \text{ per cent.}$$

Except in special cases, therefore, where cheap construction is the ruling factor, this type of converter would hardly be adopted, since it burdens the system too much with wattless current.

With regard to the employment of converters for transforming continuous current into alternating currents or multiphase currents, caution should be observed—that is to say, converters should be employed for this purpose only in cases where provision may be made to prevent racing of the machines. It is well known that a continuous-current motor with weak field excitation has a tendency to run away; this peculiarity naturally applies also to converters which run as continuous-current motors and generate alternating currents. But in this case the danger is the greater, since the field is liable to be weakened through lagging alternating currents, and the converter hence caused to run quicker. But so soon as the machine has increased its speed, the frequency, and therefore the self-induction likewise, increases, which again entails a greater lagging of the current. Hence the field excitation becomes further weakened and the speed of the machine becomes greater and greater, until it is no longer capable of resisting the centrifugal force exerted and flies into pieces. This has actually occurred on more than one occasion. In order to prevent the racing of converters driven from their continuous-current sides, they should always be run with over-saturated fields, while, as an additional precaution, safety devices in the shape of centrifugal switches arranged to cut off the continuous-current supply so soon as the speed of the machine has reached a certain limit, should be provided. Further, the converters might be separately excited, and the exciting machine situated upon a common shaft with the converter. Should the field of the converter be then weakened through lagging currents, and commence to run quicker, the E.M.F. of the exciting current would be also raised thereby, and the field in consequence again strengthened.

Considered generally, the rotary converter is a machine which may have a great future before it even on this side of the Atlantic, for, despite certain electrical difficulties, it is possible to produce mechanically good and efficient machines. Moreover, it ensures a considerably greater efficiency than the combination of two machines—that is to say, a continuous-current machine and an alternating-current machine on the same shaft. To render this clear, one more example may be given.

Let us consider the case of a synchronous motor coupled to a continuous-current generator, both having an average efficiency of 92 per cent.—that is to say, when working together without a transformer they give an efficiency of about 84½ per cent., and with transformers having an efficiency of 97 per cent. about 82 per cent. The rotary

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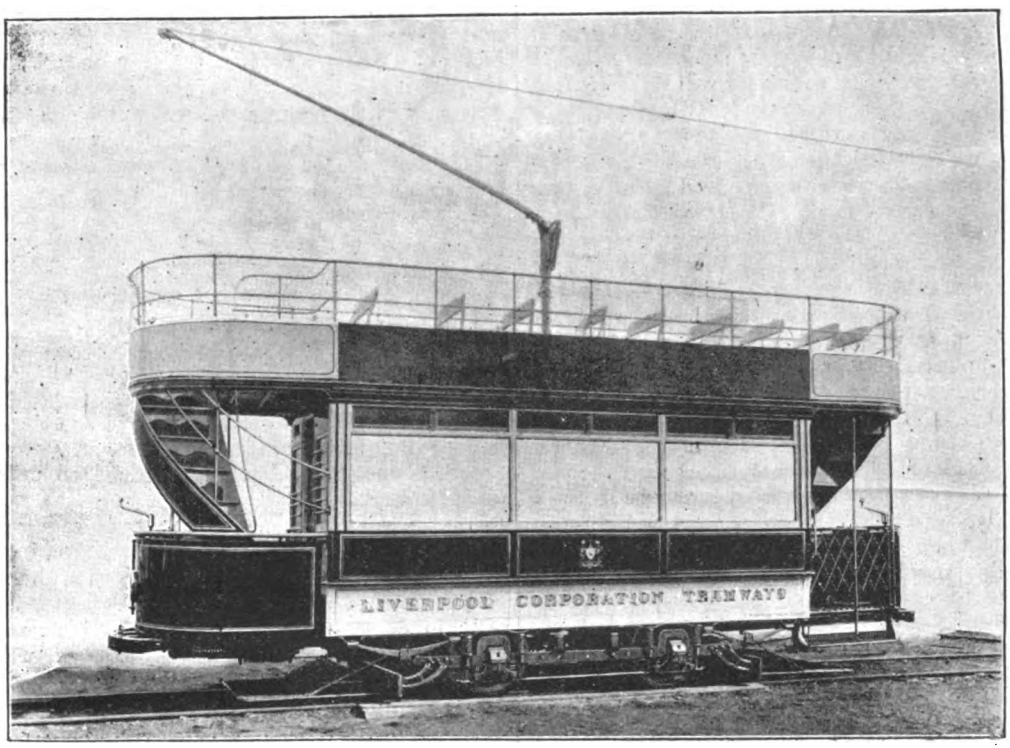
converter, on the other hand, itself has an efficiency of about 92 per cent., and working in conjunction with transformers accordingly about 89·2 per cent.

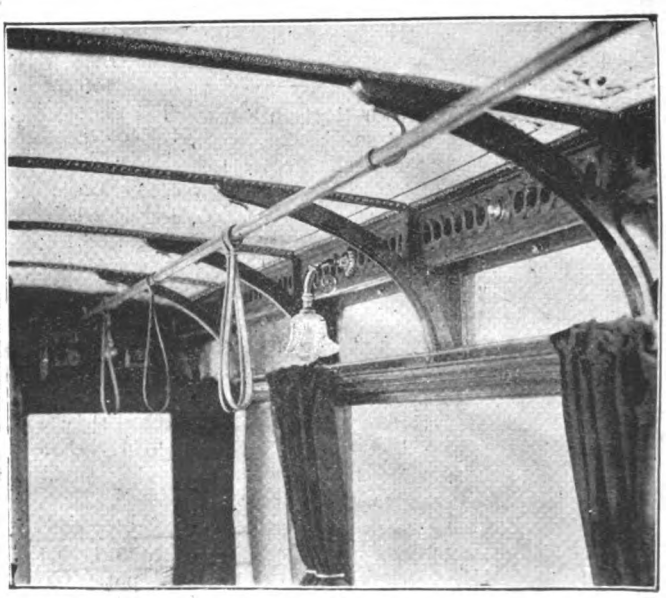
REVERSED STAIRWAY TOP-SEAT CAR.

The development of the top-seat car to suit the peculiar conditions of electric traction in Great Britain is proceeding apace. In general design, constructional details, and in finish the cars now being turned out by English manufacturers are enormously superior to those procurable even a year ago. We are able herewith to describe what must be regarded as a notable improvement in the top-seat type embodied in the cars now being supplied by Messrs. Dick, Kerr, and Co. for the Corporation of Liverpool, and which are being manufactured for them at the shops of the Electric Railway and Tramway Carriage Works, Limited, at Preston. The general dimensions of these cars are 16ft. for length of body over corner posts, and 27ft. 6in. for length over all, and mounted on a single truck with a 6ft. wheel base, they seat comfortably 57 passengers. The fact that so great a seating capacity can be obtained on a single-truck car without undue overhang at once reveals the great advantages of the top-seat type when its full possibilities are developed.



Liverpool Tramcar with Reversed Stair.

A few details in connection with the general design and finish of these Preston cars may be of interest. The most notable departure from ordinary types embodied in their design is in the roof construction. The ceiling frame is almost at right angles to the perpendicular side frame, though slightly arched to give a pleasing effect. This arrangement greatly increases the roomy appearance of the car interior, and the method of construction used at Preston is such that the roof is actually very much stronger than the ordinary clerestory form. The interior woodwork of the car is finished in quartered oak, with just sufficient ornamentation to give a handsome appearance without over-elaboration in detail. The ceiling is of pressed millboard picked out with gold. Above the windows, which are three in number, and fixed solidly in place, are pivoted sashes, by means of which any desired degree of ventilation may be provided without the introduction of draughts into the car interior. A special feature embodied in the 200 cars now being supplied by Messrs. Dick, Kerr, and Co. to the Corporation of Liverpool, is in the use of the reversed type of staircase designed by Mr. C. R. Bellamy, general manager of the Liverpool tramways, with some improvements in detail made at the Preston works. By the use of this reversed stairway, and the extension of the upper deck to the full length of the car, a very important advantage is at once gained in the increase of the carrying capacity of the car by six passengers, or practically 12 per cent. It will at once be evident that these additional passengers will be carried with practically no increase in the operating expenses per car mile. The second advantage gained by this design is the complete protection of passengers ascending and descending from any possibility of falling from the car on account of any sudden jerk in starting or stopping. The third advantage, by no means to be overlooked, is the protection of the driver from the weather. It has long been recognised in American tramway practice that the more comfortable the driver of an electric car can be made, the more energy and vigilance he is likely to exert in the proper handling of his car and the avoidance of accidents.



Interior of Car.

A number of other corporations, such as Leeds, Southport, Bolton, etc., have adopted this type of car for the orders which they have placed with Messrs. Dick, Kerr,

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and Co., and for the excellent reasons given above it seems not unlikely that it will find favour with tramway authorities throughout the country.

THE SAMSON OIL AND GAS ENGINE.

We were recently invited by the Blaxton Engineering Company, Limited, of 69, Old-street, E.C., to inspect a new type of gas-engine which they are making under the patents of Mr. Johnston. As there are several individual points in the design of these engines, we are reproducing herewith a section (Fig. 1) and a full view of the engine complete (Fig. 2), which will be of interest to engineers generally. Up to the present these engines are only listed up to 16 b.h.p., which engine runs at a speed of from 200 to 300 revolutions per minute. The smallest size listed is a 3½-b.h.p. engine, which runs at from 350 to 450 revolutions per minute. The engines are designed for working with oil or coal gas, and we gathered from the makers that they are devoting special attention to the engines in which oil is used as the source of power. Coming now to the section (Fig. 1), it is well to mention that the engine is of the single-revolution cycle, or, in other words, there is an explosion at every revolution, so that a more even turning moment is obtained than with the Otto cycle. The working portion of the cylinder is marked G in the section, while the cylinder, H, which is concentric with G, is used for purposes of exhausting the products of explosion from G. Commencing with the piston at the end of the stroke, the charge of air and gas in G is compressed, and is exploded by the hot-tube ignition shown at B. After the explosion the piston moves forward, creating a vacuum in H, until the exhaust ports, which come right round the cylinder and communicate with the opening J, are uncovered. As the valve marked I in the upper section is closed, there is no exhaust passing out through J at this portion of the stroke. A slight further movement of the piston, however, opens a second exhaust port, which allows a certain portion of the exhaust gases to escape, whereby the pressure in G is reduced to that of the atmosphere. At the commencement of the return stroke, as soon as this second port is closed the valve I is opened, which connects the valve I with the vacuum in H. The rest of the products of combustion are withdrawn through J, and a new working charge is at the same time sucked into the rear end of the working cylinder. As the piston continues its backward motion, the ports round J are closed, and a slight reduction in the size puts the exhaust cylinder, H, in communication with the main exhaust port so that the products of combustion in H are discharged to the atmosphere. A still further movement

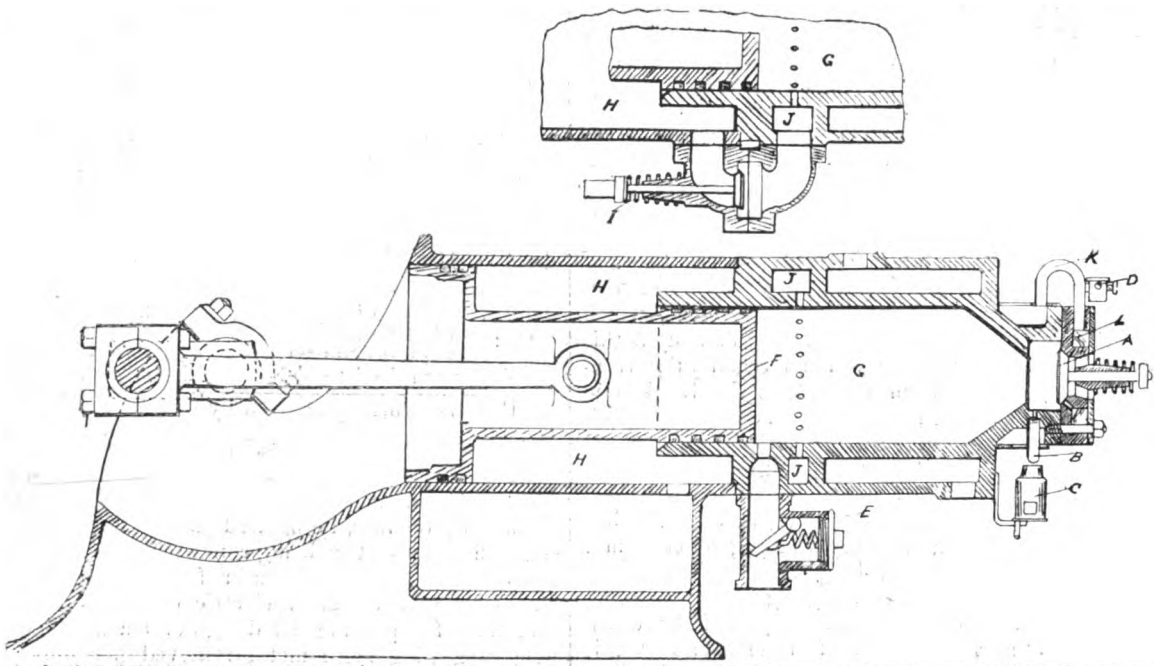

FIG. 1.—Section of the Samson Oil-Engine.—A, admission valve, B, ignition tube; C, lamp; D, oil-cup; E, exhaust valve; F, piston; G, work cylinder H, vacuum pump; I, governing valve; J, charging port; K, hot-gas pipe; L, wire gauze.

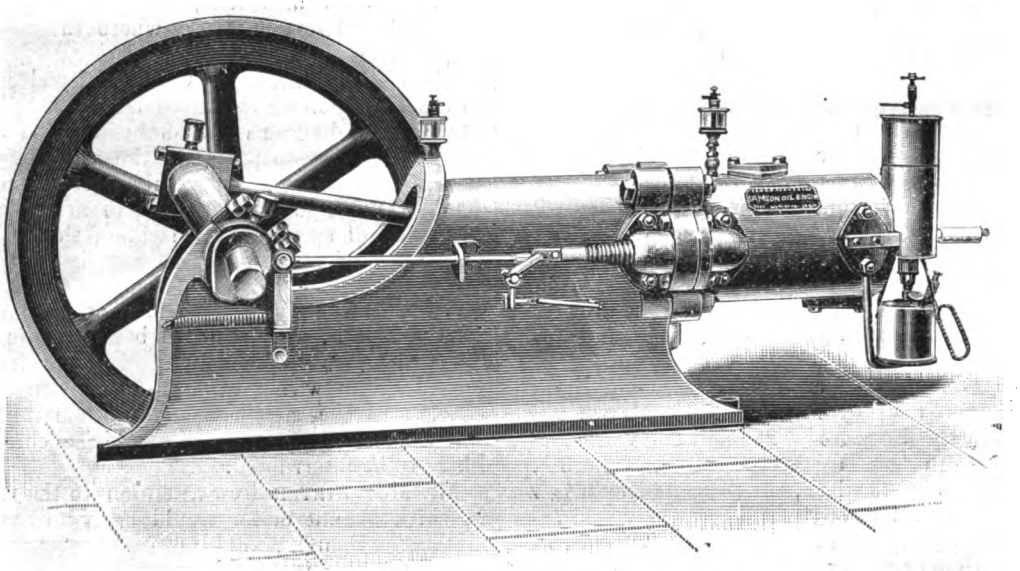

FIG. 2.—View of the Samson Oil or Gas Engine.

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backwards further compresses the working charge at every explosion. The other letters not referred to up to the present in the diagram have the following significance: C is a lamp for heating the ignition tube; B, D is an oil reservoir used in connection with the vaporiser denoted by L and K. The governing of this engine is arranged in a somewhat novel way by means of the valve, I, which on the return stroke puts the vacuum pump, H, in connection with the working cylinder, G. The governor, which is of the hit-and-miss type, operates this valve after the speed of the engine has fallen below a predetermined limit. If the speed has not so fallen the valve is not worked, and at the return stroke the exhaust in G is not completely discharged, while at the same time there is no admission of working charge, because the vacuum in H is not communicated to the cylinder, G. This governor can be seen in Fig. 2. It consists of a reciprocating rod, the end of which slides up an inclined plane. This small inclined plane is pivoted slightly underneath the end of the valve rod, I. The angle of this inclined plane is adjusted by a spiral spring, and the friction of the end of this reciprocating rod is balanced against the tension of the spring. As the speed of the engine increases this force becomes less, and the inclined plane rises, so that the end of the reciprocating rod engages with the valve, which allows a new charge to be admitted. At first sight this would seem to be a somewhat crude method of governing, but we are assured from trials that the Blackstone Engineering Company have found it in every way successful. An increase of speed increases the pressure on this inclined plane, and forces it down so that the rod does not engage with the valve spindle. The consumption of gas with this engine we could not ascertain at the time of our visit, but as an oil-engine it is giving an exceedingly good economy. The arrangement of the ports of J right round the cylinder seems to effectually prevent the mingling of the incoming charges with the exhaust gas at the early part of the return stroke. There are other details of interest about this engine which would warrant closer inspection on the part of those engineers interested in oil and gas engine work.

THE GLASGOW SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

A meeting of the above section was held on Friday last, Prof. Magnus Maclean, M.A., D.Sc., occupying the chair. It was hoped that Lord Kelvin would have been able to deliver an address on that evening, it being the final meeting of the session. His lordship was, however, lecturing to the Royal Institution in London, and whatever may be the possibilities of the distinguished philosopher's genius, the limit is reached when he is asked to lecture in two places several hundred miles apart at the same time. The address by the distinguished chairman of the Glasgow section is therefore one of the pleasant things of the coming session.

The election of a new council was first proceeded with. Prof. Watkinson, the local hon. secretary, retired, and the council recommended that he should be elected an additional member of council (making nine altogether), and that Mr. E. G. Tidd be elected hon. secretary. After some discussion this was agreed to, as also was the re-election of the council for another session.

A paper on "Some Considerations Concerning Electric Driving" was then read by Mr. Henry A. Mavor. The author dealt with small motors on 250 and 500 volt supply, such as is common in most large cities. Motors from 5 h.p. upwards presented no difficulties, but those under that size, particularly shunt machines of the type generally sold from stock, were by no means satisfactory, specially when located in an ordinary workshop. These were not only unreliable when used for high voltages but inefficient. This latter fault was probably due to stress of competition, but the buyer did not sufficiently consider the question of efficiency in its relation to price, and often by purchasing the cheapest motor made the worst bargain. As an instance, it was shown that anyone purchasing a ½-h.p. stock motor, costing about £15, such as generally sold, having an efficiency of perhaps 65 per cent., would, if he had to pay 1d. per unit for his energy, be justified in paying 33 per cent. more for the motor if he could thereby obtain one of 10 per cent. higher efficiency. The manufacturer, like the user, found small high-voltage motors rather unsatisfactory; their cost was great in relation to their size, especially if they were shunt wound. Dealing with the merits of series motors for small powers, Mr. Mavor, by means of diagrams, pointed out the chief features of a ½-h.p. motor having an armature 5in. diameter by 3in. long, wound either series or shunt. When series wound, such a machine was cheaper than shunt, their efficiency was better, consequently working cost lower; they had greater starting torque, could therefore start against a load with less current. The starting resistance could also be cheapened, as the small series motor had sufficiently high internal resistance to render a large external resistance unnecessary. If it were coupled directly to the work it had to do, there was little chance of its becoming excessive, while if it were driving a short shaft, this in itself constituted a fixed load of some magnitude, thus providing against excessive speed. While on the subject of motor driving, Mr. Mavor made a slight digression to point out that the ordinary machine tool was often a most inefficient piece of mechanism; by efficiency he meant the ratio:

$$\frac{\text{Watts required to drive machine}}{\text{Pounds of metal removed by tool}} = \text{watts per pound.}$$

This was in some classes of machines very low, a milling machine being the greatest offender in this respect, while a lathe was the most efficient machine used in engineering work. Proceeding, he pointed out the folly of insisting on high-efficiency motors being connected to machines of very low efficiency, and the lecturer felt sure that one of the most beneficial results of electric driving would be in the direction of improving the design of machine tools, with a view of getting more metal removed per unit of power. The works owner would find this a very profitable field for investigation. Proceeding to speak of insurance regulations, Mr. Mavor said that in some quarters there seemed a disposition to place undue restriction on electromotors for industrial purposes. Nothing could possibly prove more harmful to the industry, and he suggested that electrical engineers should take insurance companies into their confidence and point out exactly what dangers were likely to arise, thus preventing the imposition of absurd regulations. In concluding, the lecturer alluded to starting switches. Liquid switches were cheap and handy, but trouble was likely to arise from corrosion. Some American starting switches were unreliable, but the majority were well designed and very necessary where the motor was in the hands of inexperienced people.

Mr. W. A. CHAMEN (the Glasgow city electrical engineer), in the discussion which followed, pointed out that in one of Mr. Mavor's diagrams the shunt machine seemed capable of much greater output than the series one, and enquired if the diagrams were the result of experiment or calculation. He also pointed out that in arranging the starting resistance of small shunt machines the end of the shunt coils should be connected to the first stud of the regulating resistance, as by this means the field coils were always short-circuited on the armature and a path provided for the E.M.F. induced when breaking the shunt circuit. This elementary precaution was very frequently overlooked by the wiring contractor, with results which were obvious to the members. The automatic type of switch was very necessary in cases where the current was at all likely to be interrupted.

Mr. MCWHIRTER drew attention to the remarkable way in which a shunt motor would carry an overload. Series motors, he thought, would prove of most value when they had to work against a fixed load. Under other conditions a shunt machine was necessary.

Prof. WATKINSON spoke of the difficulty in getting speed variation, and pointed out that in many industrial operations variable speed with constant torque would be necessary, yet so far there seemed no effective method of obtaining that in a satisfactory manner.

Mr. STEWART said that he had made some investigations

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to ascertain how far it was possible to obtain speed regulation with shunt machines, by introducing a resistance into the field coils and so reducing the available magnetic induction. In some types of machine it was possible to obtain 25 per cent. increase of speed, while with others only a few per cent. increase was obtained, further experiment being stopped by injurious sparking at the brushes.

Mr. MAVOR, in reply, said that the curves were calculated, not experimental, and that a small series motor within reasonable limits of speed and power was very satisfactory. The switch arrangement mentioned by Mr. Chamen was only satisfactory with E.M.F.'s less than 250 volts and with fairly large motors. Smaller machines for high voltages had armatures wound with so many turns of fine wire that the self-induction of the armature was almost as great as that of the field coils, and the most satisfactory way was to put several lamps in series across the machine when it was switched off, thus providing an alternative path of high resistance for the E.M.F.'s induced in the armature and field coils. Motor speed regulation was not as satisfactory as it ought to be, and was a promising field for the investigator. It was also an important point that the largest installations of electric motive power where wide speed regulation is required was on electric tramways, and series motors were almost universally used. It is always well, in Mr. Mavor's opinion, to follow up established practice, as progress in that direction was most hopeful, and he thought that the principles so successful in such work were capable of much wider application.

THE PROTECTION OF PUBLIC BUILDINGS FROM LIGHTNING.

On Monday, April 23, Mr. Killingworth Hedges read before the Royal Institute of British Architects a paper dealing with the above subject. He referred to a paper read by Colonel Parnell in 1884, wherein it was shown that out of 828 cases of lightning strokes the effects of heat were visible only in 228. Colonel Parnell had also stated that, although it appeared improbable, dry woodwork was more liable to be forcibly rent without scorching than charred or burnt by a lightning stroke. Metals also were more apt to be broken or bent than fused by it. The author claimed to be the first to state that a metal rod run up the side of a building was but a small protection to the whole structure. He quoted from a paper by Dr. Lodge to the effect that the problem did not end with the actual rod, but care should also be exercised in the metallic conductors, such as gutters, etc., brought in contact with it. A quotation was also made from a paper by Prof. Kirchoff, of Berlin, who stated that "the mechanical effect of an electrical discharge was greatest where the electric fluid sprang from one body to another. Where the lightning left the conductor its mechanical effect was again exerted, so that the rod was torn, melted, or bent." After a digression on the subject of thunder clouds, with a definition taken from an old encyclopædia, the author stated that the Romans would not go near places struck by lightning, and also the witch doctors of South Africa were said to take advantage of the propensity of lightning to strike in certain places by standing on one special spot during a severe storm, whereas in the neighbourhood it would be dangerous owing to the minerals in the surrounding rocks.

Mr. Hedges mentioned a photograph which appeared in a magazine of a number of cattle which were killed by lightning near an iron wire fence, and stated that that illustrated the surging effect of a lightning flash, which might cause great damage. The cattle were probably killed by the flashing of the current along the wire fence. The lightning conductors as now usually arranged did not, he thought, guard against the "spitting" action of the discharge. They acted very well to pass off to the atmosphere the induced electricity from earth and buildings on it, but as protectors they were arranged so that if struck the building would probably be set on fire, and the lightning would most likely be very destructive before reaching the earth. The report of the Lightning Rod Conference of 1882 showed a great number of such lightning conductor failures. The characteristics of the lightning flash he gave as: (1) surging, which is due to the oscillatory character of the spark, which, unlike ordinary electric currents for lighting cities or driving tramcars, is a disruptive discharge, sudden and violent, more like the blow of an hammer; (2) self-induction, a property giving rise to counter force or choking effect, noticeable in straight wires, but which is much more pronounced in coils of wire; (3) side-flash, the result of self-induction. A disruptive discharge would, he stated, often leave an excellent conductor and side-flash through the air to other much worse conductors. For instance, the lightning-rod may be struck, but instead of following the course provided, a side-flash might select its own path through a wall of brick or stone to a neighbouring gaspipe or bell wire. A much-quoted example of this danger was an accident at All Saints' Church, Nottingham, some years ago, when the discharge passed from the lightning conductor through a solid wall of masonry 4½ft. thick to a gaspipe.

As to the protection of public buildings, the author stated that he would deal more particularly with St. Paul's Cathedral. Thus in 1898 he had been asked to report on the condition of the conductors on that building which were put up in 1872. Extracts from this report showed that the conductors were of ½in. stranded copper. Four such conductors passed from the iron supports of the cross down the outside of the dome, branching off into eight conductors, which were cross-connected by the railing of the gallery, and lower down again were united together, the eight conductors being carried down to the ground. Each tower had two conductors, with a cross-connection, the four conductors being carried to earth. There was also a single conductor passing over the ridge of the choir to an earth on either side. The above system, though considered efficient at the time the work was carried out, in the face of more modern ideas was open to serious criticism, and he called attention to the fact that on the dome, in metallic connection with the cross, were several iron straps passing down inside to the level of the gallery, where the ends apparently disappeared in the stonework. This, in conjunction with the fact that the four conductors did not appear to be soldered to the iron supports of the cross, was a source of danger, as the electric discharge was liable to pass down these iron straps and discharge through the stonework with disastrous results. None of the statues on the three sides of the building were protected. The conductor over the east end of the building afforded little protection, as it crossed the roof some 20ft. from the end, and had no projecting point of any kind, and in view of the great mass of metal in the towers the present conductors were insufficient. As to the earth connections, the conductors were originally laid in a brick sewer passing round the building, but alterations had been made, and the conductors were now inserted in earthenware pipes laid in the sewer, and were in nearly every case quite insulated. Tests made with these earth connections showed that the cables did not make good connection with the iron framework of the ball and cross, but were connected to a cable round the ball, from which the actual conductors descend to the system on the dome. The joints were in many cases quite loose, and the resistance of the conductors was high owing to the oxidisation of the copper. The author then described a few of the methods in use on the Continent, and said that the system used at Nôtre Dame Cathedral, Paris, was almost worse than useless.

The protection of Cologne Cathedral was described as far more advanced than that of Nôtre Dame, and the work seemed to be very carefully executed, and of a design which might be followed with safety. Stranded copper cables were used, and these invariably ran through galvanised iron stanchions with flat feet, by which they were bolted to the stonework. In order to avoid galvanic action setting up between the iron and copper, the eyes of these supports were bushed with lead. They kept the conductor about 7in. away from the structure, or sufficient to enable the cable to be stretched tight, and not run round projections in the manner usual in England. For this purpose there were tightening screws at several points. A somewhat similar arrangement was used for the horizontal conductors, which ran on each side of the roof, being kept well away from it. The terminals of the lightning-rods were almost

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always plain spikes, without branches, but the building had many of these, both on the highest portions and along either the tops of the walls or ridge of roof, the whole being connected together by the horizontal conductor.

The next building of which the conductors were described was the Palais de Justice, Brussels. This was protected by the Melsen system, which consisted of a network of metal rods connected together at the top, and furnished with an aigrette or bundle of eight 4mm. copper rods spread out like a feather, so that after passing along the roof the terminal points projected so little that they could hardly be seen from below, but yet broke up the area of the building so as to leave little space unprotected. Copper was used for the conductors, but where they descended a special iron box was employed, in which they were embedded in zinc, and from this the down rods could be continued in iron, and also connected to the rain-water pipes and other ironwork of the building. The provision for earth connection was very ample, there being 24 iron rods $\frac{3}{4}$in. in diameter, of which eight were fastened to the spigot of an iron pipe 2ft. in diameter, which was suspended in a well in the courtyard; another third was connected with one of the principal iron mains of the water supply of the towns, and the remaining series were taken in a similar way to a large iron gas-main. The efficiency of this system was proved by the fact that the Palais de Justice was struck soon after completion, and that no more damage was done than the partial fusion of some of the points of the aigrette which received the flash.

In American practice the author stated that the usual method was to have a round iron rod about $\frac{1}{2}$in. in diameter extending from the ridge of the metal roof about 4ft. above the top of the chimney or other elevated projection, with its lower end connected to a piece of iron in the form of a saddle, which was soldered to the metal roof; to this also was joined the top of each rain-pipe, or, where the gutters are below the roof, special tinned iron straps connect the two. The rain-water pipes have to be tightly fitted together, and it is said that each pipe 4in. diameter is equal in capacity to an iron rod $\frac{9}{16}$in. diameter. The connection between the pipe and the earth was made as follows: above the elbow portion a galvanised socket was fitted, and to this was soldered a flat bar which was led directly to the nearest water-pipe or to the earth. This was described as a very efficient system. As to the rearrangement of the conductors on St. Paul's Cathedral, the plan recommended by the author, taking into account the large amount of copper cable already on the building, was to run three new cables from the metal work of the cross framework to the roof of the dome, there connecting them with the eight existing conductors, and reuniting them at the base of the dome to the existing system, which was increased by running a new $\frac{1}{2}$in. seven-ply copper cable on the top of the parapet entirely round the building. From this horizontal conductor, aigrettes, consisting of five pointed copper rods, were tee'd at intervals by means of special brass boxes tinned inside, into which the cable was placed, the aigrettes first secured by binding, and the whole united by running in hard solder. Wherever practicable, this method of uniting the conductors would be adopted, and boxes were prepared suitable for crossings of almost any angle. However, in consequence of the exposed position, and the rule against open fires or blow-flame lamps, many of the joints had to be made by soldering. This method did not possess the advantage of poured joints, as in course of time, no matter how intimate the surfaces were, oxidation was sure to take place. Great difficulty was found in securing efficient new earths. Two sets of conductors were, one, united to the hydraulic main supplying power to the organ, and the other to the 8in. water-main; this was made by cleaning the outside, then wrapping the strands of the conductor around it, enclosing the whole with a metallic clamp, which was filled with molten lead and screwed up tight. A perforated wrought-iron pipe with a steel shoe was sunk to moist ground, the stranded conductor being dropped in the pipe and soldered to the cap at the top, and shielded from electrolysis by a lead tube. Water could be poured into the pipe through a plug which was provided. There were also other earths composed of copper plates buried in charcoal and broken arc-light carbons.

The author concluded his paper with some practical suggestions in addition to those made by Prof. Oliver Lodge in 1889. These were: That the conductors should be kept a short distance outside the building by supports. If joints were necessary, the stranded wires should be spliced and soldered. Tee and other connections, also the union of air terminals or aigrettes to the cables, should be made by splicing or carefully binding, and then protecting the joint by a metal box which is to be filled with hard solder. It was better to have a standard size throughout, and a cable of sufficient area to withstand rough usage, and also the wires or strands should not be too small or they might become brittle with age. A solid conductor should be used, and not a tubular section. Copper was cheaper than iron in the long run, as it lasted much longer, and a stranded conductor was the most convenient form. Horizontal conductors should have air terminals at various distances, these being preferably in the form of *fleur-de-lys*. All metal on a building should be earthed. Care should be taken before connecting to water and gas mains that they have leaded, flanged, or screwed joints, and are not caulked with red lead and oakum, and also to avoid the neighbourhood of small-bore fusible gaspipes. After selecting a suitable place for the earth-plate or earthed tube, arrangements should be made for keeping it moist either by watering or causing a rain-water pipe to discharge in the neighbourhood. The metallic conductor should be protected where it leaves the ground, both from accidental or malicious injury and from the natural deterioration which would take place. Tests should be made at intervals not greater than one year. Finally, he warned those who had to specify the method of protection to be adopted not to put any faith in the general opinion "that a certain space contiguous to a lightning-rod is completely protected by it, so that, if the rod is raised high enough, a building in this protected region is safe." There was nothing more illusory, as there was no space near a rod which could be definitely styled an area of protection, for it was possible to receive violent sparks or shocks from the conductor itself, not taking into account the phenomena that came under the head of surging and self-induction. The present system of lightning conductors afforded very incomplete protection, but fortunately they were generally ignored by the thunderstorms, otherwise more interest would be taken in the matter.

ROYAL INSTITUTION.

The annual meeting of the members of the Royal Institution was held on Tuesday afternoon, Sir J. Crichton-Browne in the chair. The annual report of the Committee of Visitors for the year 1899, testifying to the continued prosperity and efficient management of the institution, was read and adopted, and the report on the Davy-Faraday Research Laboratory of the Royal Institution, which accompanied it, was also read. Sixty-three new members were elected in 1899. Sixty lectures, 17 evening discourses, and two centenary commemoration lectures were delivered in 1899. The books and pamphlets presented in 1899 amounted to about 280 volumes, making, with 672 volumes (including periodicals bound) purchased by the managers, a total of 952 volumes added to the library in the year.

The following gentlemen were unanimously elected as officers for the ensuing year: president, the Duke of Northumberland; treasurer, Sir James Crichton-Browne; secretary, Sir William Crookes; managers, Sir Frederick Abel, Bart., Sir Frederick Bramwell, Bart., Dr. Thomas Buzzard, Sir William James Farrer, Mr. Hugh Leonard, the Right Hon. Lord Lister, Mr. Frank McClean, Mr. Raphael Meldola, Dr. Ludwig Mond, Sir Andrew Noble, Mr. Alexander Siemens, Mr. Basil Woodd Smith, Mr. William Hugh Spottiswoode, the Hon. Sir James Stirling, and Sir Henry Thompson, Bart.; visitors, Dr. Charles Edward Beevor, Mr. William Henry Bennett, Mr. W. A. B. Burdett-Coutts, Mr. Joseph G. Gordon, Mr. Maures Horner, Sir Alexander Campbell Mackenzie, Mr. Henry Francis Makins, Mr. Carl Edward Melchers, Mr. John Callander Ross, Mr. William James Russell, Mr. Alan A. Campbell Swinton, Sir James Vaughan, Mr. John Jewell Vezey, Colonel H. Watkin, and Mr. James Wimshurst.

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INSTITUTION OF ELECTRICAL ENGINEERS.

At the meeting of the Institution on Thursday week Prof. S. P. Thompson, president, read the list of nominations for the Council for the ensuing year, after which Prof. G. Forbes, F.R.S., gave his paper on "Distant Power Transmission."

On Distant Electric Power Transmission.

BY PROF. GEORGE FORBES, F.R.S., MEMBER.

Your President did me the honour to invite me to read a paper on the subject of the distant electric transmission of power, to which I have devoted much attention during the last 10 years. From the remarks he made at the time, it seemed to me that what he most desired was a description of the works of this character which have been established in different parts of the world, with the object of provoking a discussion, on their various merits and defects, by members of the Institution. I regret that to myself it seems undesirable that anyone should give to the Institution descriptions of works carried out elsewhere if he has not an intimate personal practical knowledge of the works; but in view of the fact that the discussion of this paper may bring out information from those who have actually had the handling of such works, I have yielded to the President's wish to a certain extent. The first part of the paper is devoted to the description of certain selected transmission plants, each one put up by a different contractor, and each one having some special point of interest. But I must freely confess that the only one of these of which I have that intimate practical knowledge which enables one to judge on the merits or defects of a scheme is the plant at Niagara Falls, the plans for which were prepared by me in 1890 and carried out between that date and 1895, and the actual working of which I have thoroughly investigated up to the summer of 1899 by a study of the journals, log-books, and complaints from consumers about faulty supply. Concerning the other installations, I have had to make use of the printed descriptions appearing in technical and other journals, which are always liable to mislead, especially as to the satisfactory nature of the supposed uninterrupted supply of power.

The second part of the paper deals with some of the problems that face the consulting engineer in his attempts to introduce the highest economy, especially in the transmission lines, as this is the most important part when the distances are great. To these sections of the paper some words have been added to give a general view of the methods in use by different contractors. Hitherto manufacturers and contractors in this country, having few great water powers in Great Britain, have neglected to attempt the supply of suitable machinery for other parts of the world, and run a risk of being passed over entirely in the future, as they have been in the past, when tenders for the electric utilisation of water powers are asked for; it is perhaps wrong to say that they have been overlooked, and more just to say that they have refused to undertake such work. I venture to put forward the opinion that this is unwise, and I trust that the immediate progress that we expect in the transmission of power generated in the neighbourhood of coal-pits will lead the manufacturers of this country to appreciate the large field that is opened to them abroad for the utilisation of water power. If this be done I believe that British manufacturers may work upon new and independent lines, and that they will have a large outlet in our Colonies and other parts of the world; because out of numerous tenders that have been submitted to me for the transmission of power from waterfalls, none of the foreign firms who have tendered seem to me to have started on the best lines for making such a work successful and absolutely free from interruptions. If our manufacturers, owing, no doubt, partly to the fact that their hands are full, have been unwilling to undertake these great works, while foreign firms have been making a splendid start, it must be allowed that the want of progress in our Colonies is also largely due to the timidity of our financial men. It is not in this country that you would have found men with the boldness to risk their capital in transmitting and distributing electricity for power purposes at a date (1890) when there was only one example of such transmission and distribution—viz., in a small village near the frontier of France and Switzerland. Nor would confidence have been placed by them in an electric transmission by means of alternating current at a date when there was not a single alternating-current motor in commercial use, nor in the advantages of lower frequency than any which had been thought of up to that date (1893), when nine-tenths of the members of this Institution who rose to discuss the question condemned a frequency of 25 periods per second as impossible and extravagant.* Our capitalists are too apt to say that such things are too experimental when any step is taken to improve methods. Yet the capitalists in America who undertook to utilise the Niagara Falls did all these things, made a commercial and engineering success of their works, and have been imitated in their methods all over the world.*

Attention must now be drawn to a few of the most interesting cases of using electricity for developing the power of waterfalls.

1. Of the various plants for transmitting electrical power from waterfalls, one which derives its chief interest from the greater distance to which the energy is transported, is in South California, at San Bernandino and Los Angelos, carried out by the General Electric Company, U.S.A. The water is taken from the streams in the San Bernandino Mountains, and it is carried in canals and tunnels for about 2¼ miles. It develops power under the head of over 700ft., three-phase electric currents are there generated and raised by transformers to a pressure of 33,000 volts, and the current is transmitted over a distance of 80 miles to Los Angelos; 80 per cent. of the water conduit is in tunnel, and of the rest part is open masonry canal and the remainder timber flumes. There are 18 tunnels whose total length is 11,555ft., the longest being 2,074ft. There are 2,662ft. of wooden flumes, 167ft. of open masonry canal, 121ft. for a sand-box, and 57ft. of reservoir and forebay at the head of the penstock. The water is taken from a point 3,422ft. above sea-level, the power-house being at a level of 2,670ft.; the slope of the canal is 9·5ft. per mile, leaving an available head of 728ft. at the power-house. The streams used are the Santa Anna River and the Bear Creek. The best description of the civil engineering works is given in the *Engineering News*, New York, March 9, 1899: Pelton wheels are used with a nozzle 3⅛in. in diameter, the wheels are 82in. in diameter, the regulation is obtained by deflecting the nozzle from its most effective position as the load falls off; four such wheels and generators are in place; the generators deliver current in three phases, and the revolving wheels carry 20 poles, the armature being external, each generator delivers 1,000 h.p., running at 300 revolutions, and giving 750 volts. There are 12 transformers in banks of three, on foundations of steel beams and concrete, 30in. above the floor, for the purpose of cooling by a forced air draught. Each transformer raises the pressure to 19,000 volts, making 33,000 volts between wires on the three-phase circuit, the star connection being used; 8oz. pressure is used with blowers 280in. diameter, each requiring 3 h.p. There are two three-wire circuits of No. 1 (B. & S.) copper wire, and the insulators are placed on the posts at the angles of an equilateral triangle. These insulators, over 6in. diameter, are bell-shaped, of glazed porcelain, and are bolted to the cross-arm. There are 44 posts to the mile of white cedar, from 35ft. to 65ft. high, with 8in. tops. At Pesadena the voltage is reduced by oil-cooled transformers to 2,200 volts, and the current is used to work a synchronous motor, which drives a direct-current generator of 525 kw. At Los Angelos there are six 250-kw. transformers reducing the electric pressure to 2,200 volts, and four synchronous motors which drive generators for lighting with continuous current. The information which would be most useful as to the results of working this plant would be about the continuity of working and freedom from interruptions. Such information cannot be obtained accurately except by a prolonged stay at the spot, examination of journals, etc. I am unable to assist in this.

2. The Snoqualmie Falls have been developed for transmitting power to Seattle and Tacoma, by the Westinghouse Company, U.S.A. The features of greatest interest in this case are the use of the high electric pressure of 30,000 volts, and the use of aluminium for the conductor on the long transmission line. It is impossible for anyone to know what success has attended these novelties unless he were to examine not only the plant, but the log-book and correspondence. Continuity of performance is of primary importance, but we cannot tell from published accounts whether this has been attained in the present plant with 30,000 volts. Also we have not any means of knowing what success has attended the use of aluminium wire. In the development of the Snoqualmie Falls a vertical shaft has been dug 260ft. deep, 10ft. by 25ft., and the tailrace tunnel is 200ft. A 7ft. 6in. steel penstock is in place, and there is room for another. The underground chamber for machinery is 200ft. long, 40ft. wide, and 30ft. high. The penstock is connected at the bottom to a steel receiver 10ft. diameter, 1in. thick, and 80ft. long horizontally, besides 60ft. length of pipe 7ft. 6in. diameter. There are four 1,500-kw. three-phase alternators at a frequency of 45 cycles, and at 1,000 volts. The armature rotates, and is 8ft. diameter, and weighs over 10 tons. Laminated poles are cast into the field frames. Transformers of 500 kw. with oil insulation are used. Mesh connection (or Δ) for the three phases is used both in primary and secondary. As to the high-pressure transmission line of 30 miles, it is said that 33 tons of aluminium are used for going to Seattle and 34 tons for going to Tacoma,

* The unqualified success of low frequency at Niagara Falls has now, however, converted even former opponents, and this Institution passed a recommendation last year that a frequency of 25 should be a standard for power transmission.

* The only financial group who ever in this country showed such boldness in electric matters was the band of men who realised that Ferranti's brilliant views were right, and who started the London Electric Supply Company.

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and that each route has two separate three-phase circuits with 30in. between wires, that the average span to Seattle is 110ft. and to Tacoma 150ft., that Nos. 1 and 2 B. & S. gauge and McIntyre joints are used. There is some discrepancy between the weights of wire used and the power that is said to be transmitted. The whole of the information here given is taken from technical journals. On this line the electric pressure has sometimes been raised to 40,000 volts, when the phenomena of brush discharge acquire considerable importance. This led Mr. Scott, of Pittsburg, to his interesting experiments on this subject, published by the American Institute of Electrical Engineers.

3. The Paderna development of the Adda River for supplying electric energy to supplement that in use at Milan, a distance of 33 km., derives its chief special interest electrically from the fact that the energy is generated direct in the alternator at the comparatively high electric pressure of 13,500 volts, the plant having been designed and constructed by Messrs. Brown, Boveri, and Co. The only other plant in the world which can be compared in this feature with Paderna is the transmission by the General Electric Company, U.S.A., from Mechanicsville to Schenectady, where both generator and motor are used at 10,000 volts without the intervention of any transformer. It would be interesting to discuss the hydraulic part of the work at Paderna, but it is advisable under present conditions to confine remarks as far as possible to some of the electric details. Under the former head it may be said that the minimum flow of the river is taken at 45 tons per second. The dam is 150m. long. The canal has a slope of 2 per cent., giving a velocity of 2·70m. a second when the flow is the maximum allowed for. There are three tunnels, whose total length is 1,686m. The open canal is 582m. The total fall varies from 28·82m. to 24·92m. The total head available is constantly 22·85m., and the suction varies from 6m. to 2m., giving a total power of 13,000 b.h.p. The type of turbines is horizontal axis, double turbine to balance pressures, radial intake and axial outlet. Each double turbine develops 2,160 b.h.p. at 180 revolutions per minute. A safety valve is provided, but is not required, as it was found, when closing the outlet of a fully-loaded turbine in two seconds, that the pressure rose only 9m. or 10m. without using the valve. The dynamos are of the well-known Brown construction. Each is of 2,160 h.p. at 180 revolutions, and develops three-phase currents. The armature is fixed and external to the revolving field, which carries 28 poles of steel with laminated horns. The poles are wound with copper strip edge-on. The diameter of the revolving field is 4·1m., and that of the whole machine is 5·14m. The exciter is in line with the alternator. The frequency is 42 cycles per second. The normal pressure is 13,500 volts at the terminals, and the current should be 64·5 amperes per phase with an induction factor of 1, or 79 amperes with 37deg. of lag. The efficiency in the former case is 95·1 per cent., in the latter 93·4 per cent. The maximum rise of temperature is 28deg. C. The machines were deliberately tested at 20,000 to 21,000 volts, and it is said that accidentally they were caused to generate current at 30,000 volts without injury. The line consists of three independent three-wire circuits on two lines of posts 2m. apart, the distance between any two wires of one circuit being 0·6m. The mean distance between the posts of one line is 60m. The distance of the high-tension transmission is 32,500m. The wires are of copper, 9mm. in diameter, the ohmic loss is 8·1 per cent., and the total loss is 11·7 per cent. for a lag of 37deg. A lag of 45deg. has been observed with a line on short-circuit. Wurtz lightning arresters are used at both ends of the line on two of the circuits, and Siemens and Halske horns on the other. At Milan the pressure is reduced by Ganz transformers of 350 kw., and transmission gives place to distribution. The above statements of facts are on the authority of E. Vannotti, and were published by Le Génie Civil, Paris.

4. The Rheinfelden plant is here mentioned to allow of discussion on it, and because it is the most successful development of a low fall on the general lines of the Niagara undertaking. It resembles Niagara in using a vertical shaft for each turbine and dynamo. It differs from Niagara in having four different types of dynamos, some giving continuous and others alternating current. The turbines are by Escher-Wyss, the dynamos by Oerlikon and the Allgemeine Elektricitäts-Gesellschaft. The hydraulic works are a model of good work, which I constantly kept before me when planning the work to be undertaken on the Nile Cataracts for the Egyptian Government. If I were attempting here to give full descriptions, I would devote much space to this excellent installation. Many members of this Institution have, however, inspected the plant, and every engineer who wishes to master this branch of our profession is obliged to read the most admirable description published at Berlin ("Die Kraftübertragungs-Werke Rheinfelden").

5. In a paper dealing with transmission schemes which have been carried out, the Genoa continuous-current plant deserves great attention. Here water power is available. The turbines are connected by insulating Raffard couplings to insulated dynamos, which are electrically connected in series. Thus 6,000 to 8,000 volts are delivered at Genoa to work insulated motors, also put in series so as to attain this high electric pressure. In a scheme purely for transmission, and not for distribution, this method of using continuous currents has a great deal of merit, and I believe that we shall all agree that we owe a debt of gratitude to M. Thury for the way in which he has worked out the method at Genoa and elsewhere. A full account of this work has been published, and deserves the closest attention. I could mention cases which have come under my own notice where this system with continuous currents would give better results than the Niagara system with alternating currents.

6. Having satisfied your President's wish and put forward as a basis of discussion some of the plants in different parts of the world with the actual working of which I have no practical experience, it is a pleasure now to turn to the work of the Niagara Falls Power Company, concerning the working of which I may be able to supply useful information. I do not propose here to give a full account of the machinery which we have made use of. It has been well described in the *American Electrician* for January, 1900. It will be better to pass lightly over this part, and devote more attention to the lessons to be learnt from the five years of working. This plant derives its chief interest from the following facts: (1) it was the first place except Oyonnax where a scheme was started on for generating electricity at a waterfall, transmitting it to a distance, and distributing it to consumers for power; (2) it was and is the largest project of the kind; (3) it was the first case of using the alternating current for power commercially; (4) it was the first case in practice where the commutator for continuous currents was placed at the distant end of the transmission line; (5) it was the first plant to adopt low frequency; (6) all the generators are of the same size and pattern; (7) the Niagara system in its general features has been adopted in almost every subsequent electrical development of water power. The principal feature of the dynamos is that the shaft is vertical and that the revolving field has its poles external to the armature. In the original drawings and specification issued to manufacturers a circulation of fluid for cooling the armature was provided; the poles were wound with copper strip and mica insulation, and not with wire; and there were no bolts on the outside ring to create undue air friction. I allowed the first three dynamos to be built without these features, but the last seven have had them reintroduced. The transformers at the power-house are the first ever made of great size, and also the first made with great attention paid to cooling by air-blast or oil. Those by the General Electric Company are 1,250 h.p. Those by the Westinghouse Company are 2,500 h.p. For the factories within half a mile a subway is used, which I built of concrete. For the new carbide works a Camp conduit, like our Doulton conduit, is used with 10,000 volts. For the Buffalo transmission bare overhead wire cables are used. The Aluminium Company had great trouble at first with the rotary transformers used for commutating the current. These were, I believe, the first machines of this class ever ordered for commercial use. The Mathiessen Alkali Works have 11 such machines, with one induction motor for starting the middle one. The others are started from this by temporary belts. They have no hunting, no sparking, and no grooves on the commutators. Hunting is prevented by a modification of the Leblanc cage on the poles. Each machine has six poles, and sparking is prevented by connecting together metallically all the commutator bars which are in the same phase. To prevent grooving of commutators the shaft is free to move axially, and motion is given to it by an electromagnet and spring, the current for the electromagnet being periodically interrupted by clockwork mechanism on the wall. The Carborundum Company's plant is chiefly interesting for the adjustable transformers, which allow very large variations in the volts and current. These have often been described in technical journals. This service could not have been given had we adopted three-phase alternators, and the rotary transformers would not have succeeded but for our low frequency. In the new works of the Carbide Company, 10 Wagner transformers, each of 2,000 h.p., were being put in when I was last there. This plant is interesting from the fact that the serious short-circuits frequently occurring in the electric furnace can be satisfactorily dealt with.

Passing over other matters, concerning which a volume might be written, it will be well to say a few words about the transmission line to Buffalo. The chief peculiarity of the Buffalo transmission line is that three-phase currents are used, though generated in two phrases. I very much preferred alternators of two phases as being more easily tested and attended to, and as giving a more useful machine. For the transmission to Buffalo I had no great preference for one over the other, but I found that we should be better served by yielding to the wishes of the contractors and putting in Mr. Scott's ingenious arrangement for changing from two-phase to three-phase. Fig. 1 shows the connections. There were six bare cables on one cross-arm of the posts all the way from Niagara to Buffalo, but this arrangement

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is to be altered. From Niagara to terminal house, Buffalo, is 25 miles; from terminal house to railway house is two miles; from terminal house to lighting house is four miles; from terminal house to three sub-stations is 4½ miles. The full-load inductive E.M.F. is 15 per cent. of the whole. At some stations the current leads the E.M.F. instead of lagging. The Buffalo cables are three insulated lead-covered cables in a pipe, and the capacity of each is 0·55 microfarad per mile from copper to lead. The conductors on the transmission line are 0·6in. diameter, 18in. apart half the way, 36in. the rest. The posts are 75ft. apart. The top cross-arms are 30ft. above ground. The posts are 8in. diameter at the top; they are not strong enough for the weight and are bent badly. Originally a barbed wire ran the whole distance over the conducting wires. After the snow-storm of Dec. 4, 1898, it was removed. It was grounded at every second post. Having looked carefully into the cause of every interruption of electric supply that has occurred in four years, I have to say that not a single electrical trouble has occurred that might not be prevented in any similar plant laid down in future. In this brief reference to the work at Niagara Falls many features of considerable importance must be omitted; but I should like to draw attention to the ingenious automatic cut-outs, with the introduction of which I had nothing to do, and which I am, therefore, free to praise, as they have been of the highest value in preventing interruptions of supply on the Buffalo transmission. The electromagnetic arrangement, which comes into play when excessive current

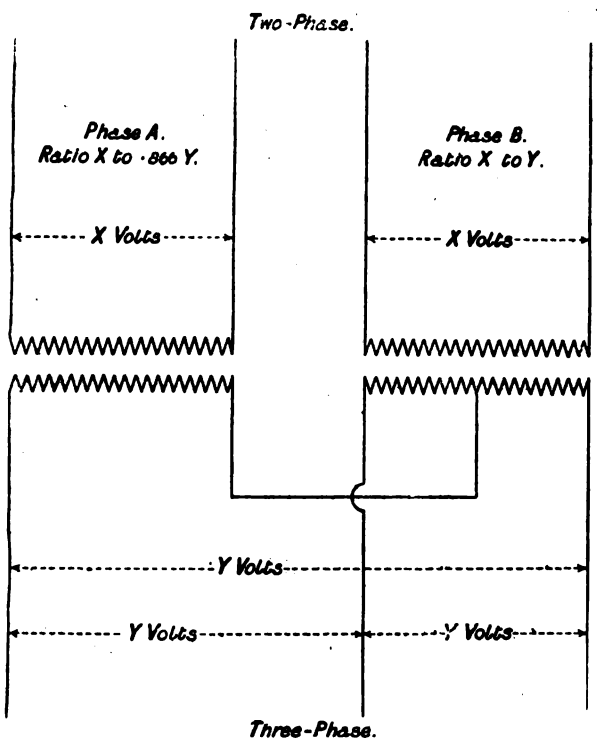

FIG. 1.—Sketch showing Transformation from Two Phases to Three Phases.

current passes due to a short-circuit, merely serves to start some clock mechanism, which after a short period cuts out the line if the excessive current is still passing. On the Buffalo distribution these automatic cut-outs are set so as to act after one or two seconds; at the Buffalo end of the transmission line after three seconds, and at the Niagara end after four seconds. Thus a short in Buffalo cuts out the distributing lines and no others. At the terminal house, Buffalo, it cuts out the supply mains, but not the transmission line; and at Niagara if a short lasts four seconds the supply to the transmission line is cut out. Another ingenious appliance at Buffalo is a motor supplied by the three transmission cables so balanced that the motor will not move except when the balance is destroyed by an earth or short-circuit on the line, when its motion removes the defective line, or switches the whole load on to the other line. There is a practical matter regarding the regulation of the turbines which deserves notice. At the period of my last inspection Buffalo was supplied by two dynamos. Now, the first three turbines put down were regulated by a purely mechanical governor, the later ones by a more sensitive electrical governor. It is found in practice that the supply at Buffalo is most steady when the two turbines driving the dynamos are regulated, one by a sensitive and the other by a coarser governor. In conclusion of these remarks about the Niagara-Buffalo transmission, it may be interesting to mention a few of the causes of interruption of the current. Some of the Italian workmen stole copper wire. They were put in prison, whereupon their relatives short-circuited the wires. Boys threw chains over the transmission wires to watch the sparks until the detectives caught them. Short-circuits or earths have also been caused by fumes and carbon dust deposited on snow on the insulators, by Fourth of July rockets, by sleet, by lightning, by careless workmen, by rats. Interruptions have occurred by overload on rotary transformers, by attendants using switches wrongly, by lightning arresters, by bad switches on consumers' premises, by accidental fire, by ice-blocks on the canal headrace. Insulators are a temptation to the owners of revolvers, but this trouble has not existed at Niagara so much as in Switzerland. These are only extracts from the nearly complete list which I made out from four years' working.

(*To be continued.*)

DISCUSSION.

The President said they must all feel that they owed a great debt of gratitude to Prof. Forbes for giving them his paper. It was not a mere catalogue of what had been done in other places, but a description taken from actual experience. Many men could have written papers on the subject, though no one but Prof. Forbes could have given them that paper, with its clear facts and wise suggestions.

Prof. Perry opened the discussion, and stated that he should have liked Prof. Forbes to have given them more information, and there were several practical points which he might have dwelt upon with advantage. He spoke of the use of synchronous motors for increasing the power factor or doing what a condenser might do. He would have liked to have had figures as to the actual size of the motor to do that. And, again, as to turbines, they had had very little information as to these machines. Some 40 or 50 years ago there was plenty of talk about them, but they could get no details of the turbines themselves, the only information being from a civil engineering point of view. He was glad to notice that papers written 20 or 30 years ago were now attracting attention—for instance, the one by Prof. Ayrton mentioned by the author. He did not quite understand why Prof. Forbes was trying to keep up the voltage in the transmission line, nor what he said about boosters. He made, however, a most curious statement. He (Prof. Perry) had always understood, and, in fact, had proved, that it was not possible to transmit power electrically with a less efficiency than 50 per cent. Prof. Forbes, however, spoke of the enormous advantages of transmitting at lower efficiencies than this. He (the speaker) and Prof. Ayrton had proved, to their own satisfaction, at any rate, that it was impossible to do that. He would like to know whether Prof. Forbes had not possibly neglected the fact that the power which was developed in a booster cost money. If one wanted to increase the voltage, it could be done either by increasing the copper or by using a booster. When more copper was used power was saved, and with a booster more power was required. He some time ago went into the comparison of the savings by means of boosters and extra copper. Prof. Perry then proceeded to work some mathematical calculations on the blackboard, which, however, he said he would send in for inclusion in the *Proceedings* of the Institution. The calculations, however, would show that, on the whole, the booster method was not so economical as to increase the copper in the line.

Mr. S. Z. de Ferranti said he must congratulate Prof. Forbes on his paper, which was of special importance because it brought forward in a concise form information as to work already accomplished, and also drew some valuable conclusions. He would inform Prof. Forbes of a fact which he did not seem to know, that there were air-cooled transformers which were made in 1889, and which were used on the London Electric Company's circuits. Air blasts were not added to them, although those were arranged for, as the cooling was quite good enough without them. The air circulation was perfect in the transformers, and they were so arranged that the heat did not strike directly on to the delicate ebonite part. They were patented in this country and would have been also in the United States save for the swearing-back system in force there, by which those who swore back the hardest secured the patent rights. There was, he noticed, a tendency to drop the rotary converter in favour of the motor-generator. This he was pleased to see, and thought none would deny that a rotary was a very tricky thing, and more suited to water-power transmission than steam generation. He himself had seen American-built rotaries "hunt" about as badly as they could do, and it was a clever business to get them in step. Motor-generators were, he thought, the best things to adopt in dealing with a long-distance transmission line. He also did not understand why people would use induction motors. He should think they would use synchronous motors. The induction motor had a bad power factor, and when one saw how admirably the synchronous motor worked one could not see why others should be used. The synchronous motor was the best thing for taking power on long transmission lines and turning it into distributing current. It was not generally realised what a valuable thing the two-phase system was with the centre earthed, as shown by Prof. Forbes. People seemed to think the three-phase system was the one for transmitting power, and he was glad to find that Prof. Forbes pointed out the fallacy of that statement. With respect to the question of what was the best system to adopt, it was quite certain, as Prof. Forbes had said, that the best system for transmission need not be the best for distribution as well. Perhaps some of them would think what he was going to say was silly, but he would ask them to bear it in mind at some future date. He considered

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that the single-phase low-frequency system was the best of all the systems. The whole of the details for this system were not yet quite complete, but when they were he felt satisfied that the single-phase system would be found to be the best to transmit power and turn it into current for distribution. The only thing at present not quite perfect was a single-phase alternating-current motor, but this, again, was better than was generally thought, as a test with a 50-frequency single-phase motor gave an efficiency of 81 per cent., and they had not far to go to bring it up to the level of the three-phase motor. The great point of that motor was its great simplicity, polyphase motors being much more complicated, and, therefore, more costly and troublesome. The use of the multiphase motor was largely a matter of fashion, engineers employing it because others had done so, and without looking for anything better. There was another point, also, which he wished to lay before the meeting. The paper under discussion was almost entirely connected with work abroad. He felt justified in speaking of work in England. There were many people struggling, at great trouble and expense, to get powers to transmit high-pressure energy all over the country, and to put England on an equality with other countries. What he wished to draw attention to was this, that there were people who were trying to give them these facilities which were wanting, and people who were opposing them. There ought, he thought, to be sufficient patriotism in the country to fight for the advancement of the science of electricity in it. It would be a great misfortune if electrical engineers could be found to say anything against these great enterprises, which, if experimented with and brought into working order, would undoubtedly benefit the country. There should be no professional men in the country ready to prevent any of these schemes being rapidly brought into practice.

Mr. G. L. Addenbrooke said he agreed entirely with Prof. Forbes. It was a great pity the value of the long-distance transmission schemes was not appreciated in this country. There was a vast field for the transmission of electric power in this country. In consequence of there being no such schemes here English manufacturers had nothing to guide them in the construction of the plant, and also had not that incentive to make them which arose from close contact, an incentive which acted both on user and manufacturer. In Germany and America manufacturers had the benefit of this close contact in their work, and were therefore able to get the necessary data to carry out improvements. As Mr. Ferranti had said, all real experiment was prohibited in England, or must first go before a town council, which meant obstruction. The council were immediately in a fog if a scheme were taken before them, and they were probably advised that one wished to make a lot of money out of them. In consequence, no experimental work was done in England. In this way the finest trade of the last half of the century was being ruined. Where would our fine railway system have been if such a policy had been pursued 50 years ago? As to whether three, two, or single phase was the best for transmission, this could be settled when the Legislature gave opportunities for doing so. Unless such opportunities were given, the capitalists of the country would not invest in electrical undertakings. There was an erroneous impression amongst them which he should like to correct, this being that respectable lighting could not be obtained from three-phase mains. He went some time ago to the Continent, where he was pleased to see excellent results in lighting with three-phase transformers. There was also the fact that did not seem to be appreciated, that if one had a first-class engine driving a motor of constant periodicity one might have a very large variation of pressure on the line, as with the periodicity the same, the rotary would tend to go round at the same rate. Very good lighting could thus with this arrangement be got from a traction plant.

Mr. W. B. Esson then asked whether any booster system was now in operation. Also in this booster system it might so happen that, apart from generating 6 h.p. to get 1 h.p., the extra cost of transformers and generators would largely exceed the cost of the extra copper. In this way he wished to show that in estimating the comparative costs the whole of the costs must be taken into consideration. He would suggest that the reason the Oerlikon Company used phase rectifiers was owing to the enormous drop in the line voltage. He should like to know if Prof. Forbes had any figures showing the difference obtained by the use of a stranded copper wire and a solid one, with reference to the figures given in Table 7.

Mr. R. Hammond said the members of the Institution must be filled with gratitude to Prof. Forbes for delivering his epitome of facts on the subject. In the next week five Power Transmission Bills were coming before the committee of the House of Commons, and the question of whether England was to have long-distance transmission was thus likely to be settled at an early date. A powerful committee had been formed. The laws governing long-distance transmission were therefore attracting a great amount of attention. He should like to emphasise the point the author had made in connection with the proper appreciation of Kelvin's law. A mere mortgage interest on the value of the copper would hardly do, but interest on capital might be made as suggested. The author placed this interest at 15 per cent., but the promoters of the Bills did not think it would be so much as that. It was not the mere loss of current on load which had to be taken into consideration as what was lost at the other end. The real choice at the present time lay between two and three phase. On that head Mr. Ferranti did not agree, but favoured single phase as a rival. However, it was the popular idea that the Power Bill promoters would have to choose between the two and the three phase systems. During the past fortnight he had spent some time on the Continent investigating the two and the three phase systems. He had found that the Continent "plumped" for three-phase, although, of course, the Continent might be wrong. There were, however, many cases where there were already large single-phase works in existence, and also many cases where the network was made suitable for two-phase, stepped up into single-phase—for instance, in Vienna. In new places, however, with a clean sheet, such as Mannheim, the three-phase system was used throughout, and no difficulty was found in transmission for lighting purposes through the city. It might be that the two phase gave an advantage in the cost of cables. He had made enquiries of Mr. Blàthy on the subject, and he strongly objected to three-phase, and gave his opinion in favour of two-phase work. He strongly supported Mr. Ferranti in saying that motor-generators were better than rotary converters. In Frankfort the tramcars were all supplied from motor-generators, and in many other instances on the Continent the same thing was done, the motor-generators being found to act much better than the rotaries.

Mr. J. Swinburne said the question was not one of Kelvin's law. When the law was first brought forward, people thought they had got hold of something new. The real novelty about it was its simplicity. The general law that the most economical arrangement was to invest capital in order to save revenue, had been known to every commercial man from the beginning of the world. The only difficulty was the calculation of the saving. When these calculations were once started they departed from Kelvin's law, and made the matter one of mere commercial calculation. There seemed a little misunderstanding as to Prof. Forbes's remarks as to boosters. If they were limited by law to 10,000 volts, they did not want to start at the station with 10,000 volts and come down a lot at the other end, but they wanted the 10 000 volts all along the line, and with a booster they were taking power from one side and putting it in on the other. He did not know whether any of them beguiled their leisure time by studying the origin of religious dogmas. At any rate, they were dealing a little in that direction with the question of three-phase motors. Some time ago the problem was to get an alternating-current motor. Then came the Tesla patents, and the people in Germany from these built up a new system. This system was perpetuated by people also going into foreign countries, as Mr. Hammond had done, and seeing everybody using three-phase motors. They would then come home and instal three-phase machines in their stations, and others round would copy. He thought that Mr. Ferranti was quite right in what he had said respecting motors.

Prof. G. Forbes, in reply, said that Prof. Perry had asked him for more figures as to the size of the phase rectifiers referred to. He thought that a man of such standing as Prof. Perry would have no difficulty in working out the figures he wanted from tables given. Prof. Perry's remarks as to the boosters were apt when he said that he did not understand them, his remarks making that obvious. His (the speaker's) ignorance was profound in thinking that the work was so elementary. They were all much indebted to Mr. Ferranti for his remarks—historical, practical, and prophetical. As regarded the air-blast transformers, he was glad to have the information given. Mr. Ferranti's remarks as to motors were of great value, and also prophetical with respect to the single-phase motors. He thought that, on looking into the matter, he himself might very probably come to the same views as Mr. Ferranti. In reply to Mr. Esson, he did not know of any booster system in any part of the world. He knew that the phase rectifiers at Oerlikon did work, but did not know whether they were economical or not. As to the variations caused by the use of stranded instead of solid wire, there were none that he knew of, except, perhaps, in skin resistance. Mr. Hammond's remarks showed the tendency to get into a groove in the matter of three-phase working.

Prof. S. P. Thompson then asked the members to return a vote of thanks to Prof. Forbes, and said that there were two points in the discussion he should like to mention. Prof. Forbes struck a national note when he spoke of electrical engineers recognising the importance of long-distance transmission in England. There was there a problem which had to be faced from a national point of view. Last year he visited a small town in Italy in which a power transmission scheme was being prepared with the sanction of the Government. More than half the power was contracted for before the dynamos were put in. The scheme provided for supplying power for various flourishing manufacturing towns in the district. The piece of Lombardy he referred to was the Lancashire of Italy, and was full of silk and other mills, and all these were going to have their power distributed to them at high pressure. The manufacturers in this country had to compete with those in Italy, and should they be debarred from having their power distributed to them in the same way, and as was done at Rheinfelden and many other places? If it were so, it would be little short of a national misfortune.

The next meeting, the President stated, would take place on May 3 at the Institution of Mechanical Engineers, when a paper would be read by Mr. H. M. Sayers on the "Calculation of Distribution Systems of Electric Traction under British Conditions."

The following is a list of the candidates balloted for at the meeting:

Associate Members.—W. J. F. Freeland, care of Messrs. Crompton and Co., Limited, Arc Works, Chelmsford; W. W. Hughes, "Western Mail" Chambers, Cardiff; J. R. P. Lunn, Electricity Works, Huddersfield; A. F. McCann, 5, Curzon-street, Mayfair, W.; J. Maclean, 19, University-avenue, Glasgow, N.B.; J. R. Salter, 26, Whitehall Park-road, Chiswick.

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Associates.—J. Burns, care of the Dover Electricity Supply Company, Limited, Park-street, Dover; P. Dewhirst, 90, Church-street, Blackpool; J. W. Ewart, 23, Lewisham-road, Highgate-road, N.W.; T. F. Courtier-Forster, 43, Fairland-road, West Ham Park, E.; W. Golledge, Royal Agricultural Hall, London; C. Holden, care of A. T. Snell, Esq., Suffolk House, Laurence Pountney-hill, E.C.; T. McGill, Electricity Supply Station, Park-street, Dover; H. S. Rawlings, 165, Sloane-street, S.W.; E. Rorke, 5A, Jermyn-street, S.W.; E. M. Sellon, Queen Anne's-mansions, S.W.; H. Sharman, 16, Circus-street, Greenwich, S.E.; T. F. Tate, 36, Great George-street, S.W.; J. G. Wilson, Castle-street, Lisburn, Ireland.

Student.—A. Ledward, 53, Beaufort-street, Chelsea, S.W.

THE THOMSON-HOUSTON INDICATING WATTMETER FOR INCANDESCENT LAMP TESTING.

We notice in a pamphlet recently issued by the British Thomson-Houston Company, Limited, a description of an exceedingly compact form of indicating wattmeter for incandescent lamp testing. In connection with a photometer, a portable instrument, such as that shown in Fig. 1, to determine accurately and rapidly the watts per candle required by a lamp, is of great value in selecting new lamps and in testing old lamps. The photometer measures the candle-power of the lamp and the wattmeter the total watts consumed, the watts per candle being then readily determined. The wattmeter illustrated is of the well-known Thomson inclined-coil type. Another advantage of the instrument is that it will accurately indicate the energy consumed by small fan motors, and is, therefore, particularly useful in comparing, for a customer's benefit, the relative amount of energy required by a fan motor and an ordinary incandescent lamp. Further, by supplying the secondary winding of a transformer with current, its core loss may be determined by the wattmeter. The accompanying illustrations (Figs. 2 and 3) show the provision made for rapidly connecting the instrument. Two special plugs, together with a screw base and bayonet, are supplied, thus providing ready means for connection to the forms of sockets most generally in use. The lamp to be tested is inserted in one of the receptacles in the base of the instrument, and the proper plug is placed in any convenient socket. Lead wires are provided suitably tipped at one end for insertion in the plugs, and at the other for connection to the binding posts of the instrument. A small secondary plug, arranged to fit the regular plugs, and provided with two small binding posts, is also provided with every instrument, by which means the power required by small motors or other apparatus may be conveniently measured. The capacity of the instrument is 150 watts. Lamps of any candle-power up to 32, and of any voltage up to 150, may be tested. The instrument is claimed to be equally well adapted for use on either direct or alternating currents, but on direct-current circuits reverse readings should be taken to eliminate the possibility of any slight error which may be introduced in all instruments of this class by the presence of local fields. For convenience, a special reversing button is provided to reverse the current in the instrument and lamp without the usual inconvenience of reversing the lead terminals. When reversed readings are made, the mean of the two is taken as the final reading. Another useful feature of the instrument is the damping device. A button is provided which releases the needle or pointer from the damping brake only when depressed. When the button is released the needle is held at the point of the last indication; therefore, if the current is turned off and then on again, or reversed, the necessity of waiting for the pointer to swing from zero to a state of rest is obviated, and very rapid readings thereby enabled. It may be added that the external dimensions of the instrument are 7⅞in. by 7⅞in. by 4½in.

FIG. 1.—Inspector's Indicating Wattmeter.

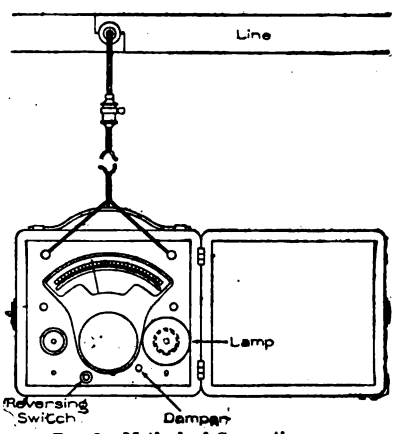

FIG. 3.—Method of Connecting.

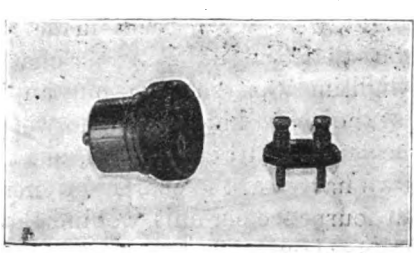

FIG 2.—Secondary Attaching Plug.

With regard to the instrument's field of application, this is probably not nearly so large on this side of the Atlantic as in the States, since our supply corporations do not undertake to provide their customers with lamps, as is the custom over there. Hence there is nothing approaching a general supervision of private installations of lamps on this side. But it would certainly pay large consumers to exercise a closer supervision over their lamps, for it is manifestly uneconomical to continue a lamp in service when its candle-power has so deteriorated that the watts it wastes cost more than a new lamp, which we are afraid is frequently the practice either through ignorance of the waste involved or lack of proper supervision. It is in such cases where the instrument above described should find useful application.

THE EAST LONDON TECHNICAL COLLEGE.

We notice that two special courses of lectures are to be given at the above college, both of which deals with electrical subjects. The first is a series of six lectures by Mr. J. T. Morris, A.M.I.E.E., the subject being "Electric Lighting and Power Stations." The syllabus deals with the position of electric lighting industry at present time—Relative cost of electricity and gas—Powers and duties of electric lighting companies, local authorities—Site of station—General arrangement—Boilers—Mechanical stokers—Thermal storage—Engines—Steam-turbines—Dynamos—Balancers—Batteries—Switchboards and controlling apparatus—Feeders—Distributing mains—Pilot wires—Board of Trade regulations—Load factor—Price for B.T.U.—Methods of charging, etc.

The second course of eight lectures is by the same gentleman, and deals with alternating currents, single-phase and polyphase currents; three-phase currents, star and mesh connections; three-phase generators and transformers; rotating magnetic fields, three-phase motors, etc.

The price of these courses is respectively 5s. and 7s. 6d., and we think they should be of much value to those attending them.

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BIASSED CRITICISM.

Where ignorance is bliss, 'tis folly to be wise.—POPE.

We have often had occasion to refer to the ignorance of our contemporary, the *Journal of Gas Lighting*, upon matters electrical. For the past ten years at least this paper has constantly criticised electrical work. It might be expected that its criticisms would be biassed, but its numerous misleading statements render it extremely doubtful if it is honest. An examination of its columns last week will show a criticism on the St. Pancras accounts. The remarks it makes are crude and utterly misleading. Whether it is capable of understanding the accounts, or whether its hatred overrules its discretion, is a matter of opinion. Public bodies, so far as their public acts are concerned, are made to be criticised. That is providential in the case of some newspapers, or there would be nothing to fill their columns, except it might be to criticise their contemporaries. But we have to deal with the *Journal of Gas Lighting*, which says of the St. Pancras accounts: "On the face of the revenue account, however, there is a credit balance of £17,649. Out of this has first to be provided interest (£7,433) and redemption (£3,374), or a total capital charge of £10,807—say, 3¾ per cent. on the capital. Cheap enough! These payments leave a net balance of £6,841, or a noble trade profit of 2·3 per cent." It then goes on in a complaining strain, that even this balance is fictitious, as "there are several little things to be squared out of this handsome sum." There can be no two opinions as to what our contemporary wishes its readers to infer. It puts, or tries to put, half-truths in such a way as to make its readers infer that all the statements as to the satisfactory working of St. Pancras, whether from St. Pancras itself or from men engaged in electrical work, are unmitigated lies. Before we have done with the *Journal of Gas Lighting* we hope to prove that, if it does not apologise to a large number of honourable gentlemen, it ought to receive the contempt such actions merit. Let us deal with the cost of public lighting first. Our contemporary asks: "Without this subsidy where would the undertaking be?" and speaks of the cost as "perhaps thrice the cost of gas." It carefully ignores such questions as relate to quantity of light, so that only "thrice" may be a sign of magnanimity when it could just as easily be written "ten times." A point might well have been made with the figures given that the St. Pancras charge for its street arc lighting was too high, but an indefinite statement of the above kind carries no weight. We have not the latest figures before us, but taking the last figures we have and the charge for energy to the arc lamps at fourpence per unit, we find that the arc lighting costs about £2 per hour for close on 150,000 candle-power, taking the 2,000 nominal candle-power arc to give 750 candles. Further, assuming the incandescent gas lamp to give actually 25 candles for a consumption of five feet per hour, and gas at three shillings per 1,000 cubic feet, the candle-power obtained for the above expenditure would be considerably less than one-half of that

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obtained electrically. If the St. Pancras accounts then charged double the cost of gas, the conditions would tell in their favour, while a charge of three times that of gas tells a little against them. But we do not know what the cost of gas for an equivalent—actual, not nominal—quantity of light would really be, and have merely taken "thrice" in order to present our contemporary with an opening to put forth its exact figures. With regard to the question of interest on capital and repayment of capital, there is no room to present our contemporary with anything. It either writes ignorantly, negligently, or wilfully incorrectly. The credit balance, assuming the books correct, is profit, hence interest, which in a municipality takes the place of dividends in a company, is here undoubtedly paid out of profits; the repayment of the capital, again, is depreciation of capital, and this again is paid out of profits, taking the place of depreciation of plant in a company's working. To call these capital charges is an abuse of terms, and to call the balance remaining after these are paid the only "trade profit" is a gross attempt to mislead. No doubt the reply will be made that these payments are compulsory, and thus differ from those analogous with a company, in that in the latter case the payments cannot be made if the profits do not permit it. But in the case referred to the payments are made out of the revenue credit balance. Even had there been a demand upon the rates, our contention would still have been that they could not be legitimately called capital charges. There is much that might be said on the further remarks, but these can be left to see how our contemporary will extricate itself from the mis-statements already referred to.

BOOSTERS.

Prof. George Forbes's suggestion to reduce copper in a transmission line by placing boosters along the same at intervals seems to us to be at fault, unless the power is distributed rather along the line than collected in a block at the end. The example taken by the author is clearly one of transmission only, and could be improved by grouping all the boosters in the power station, or by discarding them in favour of slightly stronger fields for the generators. With Prof. Forbes's scheme and example the voltage at the power station is 10,000 volts, whereas the voltage at the receiving end of the line would be 9,000 volts at full load, and 13,000 volts at no load. He saved by the system some 26 per cent. of the copper required without boosters. Now, if the boosters were all grouped in series at the power-house more copper (over 30 per cent.) would be saved in the line, and the range of voltage at the receiving end would be the same. This range could be avoided by provision for regulating the number of turns on the boosters, or by cutting out the same one by one as the load decreases. The problem of switching in and out of high-tension boosters is, however, not a simple one. We regret that in the paper the question of capital cost was not gone into, although in many cases the boosters will cost less than the copper they replace.

FORTHCOMING EVENTS.

FRIDAY, MAY 4.

Dynamicables.—At 7 p.m., dinner at Whitehall Club.

MONDAY, MAY 7.

Society of Arts.—At 8 p.m., Cantor lecture on "The Incandescent Gas Mantle and its Use," by Prof. Vivian B. Lewes. Lecture I. of three.

Society of Engineers.—At 8 p.m., paper on "The Economical Disposal of Town Refuse," by Mr. Brierley Denham Healey.

TUESDAY, MAY 8.

Society of Arts.—At 8 p.m., paper on "Art Metal Work," by Mr. Nelson Dawson.

WEDNESDAY, MAY 9.

Iron and Steel Institute.—At 10.30 a.m. annual meeting, at Institution of Civil Engineers. Annual dinner at Hotel Cecil at 7 p.m.

Society of Arts.—At 8 p.m., ordinary meeting. Paper on "The Improvement of our Roads," by Mr. A. M. White.

THURSDAY, MAY 10.

Iron and Steel Institute.—Second day. General meeting at Institution of Civil Engineers.

Institution of Electrical Engineers.—At 8 p.m., ordinary meeting at Society of Arts. Paper on "A Frictionless Meter," by Mr. S. Evershed.

FRIDAY, MAY 11.

Royal Institution.—At 5 p.m., discussion on Prof. Lodge's paper "On the Controversy Concerning Volta's Contact Force."

SATURDAY, MAY 12.

North East Coast Institution of Engineers and Shipbuilders.—At Newcastle-on-Tyne, graduates' meeting.

POWER BILLS COMMITTEE.

Yesterday the committee appointed to consider the various Power Bills now before Parliament commenced its work under the chairmanship of Sir J. Kitson. The other members of the committee were Sir A. R. Scoble, Mr. G. C. T. Bartley, Mr. T. G. Ashton, Mr. J. Howard, Mr. A. Billson, and Colonel C. W. Long.

Mr. BALFOUR BROWNE, Q.C., introduced the first Bill in the list, which is the County of Durham Power Bill. He explained that local people were largely interested in the Bill, as the promoters had powers to construct tramways and light railways in Gateshead, and also to supply electric light in that district. They had also powers to construct tramways in Jarrow, and the Durham electric light provisional order was to be transferred to the company by the Durham Corporation. The map exhibited showed the area scheduled by the Bill, and from it it would be seen that the South Shields and Sunderland areas were omitted. Generally the company had the support of the local authorities, and the Bill was only opposed by the Councils of Hebburn and Felling. The central station was to be constructed at Gateshead. The company asked for powers to supply electrical energy to any lighting authority and to any local authority having powers under Board of Trade provisional orders to supply and distribute electrical energy. They also sought power to supply for any purpose whatever. They did not seek to distribute electrical energy in opposition to local authorities, but held that a large company could supply wholesale to small districts at a much cheaper rate than they could themselves generate it. He thought that in such matters private enterprise could do better work than municipal action, and that Parliament by its recent decision in the case of the Huddersfield Tramway Bill had decided against one large municipality trading in the surrounding district, even with the consent of the smaller authorities. They proposed to leave the distribution of light in the hands of the local authorities, and it was a great point that, while these could by the terms of the Bill compel the company to supply them, the company could not, on the other hand, compel the local authorities to take a supply. The powers sought by the company were as follows: (1) Compulsory powers to purchase land for the station in Gateshead, to which there was no opposition. (2) Powers to break up streets throughout their area to lay mains. This was opposed by the Councils of Hebburn and Felling, and he argued that it would be unreasonable to allow these Councils to prevent the supply being taken through their districts in order to get to Jarrow, where the people wanted the cheap electrical energy. The company agree to allow the authority to do the street

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work themselves, and to pay the cost, and also to allow them a voice as to the route to be taken so as to cause minimum interference to the public and to the streets. To show the influence of the size of the station on the cost of supply, Mr. Balfour Browne quoted figures as to the prices charged in different groups of towns in which definite quantities of electrical energy were taken per annum. The figures were as follows:

Group.	Number of units sold per annum.	Cost per unit. Light.	Power.
1	50,000	6·39d.	3·8d.
2	140,000	5·43d.	2·04d.
3	450,000	4·67d.	1·98d.
4	1,000 000	4·41d.	2 40d.
5	4,800,000	3 76d.	1·87d.

The company expected a greater demand than 5,000,000 units per annum, and hence would be able to supply more cheaply. The load factor had a great influence on the cost, and, for this reason, they would do better than the lighting undertakings whose load factor rarely exceeded 12 per cent. The company expected a load factor of 25 per cent., and to be able to supply at from 1d. to 1½d. per unit. This would be less than a small local authority could generate for. The various industries in the district were then mentioned, and it was urged that the cheap supply of electric energy would encourage the construction of tramways in the county of Durham. The industries on the south bank of the Tyne would be valuable consumers, and he strongly objected to the proposal in the Bill of the Tyneside Power Company that a strip of land on this bank should be included in their area. The Tyneside Company, if this were granted, would be taking a most valuable part of a district, but would not touch the poorer parts which lay behind it. Mr. Browne then showed the committee some specimens of the cables to be used for the power transmission, at 5,000 volts and also at 10,000 volts. This, he stated, was absolutely safe, cables carrying 10,000 volts being used under the London streets under the Board of Trade regulations. There was also no difficulty in laying these cables in the districts. The total capital of the company was originally £457,000, but it was now found necessary to increase this to £550,000. The cost per unit generated would be ·473d., and they would be able to supply at 1d., or at least 1½d. There was little or no opposition to the Bill.

A member of the committee asked whether one uniform price was to be charged all over the district irrespective of distance.

Mr. BROWNE stated that this would not be so, as it would be naturally more over the longer distances. The authorities would also supply their consumers at whatever price they wished, this not having anything to do with the promoters of this Bill. With respect to the opposition of the Hebburn Urban District Council, he thought this was made under a misapprehension, as, if they wished to have their own generating station, they need not take the company's power, and there could be no objection to the cables passing through the district. Besides this, it would, in the event of the Council having its own generating station, be a good stand-by supply for them in case of breakdown. England was seriously behind in such schemes as these when compared with other countries. If works could get their supply in the way proposed, manufacturers could run their machines without having to waste time, trouble, money, and power in a number of small steam-engines scattered through the works. The opposition mentioned stated that, in order to convey the power through large districts, it would have to be transmitted at a dangerously high voltage. As he had pointed out before, there was absolutely no harm could come from the use of the proposed cables. As to the competition with local authorities, they were not going to compete with any such authority. The Tyneside Company, who wanted a portion of the district south of the Tyne, claimed this portion, because they stated that the north and south portions represented one manufacturing district, and, therefore, one company should supply it. This argument was wrong, and he thought it expedient that the south side should be supplied separately from the north. This piece of land was the best part of their district, and it would help them to be able to supply the poorer portions of the district at low rates. The country had now the chance of putting itself on an equality with other countries in the matter of power distribution, and he thought it should not be prevented by the opposition of a local authority.

Mr. S. Z. DE FERRANTI was then examined by Mr. F. Moon. In the course of the examination he stated that electricity could be advantageously applied to many other purposes than it was now in England if these power schemes were allowed. This country was almost the only one which had not such distribution, America and the Continent having a number of such installations, which enabled the foreign manufacturers to compete more severely with England than was formerly the case. It was much better and cheaper for a manufacturer to get the power generated for him than to generate it himself. The majority of manufacturers' works were driven by small engines, which worked most uneconomically. The small manufacturer would, by getting this cheap power, be able to compete on more equal terms with the larger manufacturer. Manufacturers not using mechanical power would also be able to do so if thus supplied. It was more economical to drive a works by means of motors rather than steam-engines, small motors also being able to be placed almost anywhere, and requiring no special provision for them. The manufacturer would only have to pay for the exact power he used, instead of having to generate a lot more than he wanted. He would only pay for what was useful and he had no stand-by losses. The distribution loss was small and it was the most economical arrangement possible. The saving of cost was also very important. He originally used steam-engines to drive his own works, but now used about 30 motors. He found a wonderful advantage from their use. In order to get cheap supply, two essentials had to be observed. The first was that the supply should be on a large scale, and the second that the demand should last over a number of hours. The last condition was equivalent to saying that the load factor must be a good one, and thus the more important factor of the two. It was important because it determined the earning capacity of a given plant. The proposed station of the company, situated at Gateshead, would be most advantageously placed as regards cheap coal, water, and transport. The load of the company would consist of electric lighting, electric tramway, and motors for power purposes. He believed from experience abroad that a ready demand would be found. As regards the Tyneside Power Bill, it would be most unfortunate if that company were allowed to take the south bank of the Tyne. This would take away from the County of Durham Company a most valuable portion of their district, and one which in the first instance would supply many consumers. The Durham Company also had already obligations in the area proposed to be taken. The result would be to make it much more difficult to give the supply cheaply in the smaller areas. He had gone into the size of plant required and of the cost of the same. The assumed maximum load was 9,000 kw., and 12,000 kw. of plant was to be erected so as to have spare machinery. The cost of plant and site would be about £297,000, while mains, etc., would cost £160,000. With contingencies, the total outlay was estimated at £500,000. The maximum load was estimated to be composed as follows: electric lighting, 2,500 kw.; the electric tramways already authorised would take 1,000 kw., leaving 5,500 kw. for power purposes. The load factors assumed, and which were on the low side, were—electric lighting 8 per cent., tramways 40 per cent., and power 30 per cent. This gave the average power factor at 25 per cent. As regards cost, those obtained at Edinburgh and Manchester were for loads mostly of lighting, and cheaper generation cost would be got by a mixed load. He estimated that the company would sell about 20,000,000 units per annum, which at 1½d. would give an income of £104,000. Working expenses at ·7d. per unit, together with £20,000 for depreciation would cost £60,000, leaving £44,000 profit, out of which 8 per cent. could be paid on the capital of the company. He considered 1½d. per unit low enough to tempt most consumers, and to get them the load required. The distribution would be on the extra high-tension system at 10,000 volts, which had been used in London for 10 years past. The Board of Trade regulations for this system

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safeguarded the public. The interference with the streets would be no greater than when laying a small gas-pipe or a line of telephone and telegraph lines underground. Mr. Ferranti explained that the cable would be concentric lead-covered and laid in a wooden trough filled in with bitumen. Hard bricks laid over the top of the trough gave mechanical protection and warned workmen of the presence of the cables. With the outer wire earthed there was no danger of accidents. The system used would be the two-phase one, and three cables would be laid in each trough, two for use at one time and the remaining one a spare. In the case of tramways the current would be transformed down, and its character changed from alternating to direct current. There was not, as a rule, much loss in transforming down and converting the alternating into direct current, but it might reach 10 per cent. The advantages of transmitting at high pressure were enormous. The amount of electricity taken would be measured by meter, and in certain cases fitted with a maximum demand indicator. The whole question of cheapness of supply turned upon the load factor obtained.

Cross-examined by Mr. Fitzgerald as to the reason why the local authorities of Hepburn and Felling should allow the cables to pass through their districts, Mr. Ferranti stated that it was for the benefit of the other neighbouring districts that they should so pass. He did not know anything of the tramway at Durham which had been mentioned. He did not know that the Durham Electric Supply Company, Limited, was owned by the same people as were promoting the Bill. Under the Bill they could distribute power to any company which was authorised to use electricity.

The enquiry was then adjourned until to-day.

The Committee stated that the Lancashire Electric Power Bill would not come on before Tuesday.

ELECTRIC DISTR BUTION OF POWER AS APPLIED TO WORKS AND FACTORIES.*

BY GEO. HARLAND BOWDEN.

(*Concluded from page 593.*)

The efficiencies of a plant driven electrically are so favourable in comparison with any other method of drive that all new works being constructed should be laid down on these lines, and such has been the progress made during the last few years in Glasgow and the surrounding districts that very few of the works and new industries lately started or now in course of construction are holding to the old methods, but are at once laying down a modern generating plant, as they see that the first costs compare very favourably in comparison, and the efficiency of the plant is so much higher. Moreover, in designing new works they are no longer tied up, as in the old and less convenient method. They have no longer to consider how they can squeeze in their machinery and work it in around the power. It is no longer a question of bringing the work to the power. The work and various operations can be carried out at the most convenient and useful situation, a couple of wires being all that is required to run to a certain spot, and there the motor or motors are installed. The engineer will arrive at the powers required in the generating station by giving due consideration, as before mentioned, to any possible future extensions, power required for lighting, and having estimated the powers in his various moters will thus arrive at the total power in the generating station. The nature of the work has then to be considered as the means of deciding how this power will be divided. In no case where 250 h.p. or more is required should the power be put all in one unit, but it should be divided in such a way that at different times in the day, when different loads are required, the powers are so arranged that the plant will be working at as near full load as required. A good arrangement in an ordinary works taking 300 h.p. to 400 h.p. is to divide the units into sizes of one-third and two-thirds of the total. It might be taken that the large unit in this case would do the work the whole of the day, driving the whole of the machinery, the smaller unit being run in parallel at night, when the lighting would come on, thus giving the total power out of the station. Then at night time, or for overtime, the smaller plant would run by itself.

Fig. 2 is a view of the generating plant in the wire mills of Messrs. Charles Dorman and Co., Middlesbrough. Fig. 3 shows a plan of the switchboard, which is erected in the works of Messrs. Scott and Co., Greenock. In this it can be seen that every part of the board is most accessible, all the connections, fuses, etc., being placed behind the board. In the arrangement of the 'bus bars the centre one is a balancing bar, the dynamo being compound wound, the idea being to make the plant, which consists of three dynamos running in parallel, more automatic. In the plant in Messrs. Scott's works any dynamo can be shut down and any one run to do any portion of the work, and by means of the circuit switches any portion of the motor plant not required to run may also be switched off. Similar results have been obtained by boards designed with a pair of 'bus bars for every dynamo, but it results in a hideous complication, requiring not a little amount of study to decide which switch to put in or which connection to make. The only argument in its favour is that any dynamo could thus be run at a voltage to charge certain batteries, but where batteries form a part of an installation, no better arrangement than that a dynamotor be installed in the engine-house for the direct purpose can be recommended, or that a small combined plant be kept there solely for this purpose.

While on the subject of voltage, in many cases where the works do not cover a large area it will be found that 120 volts is a very useful potential, considering the driving of light as well as power, but in larger works, where there is no objection to running arc lamps four in series, and where it is desirable to combine the lighting with the power, 240 volts will be found to be a very useful standard for the potential in the generating station. For many practical reasons this potential should not

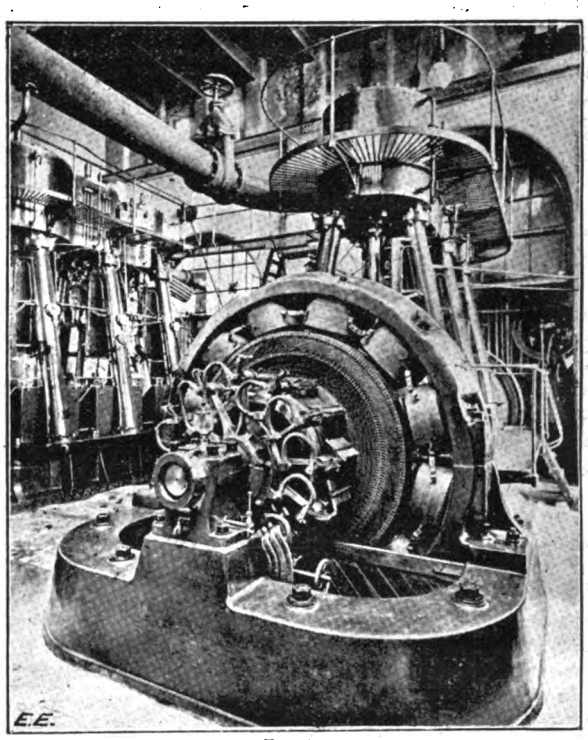

FIG. 2.

be exceeded where the mains are running in and about sheds and roofs, as in an ironworks or a shipyard. A higher pressure than this in such cases requires so much more care and attention, and so much extra precaution and expense to provide against loss. Nor is it desirable in the average shipyard to put in a plant which is going to necessitate much looking after. A plant thoroughly installed and based on the above voltage should give perfect satisfaction, and necessitate nothing more than ordinary care and attention.

There is not the slightest objection to the lighting being driven from the same engine and dynamo as the power, providing that the engine is designed for its work, and is governed to within 2 per cent. variation full load to light. The lighting should not be taken off the same mains as the motors, but should have circuits self-contained and governed by their own circuit switches on the main board. Each circuit would probably control two or three dozen lamps, thus allowing the works to be divided into suitably convenient divisions. The same remark applies to motors, they being also divided into circuits on the main switchboard, each circuit controlling a convenient number of motors. These main circuit cables deliver the current on to a secondary distributing board, known as the fuseboard. On this board each motor has its own double-pole fuse, and the liquid switch or other starting switch is fixed at the motor. This is found to be the most simple and the most satisfactory practice, and it varies very little under different conditions. It will not be found desirable to put a motor on every machine, either from the point of view of cost or from the return expected on the outlay. Nothing can surpass judicious grouping of machinery, especially with reference to engine works, wood-working plant,

* Paper read before the Glasgow University Engineering Society.

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and similar industries, or to a shipyard where the machinery has been arranged in a shed, and where it is convenient to drive small groups of punches and shears, thus possibly being able to arrange that all the motors are interchangeable—say of 20 h.p. each. Where the tools have been scattered about the yard there can be no improvement made to the application of small motors in place of the small steam-engine removed.

A comparison of the costs of driving individual machines, such as punch and shears, rails, planes, lathes, etc., by the three different methods—electricity, shafting, and steam—would have been interesting, but lack of time prevented the arranging of such a table. These individual drives would have proved most interesting, as they could have been applied singly to any works, and would give at once an idea as to how the wastes are going on in various portions of the works instead of as a whole. I am therefore going carefully into this subject, as I am sure it will prove of great interest, and I shall be very happy to place the results of my various tests before this society at some future date. It is a most peculiar fact, however, that machine-tool makers seem to have very varying ideas as to what power such machinery takes. It is not very long ago that my attention was called to a machine which the makers advised would require 90 h.p., or an 8in. belt. The engineer in charge of these works thought the statement of 90 h.p. or an 8in. belt was rather a peculiar one, as he did not expect an 8in. belt to transmit 90 h.p. He therefore tried a 30-h.p. motor, and this machine has now been working most satisfactorily for some little time, taking a maximum load of 25 h.p. Necessarily, the engines for this class of machine are designed considerably above the power required, and really are much too large for the small horse-power—7 h.p. or 10 h.p., as the case may be—which these machines require. To put the cylinders on any smaller would, however, run the risk of spoiling the good working of that machine, hence the large size of the engine, and, again, the reason for a great proportion of the extraordinary waste of fuel.

It will be of interest here to give a list of the various powers absorbed by shipyard and other machine tools :

	E.H.P.
Double punch—Running light	2·0
Punching both ends, 1in. hole, ⅞in. plate, 28 punches per minute at each end	5·0
Punch and shear—Running light	2·0
Punching hole as above, and shearing ¼in. plate, 5½in. cut, 28 strokes per minute	6 5
Large plate-bending rolls - Running light	5 5
Rolling plate $\frac{5}{10}$in. thick by 4ft. 4in. wide by 16ft. 6in. long, endways on (4ft. 4in.)	6·9
Sideways on (16ft. 6in.)	12·2
Plate ½⅛in. by 4ft. 8½in. by 21ft. long, sideways on..	19·3
Same rolls lifting and lowering top roll—Lifting	8 5
Lowering	7·0
Forcing ½⅛in. plate down	10·0
Forge fan—For 24 fires	10 5
Angle squeezer—Running light	·8
Squeezing	2 5
Wood-working machinery—Small plane	8
Tenoning machine	·8
Band saw	1·5
Cross-cut saw	2·5
Small circular saw cutting 6in. pitch pine, hand fed	6·4
Circular saw 48in., sawing 18in. teak (6ft. 6in.) per minute	24·0
Sawing 4½ft. teak, 25ft. per minute	17·7
Countersinking machine—Actual power taken in countersinking	3·5
Riveting machine—Running light	1 6
Riveting	3 0
Wall planer—Taking ⅜in. cut cast iron	5·0
Radial drill—Drilling 1$\frac{1}{16}$in. hole cast iron	1·59
Plate planing machine - Running light	·6
Reversing light	1·8
Cutting 1in. by 14ft. plate	3·1
Stern frame boring—Cutting	1·75
Shafting lathe 18in. centre—Running light	·5
One tool cutting ½½in. square cut	1·8
Two ,, ,,	2·5
Lathe 9in. centre—$\frac{1}{16}$in. cut	·6
Angle-cutting machine—Running light	1 6
Cutting angle 6in. by 3½in. by ¼in.	3·5
Winch—Lifting 28cwt. single purchase, 50ft. per minute	6·5
Ending machine—Running light	1·9
Cutting girder 18in. by 7in.	4 to 4·8
Cold saw—Running light, 24in. saw	2·0
Cutting 4in. by 4in. angle	4 to 4·5
Air compressor—10in. by 14in. cylinder, 50lb. pressure	15 to 23·5
Portable drill—When drilling 1in. hole	1·5
Hydraulic pumps—Three rams, 3¾in. diameter; 4¾in. stroke, 60 strokes per minute; pressure, 870lb.; power taken	38 0
Joiners' shop motor—Normal load	14 8 to 22
Machines being driven from this motor: one 20in. plane, one circular saw 24in., one 30in. planing and sand-paper machine.	
Electric winch—Running light	1 2
Lifting 24 cwt. 16ft. per minute	5 6

These powers are given both running light and heavy laden. It will be understood that in many cases a great part of the power is required in getting the machines under way. I am indebted to Mr. Selby Bigge, of Newcastle, for these figures, the powers being taken from actual indications on the ammeter.

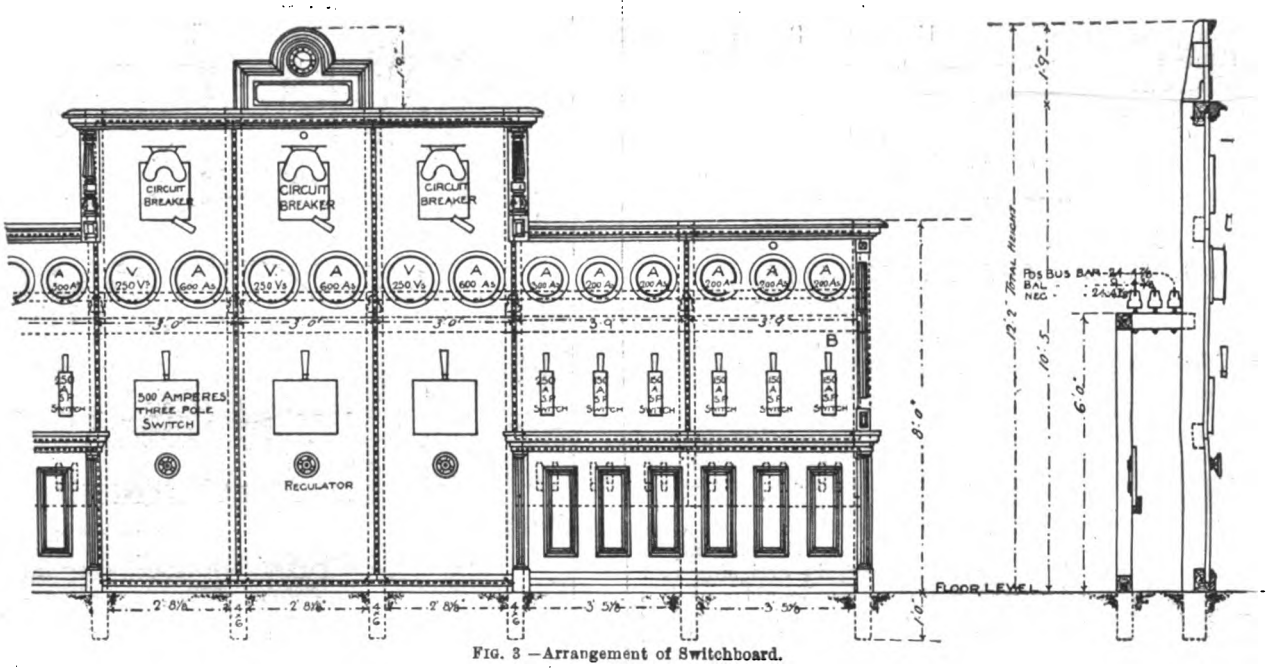

FIG. 3.—Arrangement of Switchboard.

In arranging motors to drive these various machines, it is advisable to make the plant as nearly as possible interchangeable by means of grouping the lighter machines on to a countershaft, and by allowing the heavier machines to be driven by a single motor. It has been found that for the driving of such machinery shunt-wound motors give the best results. These motors have the field winding and the armature connected directly across the circuit, so that the currents flow in parallel, and the armature current does not go through the field. Thus the shunt-wound motors tend to run at a constant speed, the variation between no load and full load being practically nil. This, however, depends greatly on the design of the motor. It has been a common practice to insert in the shunt connection a switch, to be pulled out when the motor was not working. In practice, however, this is not at all a desirable arrangement, especially considering that it is a very small loss to allow current to flow regularly through the coils, and particularly when by this means the motors are kept warm and dry and always ready for work. Moreover, it does not require two handles to be used to start the machine, with the possibility of the wrong one being put in first. For all practical purposes the liquid starting switch and resistance is found to give the most satisfactory results. There is nothing about it to get out of order, and it requires no more attention than that of ordinary cleanliness. For variable speeds such as electric cranes, elevators, pumps, and similar machinery, the series-wound motor is best adapted.

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In the series-wound motor the current passes through the field winding and the armature in series, so that the strength of the field varies according to the current. When the load increases on a series-wound motor the speed falls, and when it decreases the speed rises. It is necessary that a high resistance be first placed in series, when starting the motor, which allows only sufficient current to flow requisite to start the load. The resistance is decrease until the desired conditions are attained.

Compound-wound motors have two windings upon the field.

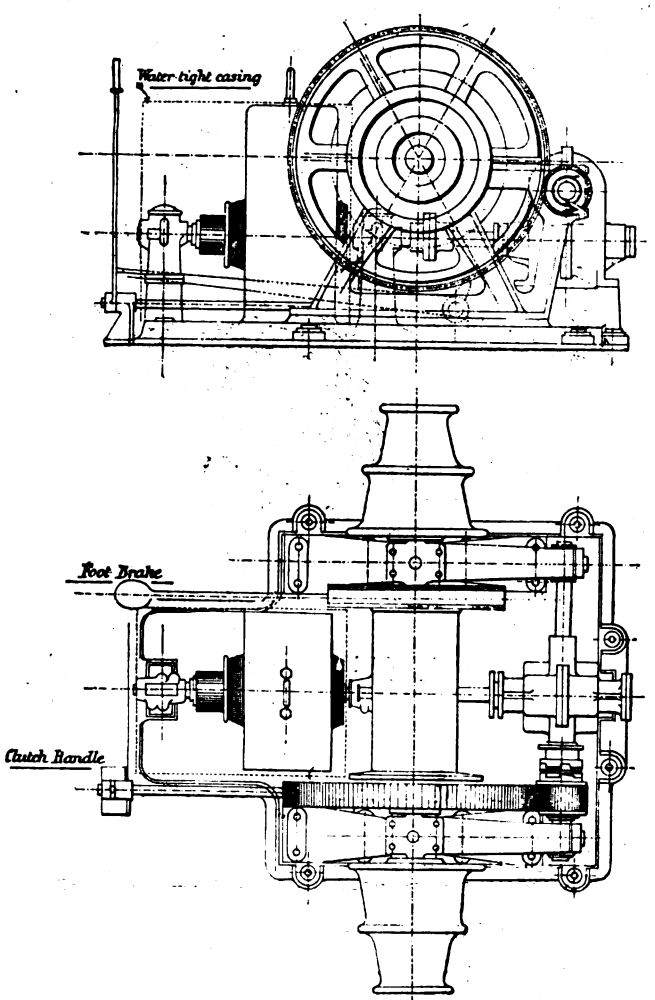

FIG. 4.—Details of an Electric Winch.

One is shunt winding connected directly across the circuit, the other is a series winding and carries the armature current. The strength of the field is, therefore, determined by the shunt current, which is constant, and the series current which varies according to the load. The two windings are usually connected so that the series winding increases the magnetisation produced by the shunt winding; thus the speed falls as the load increases. The compound-wound motor is intermediate in its characteristics between the shunt and the series wound motor, the former being practically constant in its speed, the latter varying greatly according to different loads. Where it is likely that heavy overloads will be met with, and where speed regulation is not important, the compound motor is best adapted. The speeds of the shunt-wound motor may be varied by means of a resistance or rheostat placed in position with the field circuit; adjustment of this causes variation in the current through the field, which in turn produces a change in the speed of the motor. It is also often found necessary to place a resistance in the armature circuit to control the motor speeds and obtain greater variation. This is often found necessary, though the efficiency is reduced in proportion to the throttling done. Still, there are many cases where the avoidance of mechanical complications for the variation of speeds by this means will amply justify the electrical equipment for speed control.

Care must be specially taken in the setting of the motors to reduce the risks of earths to a minimum. This is more to guard against earths in any part of the mains finding its way to the motor should there unfortunately be a leakage on the motor. Whatever form of foundation is laid, whether brick or concrete, the motor should always be set on a strong wood frame of oak or teak. When the motors are on the ground it has been found a most useful practice to cover their foundations with a good layer of pitch, which prevents any dampness rising from the earth. The motors should not be bolted through to the foundations, but should be carefully secured to the wood frame, which in turn is bolted to the foundation, thus allowing no connection between the earth and the motor through the holding-down bolts. Where the motors are fixed in roofs or in brackets, similar precautions should be taken.

One of the great advantages pertaining to an electric installation in such works as have been described is the ease with which the power can be utilised for driving various portable tools, costing little in themselves and increasing the output of the various types of works to which they are applied enormously. Fig. 4 is a view of a winch which is specially designed for application to shipyards and to steelworks. It can be erected on a trolley and made portable, or fixed on a sound foundation as required. There are a great number of these machines at work in this country, replacing the more uneconomical method which pertains to this class of tool when steam driven, and which generally requires a small boiler and a man in attendance.

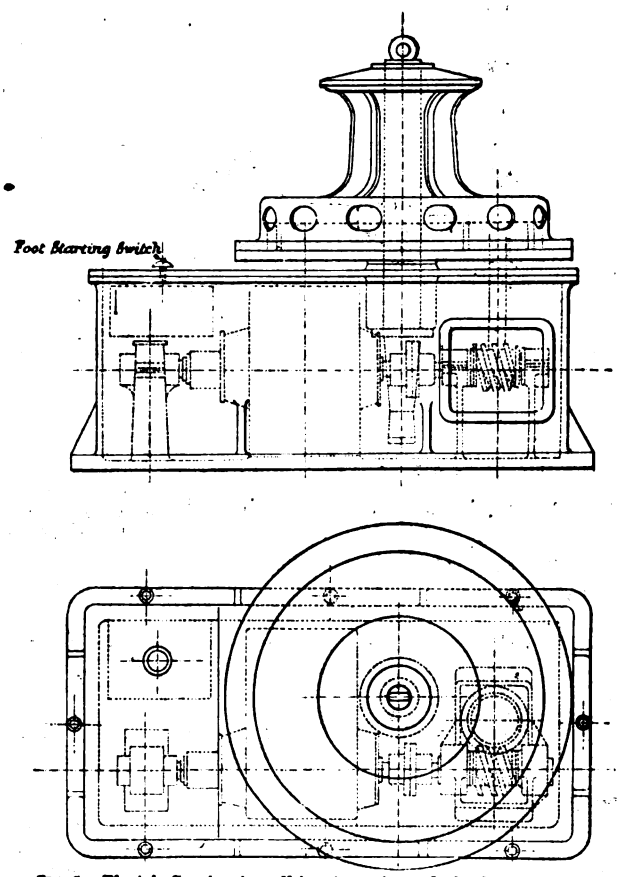

FIG. 5.—Electric Capstan to pull two tons at speed of 50ft. per minute.

There is no complication about this machine, and a boy may work it with ease and without possibly doing any danger to himself or the machine. It is encased in a watertight casing, and can be worked in the open. It can be constructed to lift any weight at any desired speed. In steelworks this winch is also of great use for such cases as the skull-breaker, and replaces

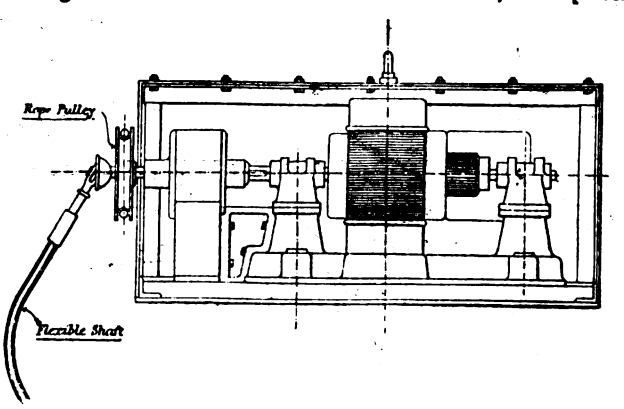

FIG. 6.—Enclosed Motor with Flexible Shaft for driving Portable Tools in a Shipyard, such as a Stern Tube-Boring Machine.

in most cases a special steam plant kept for the purpose. They take approximately 8 h.p. and 12 h.p. to 20 h.p., and are built to raise one, two, and five tons respectively. Fig. 5 is a view of an electric capstan, which in many cases is taking the place of hydraulic or steam capstans. The motor and the switching gear is in a strong watertight iron casing. The starting switch is worked by the foot, and is so constructed that on the foot being removed the capstan is stopped. Fig. 6 is also another

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very useful tool, it being an electric stern tube-boring machine. It has been specially constructed to meet the requirements of

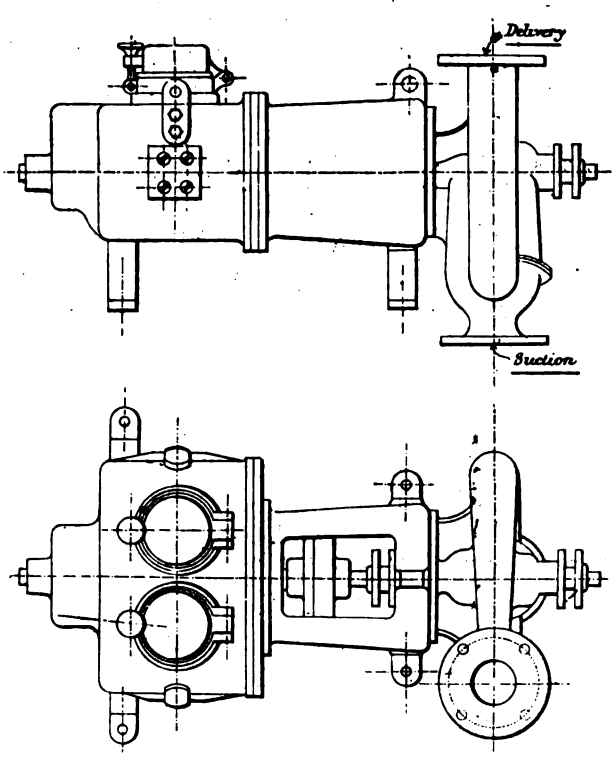

FIG 7.—Electric Centrifugal Pump.

shipyard work, and has been found to be of the greatest possible use. The speed between the motor shaft and the driving shaft in this machine is reduced by means of a patent reducing gear.

another very useful portable tool. This is an electric centrifugal pump and motor combined, which has been designed specially to meet the requirements of ships when under repair, to do pumping, such as emptying the ballast tanks when steam is off the boilers. If necessary, the combined pump and motor can be lowered into the hold of the ship. The set consists of a 3in. pump capable of discharging 60 gallons of water per minute against a head of 24ft., with a motor only weighing 7cwt. As the power taken is very small, the pump can be driven off existing lighting plants situated in the works. Fig. 8 is perhaps the most important portable electric tool which at present is used—*i.e.*, the portable drill. It advantages are too numerous to detail, but its application to various work hitherto inaccessible except by hand will at once appeal to the engineer.

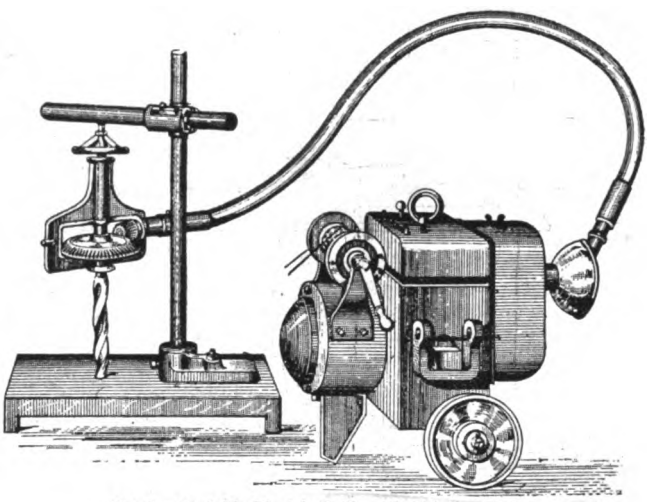

FIG. 8.—Portable Electric Drill, with 1½-b.h.p. Motor.

It can be constructed to drill almost any reasonable size of hole, and by means of the flexible shaft the drill may be placed in any position. To drill holes up to even 1¼in. diameter only takes a

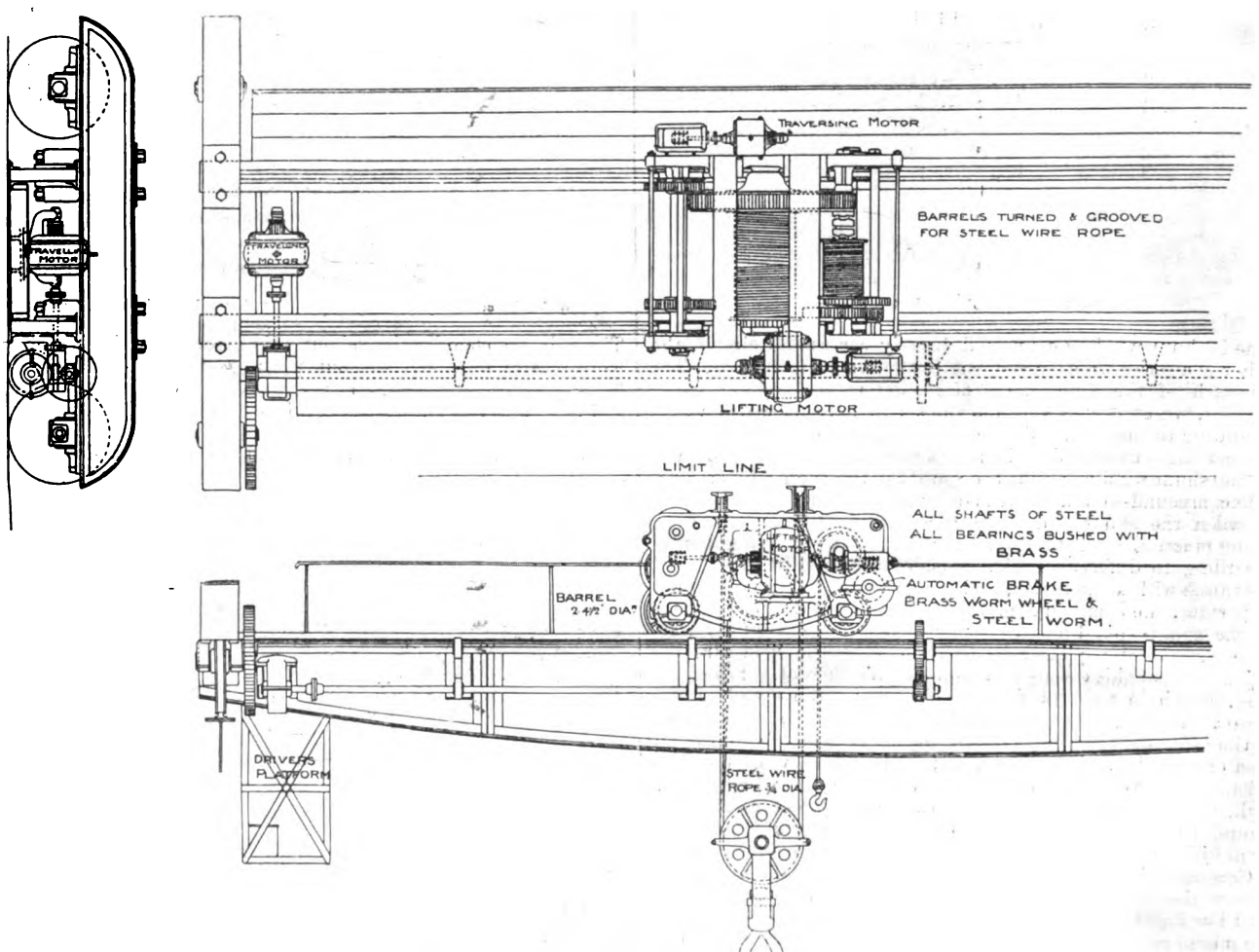

FIG. 9.—Plan and Sections of Overhead Travelling Crane.

It is fitted with a rope pulley outside the casing, this allowing it to be utilised for any handy purpose which may present itself. A flexible shafting is attached to the coupling at the end, from which a drill or other tool may be worked. Fig. 7 shows a motor of 1½ h.p., hence in many cases where a power plant is not at work, but where there is a lighting installation, they have been able to use these drills with very great improvement to the total output of the work and the decrease in its cost.

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There are numerous forms of electric drills and numerous special designs for special purposes, amongst these being a radial drill for slinging into the mouth of boiler furnaces, and for thus drilling the holes in position with great speed. The whole motor in this case swings from one fixed centre. The most approved pattern which is designed for overhead travelling cranes for loads above 30 tons is shown in Fig. 9. One of its great features is its silent working and its freedom from shocks and jars. The motors being series wound and controlled by means of resistance, allow the gearing to be reduced to a minimum, and the whole crane is in the perfect control of the man in the cage. This crane allows of very much greater speed in travelling than can possibly be attained by square shafting or rope drive, and the cost in working is also much less than that of any other method.

Most of the foregoing remarks may also be applied to the transmission of power by polyphase alternating currents; at least as far as the installing of the plant is concerned. However, it will be found that a polyphase installation in the average works holds no advantage over the continuous current; and, indeed, it has many drawbacks, the first costs also being much greater. Put a polyphase motor to drive a line shaft or a similar drive, and the results are almost perfect, but in practice considerable difficulties have to be overcome when driving machinery which requires to be continually reversing, or where the speeds have to vary. The necessary accessories, and the greater margin which has to be allowed in the powers, make the cost of such an application very nearly double that of continuous current, and that only to attain the same results.

As far as ordinary works—shipyards or engine works—are concerned, the perfection of continuous-current motors of to-day leaves little benefit to be derived from the fact that polyphase motors have no commutators. Care must be taken not to overload the polyphase motor, which must be designed for a power well above the work it has to do. This necessarily increases the size of the generators. Again, another important point is lost, as the generator must be designed at least equal to the total horse-power of the motors. For small powers the plant therefore becomes less economical, and the installation costs more throughout.

Practice has proved the ability of polyphase machinery to stand exceedingly rough usage, and where the nature of the works may be extremely dirty, and where it would be impossible to keep motors in the state which is necessary for the good running of continuous-current motors, polyphase motors will be found to give every satisfaction. The largest makers of polyphase machinery in America usually drive their overhead travelling cranes by continuous-current motors, and only the line shafting and similar drives with three-phase motors. If the power required to be generated is large—say two or three thousand horse-power—then the generator or generators should be of the polyphase type, as shown in Fig. 10. The simplicity of the design when the larger powers are reached allows of a material reduction in the cost in comparison with continuous-current dynamos of the same power. The current may easily be transformed to continuous current for lighting and crane work, this being the latest American practice. Polyphase currents since their introduction have opened up quite a new field for the engineer interested in long-distance transmissions, and when electric railways play a more important part in the traffic of our country, the transmission of power by means of polyphase electric currents will probably show decided advantages over the other system.

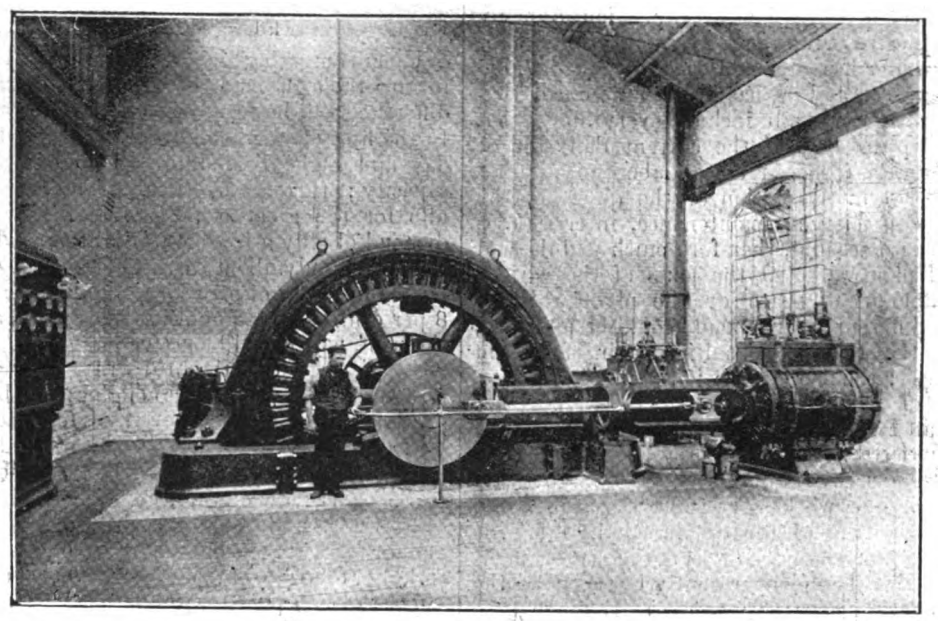


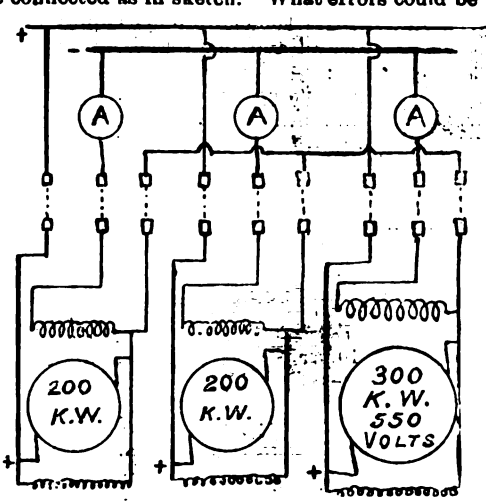
FIG 10.—Polyphase Generator.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

267. In a traction station three compound-wound generators are connected as in sketch. What errors could be made in



the records by having the ammeters connected as shown?—A. J.

268. Discuss the relative advantages of fuses and automatic cut-outs for high-tension work when large powers are being dealt with.—P. T.

ANSWERS.

Question No. 261.—This question, dealing with the testing of underground mains, has resulted in such poor answers that we have decided to delay publishing any of the same for another fortnight. Further answers will be received up to Tuesday, May 15.—ED. *E. E.*

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Question No. 262.—What would be the probable cost per kilowatt-hour of a continuous supply of electricity throughout the year to an electro-chemical process requiring, say, 2,000 kw. regularly, assuming that steam-engines are used and that coal costs 7s. 6d. per ton?

Best Answer to No. 262 (*awarded* 10*s.*).—This question is somewhat vague, and may be understood in various ways; for instance, it might be read to imply what is the actual cost of the fuel used per kilowatt-hour in generating 2,000 kw. continuously, or it may be intended to include coal and wages, or it may include coal, wages, rent, maintenance, etc. The expression "throughout the year" may also be construed as meaning throughout a year of 52 weeks of 54 hours each, or it may as equally well be construed to mean a year of 7,000 hours, which is the approximate annual number of hours worked when a plant is run day and night. The difference in the cost per kilowatt-hour in these various cases will be apparent even after a most superficial investigation of the question. As many carbide and other electro chemical processes are run without intermission, the writer has assumed that a year of 7,000 working hours is meant, and he has further assumed that the cost per kilowatt-hour shall include everything—that is, shall be the net prime cost of the current delivered at the terminals inside the furnace-room or laboratory.

Accepting such an interpretation of the question, the amounts due to depreciation, maintenance, interest, etc., must all be taken into account, therefore much will depend upon the type of plant adopted, the sizes of the various units, and the amount of spare or idle plant which is included. Many different arrangements could be proposed, and it is probable that no two consulting engineers would have the same ideas; the main dissension would be between a small number of large Corliss engines and multipolar dynamos and a larger number of small high-speed engines. The writer thinks that the best and most economical arrangement would be to have two large triple-expansion Corliss engines working at 180lb. steam pressure, and having the armature of the dynamo built upon the main crankshaft of the engine. (This is the arrangement which obtains in the new plant recently installed at the Manchester Corporation electricity works.) Each of these steam dynamo sets should be designed for continually developing 1,000 kw., but should be capable of giving, if necessary, 1,250 kw. without unduly heating, sparking, or giving other signs of being pushed beyond a safe working load. Two thousand kilowatts may be considered equal to 3,000 i.h.p., and to raise the steam necessary for this amount of power eight boilers, each 30ft. by 8ft., will be required. Three steam dynamos should be put down, so that any one may be stopped for repairs or alterations without interfering with the continuous supply of current.

Tabulating the cost of the plant and building we shall get results as follows:

Eight boilers, each 30ft. by 8ft., delivered and fixed, at £650	£5,200
Three steam dynamos, 1,000 kw. capacity, at £10,000	30,000
Chimney and foundations	2,000
Condensers, steam and exhaust pipes, etc.	2,800
Switchboard and leads	500
Building	2,000
	£42,500

Of this amount:

Depreciation will be 5 per cent.—viz.	£2,125
Interest will be 5 per cent.—viz.	2,125
Maintenance will be 10 per cent.—viz.	4,250
	£8,500

Dividing this amount by 14,000,000, the number of kilowatt-hours required per annum, we obtain 0·145d. as the amount which must be charged under this head per kilowatt-hour.

The question of rent, rates, and taxes must be next considered. Here again much will depend upon the situation. There will be vast difference in the amounts between a works situated in the centre of London and one in a small village. Hence, without definite information, we can only assume some amount—say, £500—to cover the rent, rates, and taxes of the boiler-house and generating station. The rent of the rest of the works does not enter into the question. This sum will be equivalent to a charge of 0·01d. per kilowatt-hour for an annual output of 14,000,000 kilowatt-hours. Salaries and wages will probably amount to £1,500 or £2,000 per annum. Taking the higher figure, this is equal to a charge of 0·04d. per kilowatt-hour. Oil, waste, and supplies will absorb £500 per annum, or 0·01d. per kilowatt-hour. A good Corliss engine will require 2lb. of coal per indicated horse-power hour, and, assuming an efficiency of only 7·5 per cent. for the combined plant (this is very low, and should certainly be not less than 8·0 per cent.), the coal required per electrical horse-power hour will be 2·66lb., or 3·2lb. per kilowatt-hour; and the price of coal being 7s. 6d. per ton, this is equivalent to a charge of 0·13d. per kilowatt-hour. Adding these amounts together, we obtain the total cost per kilowatt-hour.

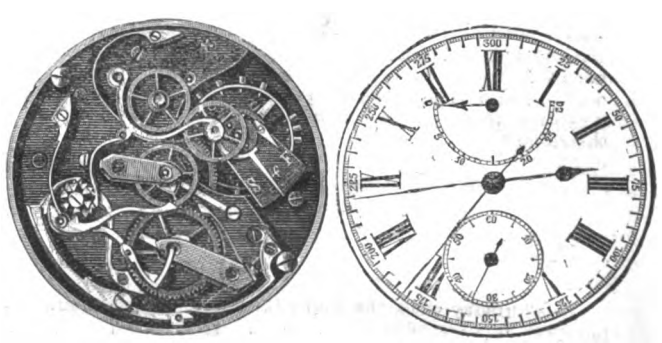
Depreciation, maintenance, interest	0·145d.
Rents, rates, taxes	0·01d.
Salaries and wages	0·04d.
Oil, waste, and supplies	0·01d.
Coal	0·13d.
Cost per kilowatt	0·335d.

Upon comparing the above figures with those published in the table of costs of the various undertakings, a vast difference will be seen, but this is very easy of explanation. In the first place, the above plant is working continuously day and night loaded up to 66·6 per cent. of its full capacity; this means that there is no costly plant lying idle for the greatest part of each day with a maximum demand of only a few hours' duration, and even the greatest demand is only about some 30 per cent. of its full capacity on the majority of occasions, the average load being about 8 per cent. What applies to the plant applies equally to the staff, which will be actively engaged in two shifts the whole time. Since the load will be constant there will be no fires banked up, and no engines and boilers ready to be thrown into work when required for emergency loads.

If 54 hours a week only are worked, the wage charge per kilowatt-hour will be a little higher, the coal charge will also, as shown above, be higher, while the charge for rent, rates, and taxes will be more than doubled. The amount put down for depreciation may be taken as a sinking fund to entirely replace the plant in 20 years, while the sum put down for maintenance should be ample to cover any wear and tear and to pay the premium to insure against breakdown.—M.

NON-MAGNETIC WATCHES.

The accompanying illustrations show the movement and dial of a new non-magnetic chronograph manufactured by Messrs. A. and J. Smith, of 191, Union-street, Aberdeen, and referred to in our columns last week. The non-magnetic properties of



this chronograph are obtained in the same manner as by the firm's ordinary non-magnetic watches, the principle of which was described in the notice in question. In the chronograph illustrated herewith the minutes are recorded from 1 to 30 in a half circle. The new features of this half-circle arrangement is that one tooth is left out of the minute recording wheel, which causes the recording action to stop when the small hand reaches the figure "30" at the end of the semi-circle, and this action only takes place again when the hand is brought back to the start, by pressing twice on the winding button, the recording action thus remaining stationary at the end of 30 minutes, although the chronograph hand is still working. It is claimed, amongst other advantages, that this arrangement reduces the possibilities and causes of stoppage, which in a minute chronograph generally arise from the minute recording wheel when in action. For price we would refer the reader back to our issue of last week.

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PHYSICAL SOCIETY.

At an ordinary meeting, held by the invitation of Sir Norman Lockyer, F.R.S., in the Solar Physics Observatory, South Kensington, on Friday last,

Sir Norman Lockyer gave "A Short Account of the Physical Problems now being Investigated at the Solar Physics Observatory, and their Astronomical Applications." The chief work carried on at the observatory is the comparison of stellar spectra with spectra obtained from lights emitted by laboratory sources. The light from a star (or the sun) and from an arc (or a spark) are focussed alternately upon the slit of a spectroscope, and the two spectra are photographed side by side upon the same plate. The number of lines in the arc spectrum depends upon which part of the arc is focussed on the slit. The image of the centre is rich in lines; the image of the edge gives a few single lines. Changes in spectra are also dealt with. The thickening and thinning of lines depends upon several things. In the first place, it depends upon the density of the substance, and thus the hydrogen lines in the spectrum of Sirius are much broader than those in α Cygni, the hydrogen being denser in the former star. Changes may also be produced by variations in quantity. A reduction in the quantity of a substance generally simplifies its spectrum, the longest line disappearing last. The motion of a luminous body to or from the spectroscope alters the wave length of the light emitted, and produces a shift in the lines of the spectrum. The amount of deviation is a measure of the velocity of approach. In the case of Nova Aurigae we have dark and bright lines of the same substance side by side. This shows that there are two bodies involved, moving with different velocities, the one giving a radiation and the other an absorption spectrum. Another change in the lines depends upon temperature. In general, an increase in temperature produces a greater number of lines, a notable exception being sodium, which gives its full number of lines at the temperature of an ordinary Bunsen flame. The spectra of metals obtained from the arc and by sparking are often quite different. Those lines which make their appearance or are intensified in passing from the arc to the higher temperature of the spark are known as enhanced lines. The comparison of stellar spectra with laboratory spectra is often easy. For instance, the presence of iron in the sun and hydrogen in Sirius is easily seen. Several lines in the spectrum of Bellatrix have been shown to be due to helium, the position of the lines being exactly the same as those due to the gases from clevite. In many cases it is possible to build up the spectrum of a star from the spectra of its constituents taken at the proper temperatures. For instance, the spectrum of γ Orionis can be closely imitated by means of oxygen, nitrogen, and carbon, together with the well-marked lines of hydrogen and helium. We can roughly estimate, by the character of the spectra of stars, the temperature of those stars, and thus arrive at a stellar thermometry. Starting with a hot star like Bellatrix, and passing through β Persei, γ Lyrae, Sirius, Castor, Procyon, to Arcturus, a cold star, we have a gradual change in the character of the lines which appear in the spectrum of any constituent. The widening of the lines in the case of spectra of sun spots enables us to trace changes in temperature of the sun, and we can compare these temperature changes with a variety of terrestrial phenomena, such as variation in latitude. The extraordinary number of lines exhibited by many metals suggests that what we are accustomed to call chemical elements are really complex bodies, which are made up of simpler ones. Attempts have been made to build up the spectra of metals by superimposing simple sets of lines upon one another. In many cases a great number of series would be required to represent things completely. In the case of hydrogen it would be necessary to have at least 27 series to give the structure spectrum only. Taking the atomic weight of hydrogen as unity, the atomic weight of the little masses which might give rise to any one of the series would be about ·0019. This is of the order of magnitude of the small bodies whose existence has been suggested by Prof. J. J. Thomson from his work on ions.

THE LONDON COUNTY COUNCIL TRAMWAYS

On Thursday week the Light Railway Commissioners, after a lengthy enquiry, decided to reject all the proposals of the London County Council for the construction of light railways within the suburban districts. The applications for powers included the following: a line from Clapham Common to Kingston; a line from Deptford, by Shooter's Hill, to Woolwich; a line from New Cross, by Lewisham, to Eltham; from Archway Tavern, Highgate, to the county boundary. The line from Deptford to Woolwich was first considered.

The Commissioners for the enquiry were the Earl of Jersey, Mr. G. H. Fitzgerald, and Colonel Boughy. The applications were opposed by the Lewisham District Board of Works and the Lee District Board, and also by the South-Eastern and Chatham and Dover Railways. The gas and water companies in the districts were also represented by counsel, and the frontagers whose houses abutted on the proposed lines as well.

The evidence given by Mr. J. W. BENN, the chairman of the Highways Committee of the London County Council, was to the effect that increased facilities for locomotion were required in the district, and that the schemes now before the Commissioners were arranged with the object of providing these facilities. With respect to the section from Deptford to Woolwich, they proposed to run a five minutes' service of tramways, when a profit on the section of about £2,300 was expected. The average car mile was likely to produce 11d., and to cost about 6d. He said that the scheme would be a most valuable one to the Lewisham district, where were no less than 4,800 acres of good building land.

In answer to a cross-examination by Mr. Balfour Browne, Mr. Benn stated that the tramways were at present yielding nearly £80,000 per year profit. The Highways Committee had decided to promote the present schemes under the Light Railway Act, as in that way they thought they would avoid some of the difficulties of the Tramway Act. They would have no objection as to reducing the time for the completion of the works from four years to two years. With respect to the action of the local authorities, he considered that they were not unduly to squeeze the Council as they had squeezed the tramway companies in the past.

Mr. C. A. CRIPPS, Q.C., representing the London County Council, stated that the Council was the only public authority who could deal with the tramways and at the same time carry out the street improvements required for these tramways and other general purposes. He considered that the Council had taken the right course in going to Parliament for powers to make the street improvements and widenings necessary, and coming before the Commissioners for the powers to construct the tramways. In order to act fairly to the districts, they had inserted clauses which provided that they should not use the light railway order until the street improvements were carried out.

The CHAIRMAN of the Light Railway Commissioners then gave his opinion that while the street widenings were quite necessary to the scheme, they were not to be carried out under the procedure of the Light Railway Act. He thought that the course taken was an infringement of the provisions of the Act, and that the land ought to have been taken under the Lands Clauses Act. The proposal now submitted to them was incomplete, as part of the necessary work had been submitted to Parliament and was not yet sanctioned.

The Commissioners were accordingly asked by Mr. CRIPPS to adjourn the enquiry until the parliamentary Bill had passed, but was refused permission, and the CHAIRMAN indicated that all the four orders applied for would be rejected on the same grounds.

We may add that if these lines had been carried out, the cars were to have been propelled electrically on the conduit system. The above decision is an important one, but a close reading of the evidence shows that the procedure of the London County Council was distinctly informal, and that a premature decision on the one half of the scheme would have been used as a strong lever to force Parliament to pass the other half. In any undertaking involving such a large expenditure as the above it is only right that the matter should be considered as a whole by either the Board of Trade or by Parliament. As, under the Light Railway Act, applications can be made every six months, the above decision does not necessarily delay the tramways in the districts mentioned by any considerable period provided parliamentary sanction to the widening of the streets is really granted.

CARDIFF.

On Tuesday two reports were presented by the electrical engineer to the Lighting Committee of the County Council.

In the original report, the *South Wales Daily News* says, Mr. N. Appelbee points to the progress made by the department. He quotes statistics which show that the growth during the year which has just ended has been very marked, and that notwithstanding all that has been said about the electric light being poor. The amount of new private lamps connected—and this, he says, may be taken as representative of the confidence or otherwise of the ratepayers—has shown an increase equal to the increase of the two preceding years put together. During the past year the Corporation sold 509,000 units, while in the preceding year they sold but 405,000 units, which represents an increase of business of 25 per cent. Dealing with the financial side of the lighting work, the engineer points to the fact that the charge in Cardiff for the public lighting is less than in many large towns—less, for example, than in Bristol. In fact, it is one of the lowest rates charged anywhere. Notwithstanding this fact, however, the following are the figures for the past few years: year ending 1896, deficit £2,200; year ending 1897, deficit £1,700; year ending 1898, surplus £65. At the end of 1898 the Lighting Committee decided to reduce the price and provide light to consumers at 25 per cent. less cost. The result of this was that in 1899 there was a deficit of £1,000. As to the price of electricity to the private consumer, the electrical engineer shows that it is not as high as at Newport. The Cardiff price for 1898 was 4·6d. per unit, and at Newport the same year it was just over 5½d., while for the fifth year of working in Cardiff it was 4½d. per unit. The engineer goes on to show the com-

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mittee that with the total lamps now being connected the present station will be fully occupied in 2½ or 3 years' time. He urges that it is time for them to consider the question more fully than that of just ordering enough plant for next year. Since Cardiff obtained powers for its electric lighting works the Board of Trade conditions under which the supply can be given have been very materially improved, and the improvements are of a nature which very much assist the other great system of supply. The Cardiff system is, of course, the high-pressure alternating current. The advantage of this is that power can be distributed over a relatively larger area than by the low-pressure continuous-current system, which is suitable for supplying the current over smaller areas. The revised conditions enable the low-pressure continuous-current system to be used for very much greater areas than was practicable formerly. Mr. Appelbee recommends the committee to build a new station, and not to build any more on the present site. He recommends, further, that the low-pressure system be adopted at the new station, which should be in some central position. He proposes that the lighting of the central area be changed on to the new system, and that the present system be used for lighting the extremities of the borough. The machines to be laid down at the new central station would give identically the same electrical energy in quantity and pressure as would be used for the tramways. Dealing with the question of systems, the engineer points to the fact that in Edinburgh the authorities started, on the recommendation of Mr. Kennedy, with two systems in one station, and that in 1898, before they had built a new station with the low-pressure system, they had discarded their high-pressure system altogether. Another case quoted, to show how the opinion of experts has changed, is Swansea. In 1894 Mr. Manville advised them to do what Mr. Massey advised for Cardiff, but Mr. Manville's last report shows that he has completely changed, and he now says that a low-pressure system for the area will be a good deal better than the high-pressure system.

The supplementary report deals with the question of the price at which energy can be supplied to the Tramways Committee. The latter body have not given any idea as to the amount of energy that will be required. They have only stated how many miles of tramway there will be, so that the electrical engineer has based his calculations on what may be regarded as a good average service. He estimates that the cost of the tramways must not exceed £261,000. He estimates that the cost of construction will be about £223,000 without land, and would leave about £40,000 for land. Dealing with the question of receipts per car mile, he quotes the fact that in Glasgow they are as high as 1s. 2d. per car mile, and in Leeds about 1s. per mile. He takes as a basis in Cardiff 10d. per car mile, and calculates that that will produce a revenue of £100,000 to £120,000 per annum. Now loan charges on the capital exclusive of lands will be something like £14,000 or £16,000, and there will be a balance of over £100,000 to meet the working expenses and any surplus for profits. He quoted Mr. Robinson, the managing director of the London United Tramways and the Bristol and Middlesbrough tramways, who says that working expenses should be about 5d. per car per mile, and on that estimate of 5d. Mr. Appelbee calculates that it will cost the Tramways Committee, supposing they generate power themselves, ·997d. per car mile. This is practically 1d. per unit, which is, roughly, the amount of energy used per mile. If Mr. Robinson's figures are correct, Mr. Appelbee says in the report that he cannot see why they should not run cars at 5½d. per car mile. If they do this there will be a surplus of something like £40,000. If 1½d. be the price per unit, there is no question about the Lighting Committee being able to make a profit and the Tramway Committee a huge surplus. The engineer shows the real position of affairs at Hull, where power was stated to be provided at ½d. per unit, while it was stated that it could be done in Leeds for ·6d. per unit. The figures on being examined showed that they did not include engineers' salaries, rent, rates or taxes, or manager's expense or insurance, and that all these things added in brought the cost up to 1·34d. per unit! In conclusion, Mr. Appelbee refers, evidently in reply to a statement by the chairman of the Tramway Committee, to the effect that the present station and staff were totally unsuitable to supplying electric energy for traction purposes, and states that the electrical engineers who manage the tramways at Liverpool, Plymouth, Bradford, Bolton, Southampton, Willesden, Manchester, Hull, Halifax, Blackpool, Birkenhead, Derby, and Sunderland are all engineers who learned their profession in electric lighting works, and who are now managing the supply of electrical energy both for lighting and traction purposes.

A long discussion ensued, during which it was stated that the department now made a profit on the private lighting, but on the public lighting there was a deficit, and there always would be at the present rate. It was proposed that the public lights be charged for at cost price, but upon Mr. Appelbee stating that he thought the adoption of the continuous current would reduce the cost, the motion was withdrawn. A further discussion ensued on the recommendation of the engineer that more machinery be secured. Finally, the engineer was requested to report as to whether he could satisfactorily run a continuous-current engine in the present station. As this would to a degree govern the matter of a new station, the consideration of the latter was deferred. As the report requested would also have an important bearing upon the report dealing with the feasibility of the Lighting Committee supplying the energy for tramway traction, the consideration of the latter was deferred also.

LEGAL INTELLIGENCE.

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED, v. MAYOR AND CORPORATION OF LONDON.

This was an action brought last week in the Lord Chancellor's Court before Mr. Justice Farwell, in which the City of London Company pursued the defendants for the non-performance of contracts entered into by the Commissioners of Sewers, and taken over by the Corporation, respecting the lighting of the City. The defendants' contention was that the contracts were void owing to the fact that members of the Corporation were shareholders in the plaintiff company.

In giving judgment on the case, **Mr. Justice Farwell** stated that the City had been lighted under the contracts in question since 1891, but that last year the defendants repudiated the contracts. He then read out the various sections dealing with these contracts, which stated that such contracts should be in writing, should specify what work was to be done, and what parish the work was to be done in, and the penalty incurred by the non-performance of the contracts. The Act provided that the Commissioners were not personally liable for such contracts, and it also provided that any person being a commissioner or member of the Court of Aldermen, etc., and also being a shareholder in a company should not take any part in the placing of any contract with such a company. If such should be the case such contract should be null and void, and, in fact, there would never have been any such contract. It was admitted by both sides that at the date of the contract seven Commissioners were shareholders in the company, but there was no evidence to show that any of these took part in the making of the contract, and he preferred to think they did not. The defendants stated that such a commissioner took part in the formation of the contract and rendered it null and void. In this connection he quoted cases to show that where there were two courses open to the Court to choose from, they must choose the most reasonable of the two. He had therefore to see whether the contract was open to any other construction. There was one which applied to works or materials supplied to the City, which should become their own property. There was the supply of water, gas, or other illuminant for lighting the City. The first of these was out of the question, but there were certain sections which enabled the Commissioners to contract for the supply of water or gas, or other illuminant, in the City, these stating that such contracting company must be compelled to give a public supply. There was a section which provided for certain commissioners executing on behalf of the Commissioners themselves, contracts which must afterwards be performed by the contracting parties. The contracts for the supply of material and for work to be done were, in his opinion, quite distinct. It had been said that the contracts were construction contracts. This was not so. They were contracts only for the lighting in the City, and were for powers given under the Electric Lighting Act, the requirements really being the regulation and efficiency of the supply. The mere fact that the defendants had the option of purchasing the plaintiffs' undertaking did not make the contracts construction contracts. If a commissioner, who was also unknown to both parties, was a shareholder in the company at the time of the contract, this was held to be null and void. But at the time of the contract there were 91 commissioners and more than 200 common councillors, and if one of these, who, unknown to both parties held a share in the company, took part in the making of the contract, it would therefore become null and void. This cause might even prohibit the making of contracts with any such companies, and thus the supply of water, gas, or light in the City. Again, assuming that the company had spent a large amount of money on the faith of the contract, it could not be right that all this should be lost owing to the bad faith of a third party. He therefore declared that the defendants should pay the costs of the action.

ACTION BY AN ELECTRICAL ENGINEER.

In the Westminster County Court last week his Honour Judge Lumley Smith, Q.C., tried the case of White *v.* Lloyd, in which the plaintiff, an electrical engineer carrying on business at 9, Mill-street, Hanover-square, sued the defendant to recover the sum of £7 in respect of electrical work done to the defendant's order.

The Plaintiff was called, and said his contract was to supply and fix 16 lights for the sum of £7. 10s., but it was afterwards agreed that only 12 lights should be put up, and he had allowed the defendant 12s. in respect of the four lights.

Cross-examined, he denied that when he gave the estimate for the work he told the defendant that he would have to pay £2. 10s. out of his contract money to the Westminster Electric Supply Corporation. The work was thoroughly well done, and the charges were fair and reasonable.

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The **Defendant** was called, and said that when he gave the order for the work he told the plaintiff that his charges were rather high, but the latter said he would have to pay £2. 10s. to the Westminster Supply Corporation for connecting the current. As a matter of fact the work was badly done, and owing to the defective insulation the wires were fused, and the lights were practically worthless.

Mr. Payne, an electrical engineer, of Catherine-street, Strand, said he had examined the work, and thought the charges were excessive considering the way in which it had been carried out.

In giving judgment, his **Honour** said he was satisfied that there was a bargain for £7, and he was not satisfied that the work was badly done; therefore judgment would be for the plaintiff for the amount claimed, with costs.

BREAKING UP ROADWAYS.

The National Telephone Company were summoned at Southwark last week, before Mr. Paul Taylor, at the instance of the Vestry of St. George-the-Martyr, Southwark, for breaking up and opening the pavement in Marshalsea-road, Borough, for the purpose of laying mains and pipes, without having previously given three days' notice.

Mr. Johnson, vestry clerk, stated that since the issue of the summons the defendant company had written to the Vestry to the effect that the wires were laid without the knowledge of the senior official. The company placed themselves in the hands of the Vestry, and subsequently agreed to pay the Vestry £10 a year in consideration of these wires being under the pavement. He was accordingly instructed to withdraw the summons.

ROBBING THE PLYMOUTH CORPORATION.

Samuel Honeycombe (lumper), Henry J. Norman (labourer), and Richard J. Gray (labourer), were charged at Plymouth police court last week with stealing about 2cwt. of iron from the back of the electrical works, Prince Rock, the property of the Plymouth Corporation. It was stated that the iron was placed in the open roadway where new rails were being laid. Prisoners were sent to gaol for 10 days with hard labour.

ATTEMPTED ARSON.

Christian Maddock, an electrical wireman at the Silvertown India Rubber and Gutta Percha Works, was charged at the West Ham police court on Saturday with attempting to set fire to a building belonging to his employers. The allegation against the prisoner, who had been engaged at the works for four months, was that he went into the pattern room and poured a quantity of methylated spirits into a pattern shaped like a saucer. Being detected in the act, he was arrested, and the pattern, overturned, was found to contain a trimmed candle, stuck in a piece of wood, partially covered by cotton waste, saturated in methylated spirit. An uncorked bottle containing similar spirit was lying on the waste. The case was adjourned.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Burnley.—The Corporation invite tenders for cables. Tenders by May 14.

Salford. — The Corporation invite tenders for cables and accumulators. Tenders by May 7.

Tunbridge Wells.—The Corporation invite offers for a number of Shallenberger (Westinghouse) 1897 pattern ampere-hour meters. Details in our advertisement columns.

Wimbledon.—The Urban District Council invite tenders for the erection of additions to the electricity generating station, Durnsford-road, Wimbledon. Tenders by May 15.

London, E.C.—The Directors of the Great Eastern Railway Company invite tenders for the supply of stores and materials. Tenders by May 8. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for creosoted poles, oak arms insulators, and ironwork used in telephone construction Tenders by May 16. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for indiarubber-covered and lead-covered branch cables and carbons for one year. Tenders by May 19. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the construction and delivery of two steam-engines and two dynamos of 1,000 kw. capacity each for their electricity works, Valley-road. Tenders by May 24. Details in our advertisement columns.

Crewe.—The Town Council invite tenders for the wiring of the municipal offices, market hall, and corn exchange, and for supplying lamps and fittings for electrically lighting the same. Tenders by June 11. Details in our advertisement columns.

King's Lynn.—The Corporation invite tenders for the supply and erection of the following plant: steam dynamos, Lancashire boiler, economiser, condenser, pipes, etc., switchboard, and cables (supply only). Tenders by May 17. Particulars in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for two or three (at the option of the committee) 630-kw. two-phase generators; and one or two (at the option of the committee) sets of surface-condensing plant. Tenders by May 28. Details in our advertisement columns

London.—The Streets Committee of the Corporation of London invite proposals from firms or persons experienced in the manufacture and use of electric motorcars for the hire of an electrically-driven dustcart. Tenders by June 1. Full particulars in our advertisement columns.

Paddington.—The Vestry invite tenders for the execution of sundry works required to be done in certain alterations to the existing electric lighting arrangements at the public baths, Queen's-road, Bayswater, W. Tenders by May 14. Particulars in our advertisement columns.

Manchester.—The Tramways Committee invite tenders for the supply of (*a*) 150 car trucks, (*b*) tramway bonds, (*c*) special track work and points and crossings. Specifications, etc., may be obtained from Mr. J. M. M'Elroy, general manager, Tramways Department, Town Hall, Manchester. Tenders by May 7.

Bradford.—The School Board invite tenders for the electric light installation at Carlton-street School. Specifications may be obtained from Mr. A. H. Gibbings, electrical engineer, Old Bank-chambers, Cheapside, on payment of £1. 1s., which amount will be returned on receipt of a bona fide tender. Tenders by 12 noon on 7th inst.

Heywood.—The Corporation invite tenders for the supply and erection of Lancashire boilers, economiser, pipe work, feed pumps, two steam dynamos, balancer booster, travelling crane, storage batteries, switchboard connections and station lighting, underground mains and feeders, and meters. Tenders by May 14. Particulars in our advertisement columns.

Rhyl.—The Urban District Council invite tenders for the supply and erection of—boiler-house plant: water-tube boiler, fittings, steam and exhaust pipes, etc.; engine-house plant: steam dynamos, pumps, etc.; switchboard, etc.; underground mains lamp-posts, etc.; accumulators, meters, crane, etc. Tenders by May 14. Details in our advertisement columns.

Worksop.—The Urban District Council invite tenders for steam dynamos, balancers, boosters, and motors. Lancashire boilers, steam, exhaust, feed-water and condensing-water pipes, fuel economiser, condenser, and feed pumps, switchboard, accumulators, cables, joint boxes, arc lamps and posts, and overhead travelling crane. Tenders by May 23 Details in our advertisement columns.

London, W.—The Central Electric Supply Company, Limited, invite tenders for the supply, delivery, and erection of two 1,200 i.h.p. Willans engines, each direct coupled to a three-phase H.T. generator; six three-phase H.T. motors, each direct coupled to a L.T. continuous-current generator; and switchboards and connections for above plant. Tenders by May 22 Details in our advertisement columns.

Rochdale.—The Gas Committee invite tenders for the wiring of the electric lighting station and offices. Copies of the specification may be obtained on application to Mr. T. Banbury Ball, Gasworks, on payment of £1. 1s., which will be returned on receipt of a bona fide tender. Tenders, endorsed "Wiring, etc.," must be sent to Mr. James Leach, town clerk, Town Hall, Rochdale, by noon on 9th inst.

Perth.—The Commissioners invite tenders for the supply and erection of 45 enclosed arc lamps and ornamental cast-iron and steel pillars, with switch gear, etc., complete. Persons tendering are to tender for the complete section, but not for part of above section. Specification, etc., may be obtained from Mr. John Begg, clerk, City Chambers, Perth, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders by 12 noon on May 7.

Mariupol.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Taganrog stating that tenders are invited by the Municipality of Mariupol not later than May 16 (29) for the construction and exploitation of an electric tramway and the installation of electric light in that town. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

West Ham.—The Guardians of West Ham Union invite tenders for the execution of the following separate contracts: (1) supplying and laying cables and wiring the buildings and premises, and supplying and fixing the lamps, switches, and all other necessary fittings complete in accordance with a schedule of lights, which may be inspected at the Clerk's Office, Union Workhouse, Leytonstone; (2) supplying and erecting the plant complete, including storage battery, switchboard, instruments, and engines and dynamos in duplicate, of a specified power, particulars of which may be obtained upon personal application at the Clerk's Office aforementioned. Tenders by May 16.

Barking. — The Urban District Council invite tenders as follows: (Contract No. 1) for the supply, construction, and erection of about 365 tons of cast iron and 235 tons of steel in an opening bridge over Barking Creek, 45ft. in clear opening, and to carry a double line of railway, together with two shore spans of 45ft. each, and the embanked approaches, and with all the electrical and other machinery and appliances incidental thereto and required for opening and closing the bridge by electrical power supplied from the generating station of the Council; (No. 2.) the construction of 73 chains of 3ft. 6in. gauge single-line railway (83lb. tramway rails) and 38 chains of double-line railway, with granite sett paving on concrete, electrical rail bonding, etc. Tenders before 12 noon on May 7.

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RESULTS OF TENDERS.

Bradford.—The Town Council have accepted the tender of Mr. W. Farnish, at £2,255, for constructing a brick chimney, 200ft. in height, at the electricity works.

Merthyr Tydfil.—The Hart Accumulator Company, Limited, Marshgate-lane, Stratford, E., have secured the contract for the supply of storage batteries to be used at the Penydaren central supply station.

Northumberland County Lunatic Asylum.—Thirty-one tenders have been received for the electric lighting of the above, to the specification of Mr. A. A. Campbell Swinton, M.I.C.E. The Visiting Committee will consider Mr. Swinton's report on the tenders at their meeting on May 21.

Newcastle.—The City Council have sealed a contract with Mr. Nuttall for supplying and laying ducts for electric wires along the tramways being constructed by him, and accepted the following tenders: Higginbottom and Mannock, cranes; Swinney Bros., Morpeth, iron and steel work in connection with tramcar sheds at Byker; Vaughan and Dymond, Newcastle, iron and steel work in connection with the power station at the Manors.

Dundee.—The Tramways Committee have accepted the contract of Messrs. Lowdon Bros. and Co., Dundee, for the traction switchboard in connection with the new electrical station, at a sum exceeding £1,000. With regard to the distribution mains that are to run along the tramway routes, the contracts have been secured by the British Insulated Wire Company, Prescot, at a sum exceeding £8,000, and the section for the ordinary town extensions has been obtained by the Callender Cable Construction Company, Limited, London, at a cost of over £2,000.

London, E.—The Electrical Power Storage Company, Limited, have received the following tenders for new stores at Millwall:

Bulled and Co.	£1,075
W. Mills	919
Watts, Johnston, and Co.	793
Jerrard and Sons	789
T. D. Leng	745
H. Groves	739
W. Martin (accepted)	712

Southampton.—The Harbour Board have received the following tenders for supplying and fixing a motor-transformer, with accessories, upon the premises, Town Quay, Southampton:

Edison-Swan Company, Limited, London	£1,145
T. Scott Anderson and Co., Sheffield	1,140
General Electric Company, Salford	1,029
T. Barton, Blackburn	990
Crompton and Co., Chelmsford	976
Brush Company, London	950
Electric Construction Company, Wolverhampton	934
Shalders and Davis, Southampton	930
Richardson and Sons, Hartlepool	870
Siemens Bros. and Co., Woolwich	860
Bruce Peebles and Co., Edinburgh	830
T. Parker, Limited, Wolverhampton	694
British Schuckert Company, London (accepted)	690

Electrical engineer's estimate, £785.

BUSINESS NOTES.

TRACTION.

Nelson.—The Town Council intend to oppose the Burnley Corporation Tramways Bill.

Paisley.—The Town Council on Tuesday agreed to Mr. Murphy's amended tramway proposals.

Twickenham.—The Council have sealed a supplemental agreement with the London United Tramways, Limited.

Halifax.—The Cote-hill section will be the first of the new lines which are to be constructed during the coming summer.

Clayton.—The draft agreement with the Bradford Corporation for tramways through Clayton Heights has been approved by the District Council.

Mansfield.—The Council have decided to grant a deputation of the promoters of the electrical tramways scheme an interview at the next meeting.

Birmingham.—The City Council on Monday approved of the proposals of the City of Birmingham Tramways Company for the equipment of the Bristol-road tramways with the electric overhead system.

Teddington.—The District Council's petition against the United Tramways (Extension) Bill will now be withdrawn, the terms of an agreement having been settled between the Council and the company's representatives.

Brussels-Antwerp Electric Railway.—The Brussels correspondent of the *Daily Chronicle* telegraphs that the Committee of the Belgian Chamber has by four votes to three rejected the Bill for the proposed electric railway from Brussels to Antwerp.

Leith.—It has now been decided that a plebiscite be taken with regard to the proposed purchase of the tramways. Mr. W. A. Bryson has resigned his position as resident electrical engineer for the burgh. The question of his services being retained as consulting engineer has been remitted to the Electric Lighting Committee.

Bradford.—It is reported that in about two months a commencement will be made with the construction of the section of the electric tramways, commencing at Four Lane Ends, which is to be carried to near the goods entrance to the Great Northern Railway Station at Thornton.

Wolverhampton.—On May 1 the Corporation took over the tramways within the borough. With regard to the lines outside the borough (Willenhall and Bilston) we learn that strenuous efforts are still being made to come to an arrangement with the Electric Traction Company, but no terms acceptable to the Corporation have so far been proposed.

Grimsby.—The petition of the Grimsby Corporation against the tramway company's Bill came on for hearing before a committee of the House of Lords on Wednesday. The Corporation was represented by Mr. Baggallay, Q.C., and Mr. G. A. R. Fitzgerald, barrister-at-law. Messrs. Loch and Co. are the parliamentary agents for the Corporation.

Salford.—Last week the first trolley pole in connection with the new system of electric tramways and of electric lighting in Salford was fixed almost at the Regent-road end of Cross-lane by the Mayor (Alderman S. Rudman). An adjournment was afterwards made to the Cattle Market Hotel, where a number of speeches was made. Councillor Williams (chairman of the Works Sub-Committee) presided.

Liverpool Overhead Railway Co.—The last number of the *London Gazette* contains the notice of this Company of intention to apply to Parliament for leave to introduce into their Bill now pending before the House of Lords additional provision to empower the Company, with the consent of the Mersey Docks and Harbour Board, to transform the dock railways into an electrical line, work same by electricity, erect generating stations, etc.

Hampton Hill.—At a recent ticket meeting of electors, resolutions were passed (1) approving of having a tramway as proposed, provided the terms are of a satisfactory character; and (2) expressing an opinion that the power to purchase as given by the Act of 1870 is absolutely necessary, and should be insisted upon; and that the necessary street widening should be carried out at the expense of the tramway company, as recommended by the surveyor.

Liverpool.—The great development of tramcar building in Liverpool caused by the adoption of electricity as the motive power has rendered necessary an extension of the Lambeth-road carriage works of the Corporation. At the meeting of the City Council on Wednesday the Tramways Committee recommended the purchase of two freehold plots of land with buildings to make the necessary extension. The total amount asked for that purpose is £3,500.

Kendal.—At a recent meeting of the Corporation the Town Clerk stated that he had sent to Messrs. Handcock and Dykes the resolutions recently passed by the General Purposes Committee, with a request to inform him whether they thought the resolutions showed sufficient common ground between the Corporation and the Light Railway and Electric Syndicate to render an interview desirable. To this he had received a reply that Messrs. Handcock and Dykes were of opinion that an interview was desirable.

London's Electric Railways.—Sir Ughtred Kay-Shuttleworth's Select Committee of the House of Commons had before them on Monday the Bill for extending the authorised Baker-street and Waterloo Railway from Baker-street to Paddington at the one end, and from Waterloo to the Elephant and Castle at the other. The original capital was £1,766,000, and it is now proposed to raise £1,000,000, and to ask also for £333,000 of borrowing powers. The principal opposition comes from the Metropolitan Railway Company.

Leeds.—The laying of rails on the section of the electric tramways to Burley, *vid* Park-lane, is being proceeded with at a good rate. When the whole work is finished, it will be possible to take a tramcar direct to the Headingley cricket ground. A local paper says: "Before the Leeds Tramway Committee can construct a tramway to serve Wortley *vid* Oldfield-lane, that thoroughfare will have to be widened; but before that can be accomplished there are bridges to be altered, so, with a view to thus clearing the way, the Great Northern Railway Company is being communicated with.'

Cleckheaton.—The Board of Trade has issued an electric lighting order upon the Council's application. The applications of the Bradford Corporation, the North Bierley Gas Company, and the British Electric Traction Company for special protective clauses have failed. An agreement has been completed with the British Electric Traction Company, whereby the company undertake to take electrical energy from the Council. The period of the purchase clause has been left to be fixed by the Light Railway Commissioners, with the proviso that the term should not exceed 28 years.

Plymouth.—For the first time in their history, says the *Western Mail*, the Plymouth Corporation tramways have yielded a profit. The revenue in the last financial year was sufficient to meet all the charges, including the interest and sinking fund, and leave a profit of £298. This is exceedingly satisfactory. Part of this successful result is, no doubt, due to the heavier returns from the Prince Rock line since the inauguration of the electric cars in September last. The more frequent and regular service, and the larger cars, have brought more passengers, and similar development may be anticipated when the same method of traction is extended to Compton.

South Lancashire Tramways.—From the proceedings of Mr. Seale-Hayne's Committee of the House of Commons, at present considering the South Lancashire Tramways Bill, which authorises

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the construction of an extensive system of tramways in the district of South Lancashire, between St. Helens and Eccles, we learn that an agreement has practically been arrrived at between the promoters and Eccles, by which that Corporation would themselves construct the tramway from the point in Patricroft at which the promoters proposed to enter the borough. The Bill passed the committee yesterday. The opposition by Mr. Garcke on behalf of the Wigan Tramway Company, who objected to the line from Ashton to Wigan, was not successful.

Cardiff Tramways.—At the last meeting of the Tramways Committee a letter was read from the directors of the Cardiff and Penarth District Tramway Company (Splott to Grangetown), in which they stated that they would be prepared to receive a deputation for the purpose of discussing the terms upon which the Corporation shall purchase the line in 1902. A deputation was appointed. Another letter from the Electric Power Distribution Company, who are desirous of making an electric tramway between Penarth and Cardiff, was read. The borough engineer was instructed to reply, stating that the Corporation had not come to a conclusion as to their future action respecting Penarth-road, and were not disposed to grant the permission asked for by the Electric Power Distribution Company.

Bolton.—On Thursday last week a trial took place on the extension of the Daubhill tram system, the new part extending from the present terminus to the junction of Hulton-lane with St. Helens-road—at the highest point of this highway. From the report before us it appears that it was found that the car-shed had been erected so near the roadway that the curve proved insufficient and the car could not be docked. At a recent meeting of the Tramways Committee the South Lancashire Tramways Bill was considered. The committee consented to the period of compulsory sale to the Corporation of the tramways constructed by the promoters within the borough being deferred until the end of 30 years from the passing of the Bill, provided that the Corporation shall at any time prior to purchase be allowed running powers over all or any part of the tramways so constructed. Messrs. Dick, Kerr, and Co. were requested to deliver eight cars of the reversible type, each of which will contain six additional passengers, and to furnish the balance of the Corporation's order—namely, 22 cars—as early as possible. A letter was received from the Board of Trade intimating that Lieut.-Colonel Yorke and Mr. A. P. Trotter would visit the town and inspect the new track on the Hulton and Horwich routes.

Newcastle.—Mr. A. P. Trotter held an enquiry on Monday into an application of the Corporation, under the Newcastle Tramways and Improvement Act, 1899, for sanction to borrow the requisite amount to meet the payments under contracts with the undermentioned: (1) Thomas Beeley and Son, boilers, £7,298; (2) Thos. Beeley and Son, superheaters, £710; (3) Middlemiss Bros., power station foundations at schedule prices, estimated at £6,000; (4) D. N. Brims, power station chimney foundations, £1,651. 13s. 11d.; (5) S. F. Davidson, car-shed foundations at schedule prices, estimated at £2,590; (6) British Westinghouse Electric and Manufacturing Company, Limited, two 1,000-h.p. dynamos, £16,450; (7) same company one 2,000-h.p. dynamo, £16,230; (8) British Thomson-Houston Company, electric tramcars, £76,972. 10s. The chairman of the New Tramways Committee is about to proceed to Westphalia in place of the city engineer, who is unable to undertake the journey, and see to the testing of the second batch of rails, about 600 tons, before being sent to Newcastle for the new tramways. The rails have now been laid along nearly the whole length of Pilgrim street. Progress is being made, also, in Northumberland street. At Wednesday's meeting of the City Council it was agreed to seal a mortgage to the Public Works Loans Commissioners for £350,000 for tramway construction.

Kingston.—From correspondence which has passed between the County Council and the Town Council with regard to the opposition of the County Council against the Tramways Bill of the Corporation, and to the rejection of the Bill by the House of Lords Committee, we gather that the application of Messrs. Greenwood and Batley, Limited, to the Light Railway Commissioners will be opposed by both Councils, and that with respect to the intentions of the County Council to apply themselves for powers to construct light railways within the borough of Kingston-upon-Thames, no consideration has yet been given to the altered circumstances that surround the question. The Kingston Tramway Committee have intimated that they consider, notwithstanding their temporary reverse, the principles which the Corporation have consistently striven for on behalf of the ratepayers are sound, and that they should be continued to be upheld, such principles being that any lines along roads in the borough should be constructed by and remain the property of the Corporation on behalf of the ratepayers of the borough, and that the profits derivable therefrom should not be diverted from such ratepayers. In the opinion of the committee, there is nothing antagonistic between the adoption of these principles and the carrying out of a still more comprehensive scheme so as to afford further communication with neighbouring localities, and that whatever steps may be taken in the future, these principles should be steadily borne in mind and insisted upon. It was reported at the last meeting that the Surbiton and Esher and Dittons Urban District Councils also propose to oppose the application of Messrs. Greenwood and Batley for powers to construct light railways in and near the borough.

Northfleet.—The following notice appears in the *Gazette*: "The Urban District Council hereby give notice that they have duly made and sealed the following by-laws and regulations with respect to so much of the tramway of the National Electric Traction Company, Limited, as lies within the said district, under the powers conferred upon them by the Tramways Act, 1870: (1) The by-laws and regulations hereinafter set forth shall extend and apply to all carriages of the National Electric Traction Company, Limited, within the said district. (2) No carriage shall be driven at a less rate than four miles, nor more than eight miles, in the hour. (3) No carriage shall be driven so as to follow a preceding carriage at a less distance than 30 yards along any portion of the line of tramway. (4) Every driver or conductor of a carriage shall stop the same when required so to do by any passenger desirous of leaving the carriage, or by any person legally entitled to travel by the carriage, and for whom there is room. (5) No carriage shall stop except at passing places or terminal stations, or when necessary to preserve the distance required by the By-law No. 3, or when changing horses, or when required to take up or set down a passenger, and then no longer than is absolutely necessary. (6) No person shall in any way wilfully impede or interfere with the traffic on the said tramway. (7) Any person offending against or committing a breach of any of the above by-laws or regulations shall be liable to a penalty not exceeding 40s. for each offence. (8) The conductor of each carriage shall carry with him a copy of these by-laws, and shall, on request of any passenger, produce the same to, and shall permit the same to be perused by, such passenger during the passage of the carriage, but shall not stop the carriage for such purpose. A printed copy of these by-laws shall be affixed and kept affixed in the office of the company, and in every waiting-room and other building of the company situate within the district. And, further, that the foregoing by-laws and regulations will come into force on June 24, 1900, unless disallowed by the Board of Trade within two months after the 20th inst., when a copy thereof was laid before the said Board. Objections to the said by-laws and regulations should be delivered to the said Board.—SHARLAND AND HATTEN, Clerks."

LIGHTING AND GENERAL.

Hastings.—A reduction has been made in the price of electric light.

Leeds.—The central fire station is to have an installation of electric light.

Bristol.—The electric lighting loan of £145,000 for extensions has been sanctioned.

Hull.—The Electric Light Committee propose to borrow £42,000 for works now in hand.

Deal.—The Council have decided not to entertain the electric lighting question at present.

Brecon.—The Board of Trade have issued an electric lighting provisional order to the Corporation.

Gravesend.—We understand that the Electric Lighting Committee are conferring with Mr. Trentham.

Torquay.—Babbacombe-road is to be included in the list of roads in which the electric main is to be laid.

Dewsbury.—It is anticipated that the electricity works will show a slight profit during the last 12 months.

Edmonton.—The Urban District Council have decided to apply for a provisional order to supply electric light.

Trawden.—The Council will not take any action with regard to the Bills of the Lancashire Electric Power Company, Limited.

Limerick.—The Board of Trade have approved of the system of electric lighting for the city submitted to them by Mr. Enright.

Beckenham.—The Urban District Council intend to apply for a loan of £7,000 for wiring private houses in connection with the electric light.

Weymouth.—Prof. Kennedy's report on the electric lighting has been adopted. The estimates are £45,000. Plans, etc., are to be prepared.

Maesteg.—It is proposed to consider at the next meeting of the District Council the question of applying for an electric lighting provisional order for the district.

Greece.—An Act has been published enabling the Government to treat with a company for the electric lighting of the town of Chalcis and of the Euripus Straits.

East London Technical College.—Special courses of lectures by Mr. J. T. Morris, A.I.C.E., A.M.I.E.E., will begin on May 8. Particulars appear in our advertisement columns.

Lancaster.—The Town Council have agreed to lay several new mains, subject to the applicants respectively giving the usual guarantee of 15 per cent. per annum for three years.

Lymington.—The Council have asked the Lymington Electric Light and Power Company to submit a scheme and estimate for the public lighting of the borough by means of electricity.

Chiswick.—The District Council have elected the following Electric Lighting Committee: Councillors Adamson, Bilton, Cook, Diplock, Eydmann, Fuller, Knowling, A. Sich, and Teuteon.

Worcester.—At the meeting of the City Council yesterday a scheme was presented for enabling the Electricity Committee to undertake the wiring of private houses, and to borrow £1,000 for the purpose.

Wimbledon.—The Urban District Council intend to expend about £1,000 in extension of the public and private lighting. The works will be carried out under the direction of the resident electrical engineer.

Thames Valley Electric Supply Co.—This Company has been registered with a capital of £25,000, the object being to carry on the business of electrical engineers, electrical apparatus makers, tramway and light railway proprietors, etc.

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Worksop.—The Urban District Council have decided to serve notice on the National Telephone Company requesting them to remove the stays erected on Carlton-road and elsewhere.

Banbury and District Electric Supply Co.—This Company has been registered with a capital of £25,000, the object being to carry on the business of electrical engineers, electricians, suppliers of electricity, tramway and light railway proprietors, etc.

Birkenhead.—The Gas, Water, and Electrical Committee of the Birkenhead Corporation report that the result of the year's working in the electrical department shows the sales to amount to 238,546 units, an increase over last year of 68,870 units.

County of Kent Electrical Power Distribution Co.—This Company has been registered with a capital of £25,000, the object being to carry on the business of electrical engineers, electrical apparatus makers, tramway and light railway proprietors, etc.

Mexborough.—Mr. H. Waring, of Burton-on-Trent, has been appointed electrical engineer to the Urban District Council. The surveyor has been instructed to prepare sketch plans and design for the erection of the dust destructor buildings on the new site.

Books Received.—We have received from the publishers, Messrs. Whittaker and Co., of Paternoster-square, London, a copy of a work entitled "English and American Lathes," by Joseph G. Horner, A.M.I.Mech.E. The published price of the work is 21s. net.

Scarborough.—The electric lighting company having stated that they are prepared to sell the undertaking on the basis of the present and prospective valuation, the Corporation have replied that they are prepared to buy at a fair valuation to be decided by arbitration.

County of Northampton Electric Power and Traction Co.—This Company has been registered with a capital of £25,000, the object being to carry on the business of electrical engineers, electrical apparatus makers, tramway and light railway proprietors, etc.

St. Marylebone.—The Vestry have decided to oppose all stages of the confirmation Bill granting electric lighting powers to the Marylebone Electric Supply Company, Limited. If, however, the Bill should be confirmed, it is suggested that the area affected should be coincident with the new borough area.

Milnthorpe.—The Parish Council have decided that the question of electric lighting be fully discussed at the next meeting, when a committee will be formed for ways and means. It is stated that steam power quite adequate for all purposes is available in the immediate neighbourhood of the village on easy terms.

Patents Act.—Notice has been given that Theron Clark Crawford, of New York, U.S., has applied for leave to amend the specification of letters patent No. 5,863 of 1898, granted to William Lawrene Voelker for improvements in incandescent electric lamps and in processes for manufacturing them.

Belfast.—The members of the Law and Improvement Committees have been appointed a special committee to enquire into and report to the Council as to the desirability of establishing a municipal system of telephones in the city. A great increase is reported in the output of electricity at the Corporation's station.

Brighton.—The Lighting Committee of the Town Council have received 44 applications for the post of resident electrical engineer and manager of the Corporation electricity works. They recommend for the post Mr. John Christie, who since May, 1898, has been resident engineer to the Glasgow Corporation electricity department.

Hull.—A smoking concert was held on Tuesday at the East Hull Liberal Club to celebrate the opening of the electric light, which has just been installed in the building. Messrs. Reame, Wokes, and Co., of Hull and Middlesbrough, were the contractors for the installation, which comprises 150 lights in the various rooms, and a row of coloured footlights on the stage of Ripon Hall.

St. Helens.—The salary of Mr. J. S. Highfield, the electrical engineer, is to be increased by £100 per annum, in addition to £50 per year received from the Health Committee for services in connection with the electrically-worked destructor; also the salary of Mr. E. M. Hollingsworth, assistant electrical engineer, by £40 per annum, and the salaries of Mr. G. H. Carter and Mr. E. E. Eccles, shift engineers, each £25 per annum.

Removals.—We are informed that the Universal Battery Company have removed to larger premises at Mid-Kent Works, New Beckenham, S.E. The telegraphic address is "Universal, Beckenham," and the telephone "No. 133, Bromley."—We are also informed that, owing to the demand for more room for manufacturing purposes, the British Thomson-Houston Company, Limited, have removed their stores from Bankside to 4 and 6, Bath-street, City-road, E.C.

Appointments Vacant.—The Board of Police of Greenock invite applications for the post of resident electrical engineer (£300).—An installation inspector is wanted at the Manchester Corporation electricity department.—The Corporation of Glasgow invite applications for the post of outside superintendent for their telephone exchange system. Particulars relating to the above vacancies and others for an assistant electrician, a foreman, etc., will be found in our advertisement columns.

Westminster Electric Supply Company.—A circular letter from the secretary of this company announces that the majority of the directors finding that the majority of the shareholders are desirous of the new issue of capital being made at par, have decided to accept the verdict. The extraordinary meeting and poll will, however, have still to be taken as a matter of form. The present shareholders will thus be entitled to one new share for every three shares they hold, which at the present price amounts to a bonus of about £3. 7s. 6d. per share.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the British Insulated Wire Company's further issue of 30,000 ordinary shares of £5 each, and 30,000 6 per cent. cumulative preference shares of £5 each. The committee have been asked to allow the Cape Electric Tramway's shares of £10 each to be quoted in the official list. They have ordered to be quoted in the official list the Commercial Cable Company's 3,333,300dol. additional capital stock.

Halesowen.—At Wednesday's meeting of the Council the Electric Lighting Committee reported that they had considered the report of Mr. Wilson, the expert, in which he strongly urged the Council not to dispose of their order for electric lighting until they had obtained traction powers for their district. The committee recommended that the Council make application to the Board of Trade for a provisional order under the Tramways Act, 1870, and that the clerk be instructed to take all steps necessary for obtaining the order. The reports were adopted.

Personal.—Mr. R. Marshall, of Siemens Bros., has been appointed mains superintendent at Ayr. The late superintendent, Mr. S. Price, has taken up his duties as engineer to the Pembroke Commissioners.—We understand that Mr. F. J. Down is severing his connection with Messrs. Laing, Wharton, and Down, Limited, and that he purposes shortly to take up business in the supplying of specialities for traction, electric light, and power purposes. Mr. Down, it may be mentioned, has had some 17 years' experience with American and Continental practice, his experience extending to every branch of the profession.

Bath.—At a meeting of the Electric Lighting Committee on Thursday last week, the Works Committee advised, upon Mr. Metzger's recommendation, the adoption of the Gosling furnace at the electric light works, which it was stated would save 20 per cent. in the cost of fuel. In the event of a saving not being realised after a week's trial, the apparatus would be removed free of cost to the committee. The recommendation was approved. Mr. Metzger reported a case of a new building where he had found the temporary wires connected in such a way that current was actually being used by the contractors' men without passing through the meter. The Electric Lighting Committee decided that on any future occurrence of the acts complained of proceedings will be taken.

Edinburgh.—The estimates of the Electric Lighting Committee for the year from May 15 show an estimated expenditure for 1900-1, including £5 800 for rates and taxes, of £45,175, making, with £40,000 for sinking fund and interest, a total of £85,715. The estimated revenue—giving effect to the proposed increase of ½d. per unit on the present price of 3½d. for private lighting, in consequence of the rise in the price of coal—is £90,000. The estimated expenditure for 1899-1900 was £63,285, the estimated revenue being £73 405. The actual expenditure in 1898-99 was £42,351, and the actual revenue was £48,238. The estimated capital expenditure in 1900-1 for works in Dewar-place, M'Donald-road station, and the extensions of mains and cables, etc., throughout the city, is £113,450. The price for public lighting is to be £13 per lamp per annum, a reduction on the present charge of £1; the price for motor power will remain at 1½d. per unit. The number of lamps applied for during the last fortnight is equal to 5,348 8 c.p. lamps, and includes 15 motors.

Parliament.—In the House of Lords, on May 1, the Ipswich Corporation Tramways Bill was read a third time and passed. The Brighton Corporation Bill was read a second time. In the House of Commons on April 26 the Hastings Tramways Bill, promoted by Mr. W. M. Murphy, was read a third time. On the 27th ult. the City of London Electric Lighting Bill and the Metropolitan District Railway Bill were read a third time, and the Newport Corporation Bill was read a second time. On the 30th ult. the Dublin Electric Lighting Bill was read a second time, and the London County Council Tramway Bill (No. 2) a third time. The Bill promoted by the Great Grimsby Street Tramways Company has passed Lord Jersey's Select Committee of the House of Lords. The Examiners of Standing Orders have certified that the forms of the House had been complied with by the promoters of the Burnley Corporation Bill and the Electric Lighting Provisional Orders (No. 4) Bill, which includes the confirmation of orders relating to the urban districts of Bredbury and Romiley, Cheadle and Gatley, and Lytham. The Bradford Corporation Bill has passed Lord Fitzmaurice's Committee of the House of Commons. Sir James T. Woodhouse, member for Huddersfield, has given notice in the House of Commons that, on the consideration of the Huddersfield Corporation Tramways Bill, which was set down for last night, he would move the recommittal of the Bill to the committee "to consider and report as to the expediency of reinserting" the clauses relating to the construction of lines outside the borough boundaries. It will be remembered that Mr. C. P. Trevelyan placed a similar motion on the order book, and he has now agreed to second the motion of Sir J. T. Woodhouse. In the House of Lords notice of opposition to the Airdrie and Coatbridge Tramways Bill has been given on behalf of the North British and Caledonian Railway Companies and the Airdrie and Coatbridge Water Company. The Standing Orders Committee of the House of Commons have decided to allow the Glasgow District Tramways Bill to proceed on condition that all the provisions with reference to tramway construction on the north side of the Clyde, with the exception of the provisions dealing with the burgh of Dumbarton, are struck out of the Bill.

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Twickenham.—The District Council have obtained a return from the National Telephone Company giving particulars of all overhead wires erected in the district by the company up to Feb. 28 last, and the surveyor has arranged with the district manager to send in a monthly return of all future wires erected.

West Bromwich.—Mr. G. W. Willcocks has held an enquiry into the application of the Town Council to borrow £30,000 for electric lighting purposes. Mr. Quin said it was estimated that the total annual revenue would be about £3,756 and the total expenditure £3,348, which would leave a small surplus to the good.

"English Illustrated Magazine."—The May number opens with another instalment of Mr. Drummond's powerful "Beaufoy Romances." An interesting article on the collection at Bethnal Green Museum is amongst those interspersed between the short stories, which are rather of the sorrowful and sad order this time.

Turkey.—A Reuter's telegram states that an iradé has been issued prohibiting the importation into Turkey of all apparatus connected with electricity, including electric bells. This is only a renewal of a former decree which, it is said, was abolished after it was shown that dynamos had no connection, as they were supposed to have by the Turkish officials, with dynamite.

Ruthin.—At the last meeting of the Town Council a report was submitted upon the question of supplying the town with electric light. It was calculated that the same number of lamps could be supplied as were now used with gas for less than two-thirds of the amount estimated for street-lighting purposes for the current year. The report was referred to a special meeting of the Council.

Barrow.—The balance-sheet for the first year's working of the Corporation electri ity works is very satisfactory. A gross profit of over £750 has been made, which provides far more than the payment of interest on the loans. The committee have recommended the Council to make, from May 7, a reduction in the charges for electricity for the current year equivalent to about 10 per cent.

Croydon.—Last week, at the Croydon Union Infirmary, Councillor G. J. Shirley, chairman of the Infirmary Committee, performed the ceremony of switching on the electric light. The installation comprises some 800 lamps, totalling some 13,000 c.p. The whole of the work has been carried out by a local firm (Messrs. W. J. Bishop and Co.). Mr. A. W. Sclater was the consulting engineer.

New Issues.—An issue is being made by the Folkestone Electricity Supply Company, Limited, of £25,000, in 4½ per cent. first debenture stock, at the price of 102, to be repaid on July 2, 1938, at par, or earlier at 105 per cent., on six months' notice.—The Electric and General Investment Company, Limited, are offering for subscription £125,000 4½ per cent. debenture stock of the Potteries Electrical Traction Company, Limited, at the price of 105 per cent.

London Gazette.—A final dividend of 9½d. in the pound has been declared in the estate of J. H. Clarke, 30, Bold-street, Southport, payable at the offices of Messrs. Yates and Scampton, 4 and 6, Wood-street, Bolton, accountants, on May 18.—A first and final dividend of 2s. 10d. in the pound has been declared in the estate of B. Wild, 52, Forest-road, Southport, payable at the offices of Messrs. Yates and Scampton, 4 and 6, Wood-street, Bolton, accountants, on May 18.

Manchester.—During a recent Local Government enquiry into a loan for further expenditure at the gasworks, amounting to a very large sum, Mr. J. G. Newbigging, the engineer of the gas department, said that, notwithstanding the great demand for the electric light, the consumption of gas maintained a steady average increase of about 5 per cent. per annum, and the rate of increase was likely to be kept up. It was largely due to the constantly increasing demand for prepayment meters and for gas for purposes other than lighting.

A Useful Gift.—We have received from the General Electric Company, Limited, a specimen of a rule which the firm are supplying free to the trade on application while the limited supply on hand continues. The rule displays several tables of equivalent weights and measures, besides numerous notes for the use of draughtsmen, all of which are compactly arranged and easy of reference. The rule should prove of use in the drawing office, also, we venture to think, in the editorium, while no fault can well be found with the price.

Bridgwater.—At a recent public meeting a resolution was passed expressing regret that the Corporation had ignored the wish expressed at the last meeting of ratepayers in favour of the abandonment for the present of the electric light scheme. For the other side it was contended that there was no obligation on the part of the Corporation to consult the general body of ratepayers concerning schemes of this description, and that the abandonment of the electric light scheme now that it had been proceeded with so far, would be attended with a good deal of pecuniary sacrifice.

Walker.—The adjourned meeting of the Urban District Council was held on Tuesday. The report of the Electric Lighting Committee, the chief item being the recommendation that the meeting accept the already settled agreement with the Newcastle Electric Supply Company, referred to by us April 6, was adopted. The *Newcastle Daily Chronicle* sums up the agreement as follows: Whether or not the Newcastle Electric Supply Company's Bill should be passed through Parliament, the company agree to pay the Council's parliamentary costs this session and the cost of the agreement. If the Newcastle Company's Bill is passed, and the Local Government Board grant their sanction to the loan, then the agreement, which extends for 10 years, provides that the company shall obtain on behalf of the Council tenders for cables, mains, and laying the same for the exclusive use of the Walker district—the tenders requiring the Council's approval. The company shall be responsible for all work being executed in accordance with the specification, the same to be executed under the supervision and to the satisfaction of the Council's engineer. The Council will pay the cost of these works and of a refuse destructor to be erected by them out of the loan, the principal and interest of this loan to be repaid by the company to the Council during the 10 years. During the term of the agreement the company is to carry out the Council's provisional order and destroy all refuse from day to day free. The system of supply is that which the Board of Trade has approved, and the charges shall not at any time exceed the lowest for the time being charged by the company in Newcastle or elsewhere. No generating station to be erected in Walker unless with the sanction of the Council. The company's Bill will give the company no power to supply electrical energy in Walker, but will give the company and the Council power to enter into agreement respecting the same. The company guarantee a supply of electrical energy within eight months from the Bill receiving the Royal assent or the acceptance of the tenders.

Ilford.—Henley's Telegraph Works Company have given notice of an application to lay electric cables under the footpath leading from the Castle Rising Farm to Aldborough-road. This footpath is Crown property, and the company have been informed not to interefere with the road without proper authority. An interview is to be held between the Commissioners of Woods and Forests, Messrs. Clutton, Shaw, and Hawtayne. Electric cables are also to be laid over land in the Park Estate, and Messrs. Douglas, Young, and Co. have been making preliminary enquiries as to how the Council propose to make good the damage. This matter will come before the next meeting of the Urban District Council.

Eastbourne.—On the agenda for yesterday's meeting of the Town Council was a recommendation of the Electric Light Committee on the improvement and development of the municipal electricity supply works, as follows: That the Council be recommended to transfer the electric light works to Roselands, and to instruct Mr. W. C. C. Hawtayne to prepare the necessary plans for the new works, mains, etc, in accordance with Scheme II. of his report, but designed for 50 periods (Scheme IV.), and that the borough engineer prepare the plans of the new buildings required, including the alterations to the destructor, in consultation with Mr. Hawtayne; and, further, that tenders be at once invited by advertisement for the new main switchboard and 400-kw. steam alternator with boiler, as recommended by Mr. Hawtayne and included in Scheme II. Mr. Hawtayne estimates (Scheme II) that the cost of erecting a new generating station at Roselands and transferring the generating plant to this site will be: buildings, with new chimney shaft, for combined scheme of lighting, sewerage, and destruction of refuse, £9,500; proportion to be allocated to electricity supply works, £5,500; economiser, with all accessories, £600; replacing existing belt-driven plant by a 400-kw. steam alternator with boiler, £5,050; transferring the existing steam alternators, etc., to Roselands, £650; main switchboard, £1,000; new transformers, feeders, and network as before, £10,700; and for larger and longer feeder cables from Roselands to the area of supply, £4,152; alteration to present public arc lighting, £260; supplying consumers with new lamps, providing necessary house services, cut-outs, meters, etc., £4,000—total, £31,912. To that sum should be added the costs of the site at Roselands, less the value of the present buildings and land. The estimated cost of plant and mains, etc., as included in Scheme II, but designed for 50 periods and 2,200 2,400 volts (Scheme IV.), is £33,562. Mr. Hawtayne has also reported on the remodelling of the mains. He says that a considerable amount of energy is being wasted in Eastbourne, and that waste could only be checked by getting rid of as many small transformers as possible, and substituting for the present system of distribution a proper low-pressure system of mains fed at intervals by large transformers grouped in sub-stations. The cost of the alteration would be approximately £10,700. The present house service fuses and meters would also partly require replacing, and a further sum of about £4,000 would be required for that work. With regard to the public arc lighting, Mr. Hawtayne states that the existing 25 public arc lamps (run in series off the old Brush machines) should be connected up to the low-tension distributing network, and altered or, preferably, replaced by lamps of a later type at a cost of about £260. To carry out the proposed extensions of street-lighting 38 additional arc lamps would be required, at a capital outlay of about £1 500. The substitution of a new switchboard for that at present in use would cost approximately £1,100. On the question of the site of the works, Mr. Hawtayne advises the construction of new works at Roselands, in conjunction with the remodelled refuse destructor and sewage works. The cost of buildings, with a new chimney shaft, for a combined scheme of lighting, sewerage, and destruction of refuse, would be about £9,500. On the question of changing over from the alternating-current to the continuous-current system, he points out that in the case of Eastbourne it would not be possible to adopt the continuous-current system without considerable alteration to the whole of the cable network, and practically reopening the whole of the streets where cables were now laid. The lighting the remainder of the streets in the borough by means of electric incandescent lamps (the total number being 997, each with two 16-c.p. lamps, and 53 each with two 32-c.p.) would cost £17,450, and £4,230 for maintenance, etc.

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COMPANIES' MEETINGS AND REPORTS.

GLOUCESTER RAILWAY CARRIAGE AND WAGON.

An extraordinary meeting of the above Company was held at the Bell Hotel, Gloucester, on Saturday last, to submit resolutions that the capital of the Company should be increased. There was a very large attendance of shareholders.

The **Chairman** (Mr. H. Wright, of Birmingham) moved, "That the capital of the Company be increased to £250,000 by the creation of 25,000 new shares of £7 each." He referred to the circular which had been issued to the shareholders, in which the directors stated that in view of the increased demand for railway rolling-stock, especially on deferred purchase, they had come to the conclusion that an increase of the share capital was now desirable, and pointed out that the proposal was not the result of a sudden idea, the subject having been discussed by the Board two years ago. It was now considered a suitable time for making the addition to the capital, in view of the present large business of the Company and the prospect there was of its still further increasing. Since the last increase was made in the capital of the Company they had gone on spending money on the land and works, and in effecting economical improvements to such an extent that the present expense was double what it was then, and they had managed to do all that work without calling on the shareholders to increase the capital. Although so much had been done in that direction, they could foresee that further improvements would have to be effected. Science had made great advances, especially in the direction of economical appliances, and the Company must continue to keep abreast of the times in that respect in order to be able to compete with those owners who did avail themselves of those continually recurring improvements. The new issue would help the Company in every possible direction.

Mr. Vassar Smith seconded the motion, which was unanimously agreed to.

INDO-EUROPEAN TELEGRAPH.

The annual meeting of shareholders of the Indo-European Telegraph Company, Limited, was held at Winchester House, E.C., on Monday.

Mr. J. H. Tritton, who presided, said, with regard to wireless telegraphy, the directors had come to the conclusion that its commercial value had yet to be proved, and that to-day, as a year ago, it was not of much importance. Great pressure was still being exercised to bring about a reduction of telegraph rates between this country and the East. The Board had no desire to stand in the way of a sensible reduction of the rate of 4s. per word at present in force, but the consent of the Governments interested had first to be obtained before such a measure could be carried out. It was highly problematical that any reduction of the rates between this country and India would be followed by any large increase in traffic. The year's revenue amounted to £142,343, or an increase of £7,700, while the expenses, amounting to £74,657, were normal An arrangement had been made whereby the Company would supply the Shah of Persia with telegraphic messages at any time during his European tour.

The report was adopted.

WESTERN TELEGRAPH.

The report of the directors for the half-year ended Dec. 31, to be submitted to the meeting on the 9th inst., shows a revenue of £139,596 and working expenses of £25,596 After providing £3,200 for debenture interest and sinking fund and £1,516 for income tax, there remains a balance of £109 284. A sum of £5 063 was brought forward, making a total of £114,347. First and second interim dividends, amounting to £62,379, have been paid, and £45,000 transferred to the reserve fund, leaving the sum of £6,791 to be carried forward.

SUBMARINE CABLES TRUST.

The report of the trustees for the year ended April 15, to be submitted to the meeting on 8th inst., states that the revenue, including the balance brought forward, amounted to £24,870. The expenses were £1,269 and the payment of the coupons to £20,286, leaving, together with £21,555, a balance of £3,315. Twenty-seven certificates have been drawn for redemption at £120, absorbing £3,240 of the available balance, and leaving a sum of £75 to be carried forward.

CHISLEHURST ELECTRIC SUPPLY.

Directors: A. Travers Hawes; Edmund Charrington; James Ford; Francis E. Gripper; Sir Patteson Nickalls, J.P.; R. Leonard Powell. Secretary and manager: F. S. Hanning, Electricity Works, Chislehurst.

In their report for the year ending Dec. 31, 1899, the directors state that current was first supplied to consumers in February, 1899, when the equivalent of 806 8-c.p. lamps were connected. By the end of last year this number had increased to 4,017, a result the directors consider satisfactory. The revenue from the sale of current, etc., exceeds the total expenditure by £83. 1s. 7d., which sum the directors propose to carry forward to next account. A prospectus, offering the shares of the Company to the inhabitants of Chislehurst, was issued in December, at an unfortunate time, and the response not amounting to the figure mentioned on the prospectus, the applications were returned, and no allotment was made.

Dr. Revenue Account.	£	s.	d.
Generation of electricity	483	12	9
Distribution of electricity	80	16	8
Rates and taxes	12	13	4
Management expenses	50	6	10
Total expenditure	627	9	7
Balance carried to net revenue	83	1	7
	£710	11	2

Cr.	£	s.	d.
Sale of current per meter at 8d. per B.T.U.	691	3	2
Rental of meters and other apparatus	19	8	0
	£710	11	2

General Balance Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	1,602	0	0
Due to sundry tradesmen and others	16 073	3	9
Sundry creditors on open accounts	353	9	3
Balance at credit of net revenue account	83	1	7
	£18,111	14	7

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	17 359	5	6
Stores on hand	1	3	6
Preliminary expenses	64	13	11
Sundry debtors for current supplied	438	19	10
Cash at bankers	247	11	10
	£18,111	14	7

Statement of Electricity Received, Sold, etc.

Quantity received in B.T. units	31,207
Quantity sold by meter	21 454
Quantity used on works	3,844
Total quantity accounted for	25,298
Quantity not accounted for	5.909
Maximum supply demanded (kilowatts)	31 5

CALCUTTA ELECTRIC SUPPLY.

Directors: Colonel A. J. Filgate, R.E. (chairman); E Boulnois, Esq., M.P.; P. V. Luke, Esq., C.I.E.; Sir Guilford L. Molesworth, K.C.I.E.

Third report of the directors to be presented at the annual general meeting of the shareholders to be held at the City Terminus Hotel, Cannon-street, E.C., on May 11, 1900, at 2 p.m.:

The supply of electrical energy commenced on April 17, 1899, as stated in the last report, and at Dec. 31 last there were connected to the Company's mains an equivalent of 9,463 lamps of 8 c.p., of which 8,170 lamps were for lighting purposes, and the equivalent of 1,293 lamps for power; 54,897 units were sold (42,947 for lighting, and 14,850 for power), and the gross revenue was £2,041. 12s. 2d., while the costs, after charging the management and administration expenses to revenue, amounted to £1,389. 16s. 5d., leaving a net profit of £651. 15s. 9d., which it is proposed to carry forward. The directors congratulate the shareholders upon this successful result of the commencement of the Company's working. Applications continue to come in from new customers in considerable numbers, and the few wiring contractors in Calcutta are kept well employed. It is satisfactory that landlords, both European and native, show a willingness to pay for the electric wiring required by their tenants. It is reported that the design of the whole station and mains is good, and that the supply of electricity has given general satisfaction. At the time of the formation of the Company it was not estimated that any important revenue would be derived from the supply of current for motors, but the directors have much satisfaction in stating that the use of fans driven by electric power, in place of punkahs, has become quite popular. It is reported that 2,000 are supplied or on order for use this hot weather, and when it is remembered that a large proportion will be running during the 24 hours for at least eight months of the year, it will be seen that the employment of electric fans will probably form a large and lucrative source of revenue to the Company. The Government of India is desirous of passing a general Electric Lighting Act for the whole of India, which shall supersede the present Calcutta Electric Lighting Act, and Messrs. Crompton and Co. have, with the assistance of the directors of this Company, prepared a draft of the proposed new Act, which is now under its consideration. The difficulties in connection with the extension of the Company's license to the period of 42 years have been removed, and the Government of Bengal have agreed to the renewal, and also to the addition to the original area of large districts to the south of Calcutta, including the Alipore and Ballygunge suburbs. The formal documents to give effect to these changes are promised shortly. Additional mains have been laid in many of the streets in Calcutta beyond those comprised in the original contract; many more will soon be required, and further considerable capital expenditure will have to be incurred for the supply to the new districts. Under these circumstances the directors propose that the nominal capital of the Company shall be increased to £200,000 by the creation of 20,000 additional shares of £5 each, and the necessary resolution to give effect to this proposal will be submitted to

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the meeting. There are many other towns in India where electricity may no doubt be profitably employed, and the directors are in negotiation for the necessary powers to supply some of these places. Should these negotiations prove successful, the shareholders will be called together to consider, and, if approved, to sanction these schemes, and to provide the capital required. In accordance with the articles of association of the Company, Mr. Edmund Boulnois, M.P., retires by rotation from the Board of directors, and, being eligible, offers himself for re-election. The auditors in London, Messrs. J. H. Duncan and Co., chartered accountants, also offer themselves for re-election.

Revenue Account.	£	s.	d.
Station costs—Wages	274	7	8
Coal	301	17	6
Engine-room stores and water	33	14	7
	609	19	9
Proportion of administration and general expenses	779	16	8
	1,389	16	5
Balance—net revenue	651	15	9
	£2,041	12	2
	£	s.	d.
Sale of current (less rebate, etc.)	1,632	0	6
Rental of meters	45	17	6
Rental of fans	66	11	7
	1,744	9	7
Interest and exchange	284	10	1
Transfer fees	12	12	6
	£2,041	12	2

Balance-Sheet. Capital and Liabilities.	£	s.	d.
Authorised issue, 20,000 shares of £5 each	100,000	0	0
Issued, 20,000 shares, £5 per share called up	100,000	0	0
Less arrears	1,026	0	0
	98,974	0	0
Sundry creditors	5,213	12	11
Net revenue account, balance at credit	651	15	9
	£104,839	8	8
Property and Assets.	£	s.	d.
Amount brought forward from last year	50,158	3	2
Expenditure during the year on contract account	30,098	4	2
Proportion of administration and general expenses	591	2	1
	80,847	9	5
Stores on hand	10	19	9
Sundry debtors	687	4	2
Cash in hand	23,293	15	4
	£104,839	8	8

PROVISIONAL PATENTS, 1900.

April 23.

7433. Improvements in joints for rods carrying electric lamps and other purposes. Hugo Hirst and John Hillery Collings, 73, St. Stephen's-road, Upton Park, London.

7434. Improvements in connections for electrical cables and kindred purposes. Hugo Hirst and Martin Zellermayer, 73, St. Stephen's-road, Upton Park, London.

7471. Improvements in electric telegraphy. Sidney George Brown, 9, Putney-hill, Putney, London.

April 24.

7510. Improvements in electrically-governed feeding and drinking appliance for animals, live stock, birds, and the like. Charles Miles, Withleigh-road, Greenmore-road, Upper Knowle, Bristol.

7511. Improvements in electrical time checking and registering apparatus. Charles Miles, Withleigh-road, Greenmore road, Upper Knowle, Bristol.

7513. Improvements in secondary batteries. Sherard Cowper-Coles, Grosvenor-mansions, Victoria-street, Westminster, London.

7535 Improvements in sound transmitting and receiving instruments. Colin Salmond, 100, Wellington-street, Glasgow. (Complete specification.)

7547. Incandescent electric lamp. William Edwin Irish, 77, Calabria-road, Highbury, London.

7561. Improvements in maximum electric meters. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Henry O. Westendrap, United States.) (Complete specification.)

7562. Improvements in third-rail insulators for electric railways. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

7566. Improvements connected with the production of electric light. Ewald Rasch, 46, Lincoln's-inn-fields, London.

7567. Improvements in electric bonds for electrically connecting the meeting ends of two contiguous electric conductors. Harold Pitney Brown, 6, Bream's-buildings, Chancery-lane, London. (Complete specification.)

7583. Improvements in contacts for incandescent electric lampholders, electric switches, and so forth. John Griffiths Sanders Lee, 70, Chancery-lane, London.

7606. Improvements in electrical controlling switches. Charles August Lindstrom, John Hewitt, and Thomas Hewitt, 115, Cannon-street, London. (Complete specification.)

7609. Improvements in glow lamps for high-tension currents. Paul Scharf, 46, Lincoln's-inn-fields, London.

April 25.

7639. Improvements in dynamo-electric machines. Sydney Holmwood Holden and Chamberlain and Hookham, Limited, 18, Southampton-buildings, Chancery-lane, London.

7645. Improvements in distribution of polyphase currents. Samuel Edgar Fedden and Walter Jamieson, Orangefield, Greenock.

7648. Improvements in electric arc lamps. Francis Maddison Long and Ernest Schattner, 55, Chancery-lane, London.

7657. Improvements in and connected with cord grips for electric lampholders, ceiling roses, and the like. William Thomas Burbey, 77, Chancery-lane, London.

7675. Improvements in electrical time-distributing apparatus. Henry Harris Lake, 45, Southampton buildings, Chancery-lane, London (Hermann Cuénod, Switzerland.)

7691. Improvements in electrical work-measuring instruments George William Johnson, 47, Lincoln's-inn fields, London. (Hartmann and Braun, Germany.)

April 26.

7695. Improvements in wall plugs for electric lighting and heating. Sydney Stuart Galsworthy, 10, Craven Hill-gardens, Lancaster-gate, London. (Complete specification.)

7712. Improvements in electric billiard-marking time check relating to the balls being out of play at the end of a stated time. Marsham Oliver, Empire Billiard Saloon, Penstone-street, Sheffield.

7721. Adjustable bracket for electric lighting. Peter Ludwig, Heumarkt 21, Cologne, Germany.

7725. Improvements in or connected with electric accumulators or storage batteries. Arthur Georges Nesfield, 57, Chancery-lane, London.

7737. Improvements in and relating to arc lamps. Alberto Tribelhorn, 11, Southampton-buildings, Chancery-lane, London.

7753. Coupling for electric or other wires. Rolland Thompson and John Dunphy, 11, Queen Victoria-street, London.

7759. Improvements in electrically-operated submarine working devices. Leon Pauer and Joseph de Kutschera, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7768. An improved negative accumulator electrode. Ernst Waldemar Jungner, 18, Buckingham-street, Strand, London. (Complete specification.)

7777. Improvements in apparatus for wireless telegraphy. Guglielmo Marconi and Marconi's Wireless Telegraph Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

7781. Improvements in apparatus for wireless telegraphy. Charles Grey Robinson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7782. Transmitting and receiving switch for wireless telegraphy. Charles Grey Robinson, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

April 27.

7784. Improved system of distribution and collection of current for electric traction. George Davis, 38, Margravine-gardens, West Kensington, London.

7792. Improvements in electrically-operated brakes for centrifugal drying machines or hydro-extractors. Henry Crofts Longedon and Sydney Dale, 17, Hanover-street, Keighley.

7795. Improvements in electric light fittings. Harry Wright Calderbank, 55, Market-street, Manchester.

7805. Method of and apparatus for utilising or converting wind force or pressure into electrical energy or work. James Kershaw Grindrod, 2, Old Market-chambers, Yorkshire-street, Rochdale.

7807. Improvements in and relating to electrical switches and electrical accessories generally. George Whittaker Holt and Archibald James Hallam, 63, Lionel-street, Birmingham.

7851. Improvements in and connected with electric incandescent lamps. Otto Riebensahn, 77, Chancery-lane, London. (Complete specification.)

7861. Improvements in or relating to electrical reciprocating apparatus. John Brown, 111, Hatton-garden, London.

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APRIL 28.

7881. A direct-acting magnetic brake electric arc lamp. John Lenderyon and Tom Samuel Millward Wyatt, Rogerstone, Monmouthshire.

7897. Improvements in surface-contact systems of electric traction. Edward Henry Tyler and Arnold Greaves Hansard, 15, Kirkstall-road, Streatham Hill, London.

7941. Improvements in electrical safety fuse apparatus. William Henry Beck, 115, Cannon-street, London. (Henry Privat, Germany.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published May 19, 1900.

1899.

5975. Magnetic separating machines for extracting iron and steel particles from borings and turnings of brass and copper and other non-magnetic metals, also from charcoal and earths. Parkinson.

6602. Receiving apparatus for so-called Hertzian waves for transforming same into perceptible signs. Schäfer, Renz, and Lippold.

9811. Manufacture of insulating material for electric cables and the like. Heyl Dia.

10081. Electrical resistances. Levy.

10301. Overhead systems for electrical transmission of energy. Routledge.

11244. Compounds for battery solutions. Blumenberg.

11901. Electrical brush-holders. Poole.

11983. Attachments for collectors in electric tramways with slotted conduits. Smith.

12420. Wireless telegraphy. Braun.

13074. Apparatus for electrolysis. Schoop.

13105. Electric arc lamps. Jandus Arc Lamp and Electric Company, Limited, and Jones.

13226. Construction or arrangement of appliances for underground or conduit traction by electricity. Rose and Hall.

13230. Apparatus for supporting pendant globes applicable to the globes of enclosed arc lamps. Söderlund and Ekvall.

13256. Means of lessening the danger attendant upon the employment of overhead conductors in electric tramways. Smith.

13424. Electric cranes and similar revolving appliances. Aldridge.

16352. System of telegraphy. Bedell.

16922. Electric spark fuse. Hardingham. (Schulz.)

18904. Method of and means for preventing electric sparking at contacts in circuits, including electromagnet coils or other coils or conductors in which a self-inductive or sparking capacity exists. Wise. (Buckingham.)

1900.

420. Electric arc lamps. Bremer.

3196. Telegraphic apparatus. Wojniewicz

3315. Electric heating apparatus. Brookes. (Boston Electric Heating and Power Company.)

4230. Electric gas lighters. Fitzpatrick. (Hubert.)

5003. Means for automatically reviving or reinforcing exhausted pulsations upon a telephone line. Mengis.

5179. Tool or means for forming or compressing joints of lead pipes or sheaths for electric cables, metal articles, and the like. Day. (White.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	Apl. 28	4,195	4,019	+ 176	68,964	65,313
Blackpool Corporatn.	,, 26	352	209	+ 143	1,623	1,188
Blackpool-Fleetwood	,, 28	393	293	+ 100	3,919	3,941
Bradford City Trams	,, 29	397	310	+ 87	1,855*a*	1,422
Bristol Tramways Co.	,, 27	3,021	3 063	- 42	—	—
City & South London	,, 29	1,274	1,032	+ 242	20,962	18,322
Dover Tramways ...	,, 28	166	158	+ 8	2,653	2,579
Dublin U.T., electric	,, 27	4,078	998	+3,080	—	—
Dublin S.D. Electric	,, 27	1,176	708	+ 368	—	—
Halifax Corporation	,, 28	590	455	+ 135	2.665	1,765
Hull Corporat'n E.S.	,, 28	911	—	—	4.173*a*	—
Liverpool Corporat'n	,, 21	8,365	6,200	+2,165	109 691	95 107*b*
Liverpool Overhead	,, 29	1,433	1,408	+ 25	23,903	22,863
Sheffield Corporation	,, 29	2,104	—	—	—	—
South Staffordshire	,, 27	650	657	- 7	10,893	10,467

a Since April 1. *b* Partly electrical.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	..	13/16-15/16
British Insulated Wire, Ord., 1-40,000	5	..	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 6½
—— 5 per cent. Mortgage Debentures	100	..	98-103
British Electric Works, Ordinary, 50,001-95,000	1	..	¾-1
—— 6 per cent. Cum. Pref, 1-50,000	1	..	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	4¾-5¼
Brush Electrical Engineering, Ordinary	2	..	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	..	2-2¼
—— 4½ per cent. Debenture Stock	100	..	108-113
—— 4½ per cent. 2nd Debenture Stock	100	..	103-105
Callender's Cable, Debentures	100	..	112-116
—— Ordinary	5	..	14½-15½
—— 5 per cent. Pref.	5	..	5½-6
Crompton and Co.	2	..	3½ 4
—— 5 per cent. Debentures	—	..	99-102
Edison and Swan United, Ordinary	2	..	2-2¼
—— 5 per cent. Debentures	5	..	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	..	98-98
Electric Construction	2	..	2¼-2½
—— 7 per cent. Cumulative Pref.	2	..	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	103-106
W. T. Henley's Telegraph Works, Ordinary	5	..	13½-14½
—— 4½ per cent. Preference	5	..	5¾-5¾
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	..	100-103
Telegraph Construction and Maintenance	12	..	35-39
—— 5 per cent. Bonds	100	..	102-105
Telegraph Manufacturing, Ordinary	5	..	10-11
—— 5 per cent. Cum. Pref.	5	..	5½-6
Willans and Robinson, Ordinary 1-30,000	5	..	11½-12½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	..	7½-7¾ xd
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	7-7½
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	..	5½-5¾
Chelsea Electricity Supply	5	..	6½-7¼
—— 4½ per cent. Debentures	100	..	109-111
City of London, Ordinary	10	..	9½-10½
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9½-10½
—— 6 per cent. Cum. Pref.	10	..	12-13
—— 4½ per cent, Debentures Prov. Certs. All pd. Ed.	—	..	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4¼-5
—— 4½ per cent. First Mort. Deb.	100	..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9½-10½
London Electric, Ordinary	3	..	1¾-2
—— 6 per cent. Pref.	5	..	4¼-4
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1¼-1½
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6½-7
River Plate Electric Light and Traction, Deb.	100	..	76-85
Royal Electrical Company of Montreal	1½	..	170-190
—— 4½ per cent. First Shares Mortgage Debentures	100	..	104-10
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	8½-9½
Westminster, Ordinary	5	..	14½ 15½
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-Shares	5	..	4¾-5¼
—— ,, ,, deferred	5	..	5-5¼
City and South London, Consolidated Ordinary	100	..	64 67
—— Ordinary	10	..	6-7 xd
—— 4 per cent. Debenture Stock	100	..	125-130
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	..	13½-13¾
Waterloo and City, Ordinary	100	..	101-103
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17-18
B. Libane Tramway	100	..	102-104
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	9¾-10¼ xd
British Electric Traction, Ordinary, 1-30,000	10	..	16 17
—— 60,001-75,000	10	..	16-17
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	12¾ 13½
—— 5 per cent. Perpetual Debenture Stock	100	..	124-127
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	..	5-5½ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	104 107
Isle of Man Electric Power, 1-95,000	1	..	7/16-½
—— 6 per cent. Preference, 100,001-170,000	1	..	9/16-⅝
Kidderminster and District Lighting and Traction, Pref.	10	..	9½-10½
New General Traction, Ordinary	5	..	3¾-4¼
—— 6 per cent. Cum. Pref.	5	..	5¼-5¾
North Staffordshire Trams	6	..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— Preference	10	..	10¾-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9½-10½
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	½-¾
National Telephone, Ordinary	5	..	4¾-5¼
—— 6 per cent. Cum. First Pref.	10	..	13-15
—— 6 per cent. Cum. Second Pref.	10	..	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	..	5¼-5¾
—— 3½ per cent. Deb. Stock, Red.	100	..	97-100
Oriental Telephone and Electric Company	1	..	¾-1 xd

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NOTES.

Faraday House.—Prof. Carus-Wilson will commence a special course of lectures upon "The Construction and Use of Motors" to the senior students of the Electrical Standardising, Testing, and Training Institution on Monday, May 28.

Protection from Shock.—We learn that the Society of Agricultural Industry and Commerce of Milan is offering a gold medal to the person of any nation who makes known the best method of protecting working electricians from accident in the course of their duty.

Electric Lighting in China.—We gather from the Berlin correspondent of the *Financial Times* that Messrs. Siemens and Halske, of Berlin, have started a small lighting station at Pekin. The European quarter is shortly to be lighted electrically, and it is hoped that the Chinese merchants will also become consumers.

Society of Model Engineers.—A meeting of this society was held on Tuesday, May 1, at the Memorial Hall, Farringdon-street, E.C., about 70 members and friends being present. Mr. W. H. Dearden read an interesting paper on "Tools and Toolmaking." After the paper, trials of model steam and electric locomotives took place on the society's track.

Turkish Reforms.—Reuter's correspondent at Constantinople informs us that the local Press in that town are, in order to allay public distrust of the Government, publishing articles containing schemes which, it is stated, are to be carried out for the welfare of the country. Amongst these schemes, which we are afraid will go no further, are the renovation of the ships of war, the construction of the telegraph lines, and railway and water works.

Wilful Damage.—We regret to have to refer to an outrage against the German manufactures at the Paris Exhibition. It seems that the 1,500-h.p. dynamo exhibited by Messrs. Lahmeyer and Co., of Frankfort-on Maine, was temporarily disabled on Saturday last by a handful of sand and gravel placed in one of the lubricating boxes. The agent of the firm has naturally reported the matter to the exhibition authorities, but so far it has not been discovered who perpetrated this outrage.

Home Truths.—It is stated that in a recent report of Mr. W. Brophy, the chief electrician of the Boston electric wiring department, to the mayor of that town, the following statement occurs: "I think it best for you to discontinue the electrical construction division, that has proved a rest for the weary, a spawning bed for embryo statesmen, and has accomplished so little of the real work for which it was organised—viz., guarding the city treasury against the rapacity of electrical contractors and dealers." We expect that the employés of this department will be shortly applying for berths in the West Ham electricity station.

Electric Flower-Forcing.—In its columns devoted to science gossip, *Invention* states that the use of the electric arc in the culture of early lilies is shown by Mr. M. G. Kains to be quite practicable, but he finds that this light should not be used until the lily-buds are an inch long, and that it should then be passed through glass to screen out the ultra-violet rays. In his experiments a dark-brown burn appeared on the plants under the naked light. The light was continued nightly for four months, and the plants were taller and earlier in blossoming, but less robust and with shorter-lived flowers, than those grown in the dark.

The Canadian Electrical Association.—The convention of the Canadian Electrical Association is to be held on June 27, 28, and 29 at Ottawa. Amongst the papers to be read on that occasion are one by Prof. R. B. Owens, of McGill University, Montreal, on "Utilising the Available Central-Station Capacity," and another by Mr. F. H. Leonard, of Montreal, on "The Effect of Power Factor on the Operation and Investment, with Special Reference to Induction Motors and Enclosed Arc Lamps." We hope that the disastrous fire which recently occurred in this great Canadian city will not prevent the arrangements for the convention being carried out.

Incandescent Gas Mantles.—On Monday last, Prof. Vivian B. Lewes delivered the first of a series of three lectures on "The Incandescent Gas Mantle and its Use" before the Society of Arts. The lectures will be continued on May 14 and 21. The first lecture was devoted to the history of the subject, and to the sources and preparation of the oxides employed in the manufacture of the mantles. In the next lecture the details of manufacture will be taken up, and the theory of the mantle discussed. The debatable subject of causes which lead to the luminosity will again be treated. The last lecture is to be devoted to practical details on the use of incandescent gas mantles.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, when the following were elected members: Mrs. E. S. Beale, Mr. E. Callard, Mr. E. J. Duveen, Mr. E. Pearson, Lord Russell of Killowen, and Mr. J. A. Thierry. The thanks of the members were returned to Prof. F. Clowes for his donation to the fund for the promotion of experimental research at low temperatures, and the Chairman announced that he had nominated the following vice-presidents for the ensuing year: Sir F. Bramwell, Right Hon. Lord Lister, Dr. Ludwig Mond, Sir A. Noble, Mr. A. Siemens, the Hon. Sir J. Stirling, Sir J. Crichton Browne, and Sir W. Crookes.

The Institution of Junior Engineers.—A visit was paid by this institution on Saturday last to the Bromley depôt of the Poplar District Board of Works. The members were conducted over the works by Mr. J. Williams, one of the Board officers, and Mr. S. Streeter, clerk of works. The depôt includes dust destructor, power stonebreaking, and clinker grinding, for the manufacture of paving, etc., from the residue of the destructor. All the steam required to drive the various machines is raised from the combustion of the dust refuse. There are also steam disinfecting apparatus, engineering workshops, etc. The electricity works adjoining, in course of construction, were seen and their general arrangement explained.

Man Power.—A good example of useless statistics is given by the comparison made by Mr. C. D. Wright, of the United States Labour Commission, in an article reproduced in *Guntor's Magazine*. The author assumes that 1 h.p. is equivalent to the power of six men, and proceeds to calculate the extra population which would be required in the United States if the steam-engines were done away with in favour of man power. He finds that 36,000,000 additional men beyond the some 4,500,000 now employed would have to be found. With the usual proportion of total population to active workers, the increase would mean a new population of 180,000,000. These figures are, of course, quite useless, as it would be impossible to adapt man power to the work to which steam-engines are put.

The Pan-American Exhibition.—This exhibition, which is to be held in 1901, is to be lighted by electricity on a very large scale. The Court of Fountains is to have 100,000 incandescent lamps of 8 c.p. and 16 c.p. to illuminate it, thus giving a very fine light without any particularly brilliant point, such as would be caused by arc lamps. The tower in the exposition is to be 300ft. high, and will have a water display consisting of water dropping

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from a height of 70ft. This water is to be subjected to electrical effects, each drop being coloured according to its position at different parts of the fall. An illuminated cascade is to be provided, and designs are being developed for electric fountains and for illuminating the Grand Canal for some miles. If the electric fountains are equal to those exhibited last summer at the Crystal Palace, there is no doubt that this portion of the illumination scheme will be a success.

Car Stops.—There is at present great need for reform in the matter of running tramway cars, in that cars stop a number of times within a few minutes in order to pick up passengers. This constant stopping and starting must cause great wear on the car machinery, and also tends to annoy the passengers already on the car. We notice a case in America where a car was stopped either to pick up or put down passengers no less than 550 times in 600 minutes. The accuracy of the count cannot, of course, be vouched for, as it depends on the memory of the motorman of the car in question, but at any rate it shows that a very large number of stops were made which were not at all necessary. Fixed stopping places are now being adopted on certain tramway lines, and we feel sure that benefit will result from this in the increased speed at which a journey is performed, in the longer life of the car machinery, and in the saving of the passengers' tempers.

New York Trams.—A novelty in electric car running is, we understand, soon to be tried on the New York tramways. It is soon to be possible to take a trip from New York to Boston in a well-equipped private trolley car. Special cars will also stop at the nearest corner to one's house and convey them wherever they wish up or across country. The price of these excursions is going to be remarkably cheap. The scheme in hand is to fill up the gaps in the trolley tracks at various places between New York and Boston, which is expected to take two months only. People travelling more than one day will be able to have their car put on a side track at night and have a comfortable sleep. Other similar information is also given, but we have not space to recount it all. The whole scheme does not at first sight strike one as being very simple, and the accommodation one is to get for a few shillings inclines us to the view that the article was written to fill up a vacant corner, and not that anything more than an ordinary extension is being considered.

Electricity in Bohemia.—During the past few years electricity has become very popular in the large industrial centres of Bohemia. The numerous industries, such as the manufacture of woollen goods, porcelain, metal, and other goods, are expanding on account of the new power. The system, we learn, that the large Austrian and German electrical manufacturers pursue is to have a representative in Prague, who, directly he finds an owner wishing to have his works electrically fitted, goes to him and submits estimates and prices, and the matter is generally settled with but little correspondence with the head firm. The *Western Electrician* states that great possibilities are opening up in Bohemia for electrical undertakers, and that the city of Reichenberg has at present under consideration a scheme for more than a dozen narrow-gauge electric railway lines which will connect the town with the neighbouring towns. The city of Gablonz has already, we learn, started an electric tramway service. Water power is very plentiful in Bohemia, and we should expect the electric work to be carried out much on the same lines as the Swiss works.

Conductivity of Amalgams.—The following is an abstract of a paper by Mr. A. Larsen, appearing in the *Annalen der Physik und Chemie*. The abstract is taken from the *Journal* of the Chemical Society, and reads as follows: The relative conductivity, Lt, of liquid amalgams of lead, zinc, cadmium, tin, and bismuth—that is, the conductivity compared with that of mercury at the same temperature—increases proportionately with the temperature, the absolute increase depending on the concentration of the particular amalgam; if $Lt = 1 + \delta t$, then $\delta t = \delta_{20}[1 + \alpha(t - 20)]$ the coefficient α varying from 0·0004 for cadmium and zinc amalgams to 0·002 for bismuth amalgams. It appears that in dilute liquid amalgams the dissolved metal is dissociated, and that the degree of dissociation increases both with falling concentration and with rising temperature. The curve connecting relative conductivity and concentration of the amalgam shows a break where the limit of solubility is reached. The relative conductivity, and therefore the concentration, of amalgams saturated at various temperatures increases nearly proportionally with the temperatures.

Clearing Cross Wires.—On April 5 last a heavy snowstorm in Colorado resulted in very great damage to overhead wires. The telephone wires were, perhaps, the chief sufferers, although the street railway companies also suffered. The snowstorm raged all the afternoon and evening of April 5, and the snow ceased falling on the morning of the 6th. In order to restore traffic on the Denver Tramway Company's lines in the early morning of the 6th, the necessary repairs to the overhead trolley wire were made under the direction of a Mr. Durbain. As soon as this had been done, and the cables hanging on the trolley wires were disconnected, there still remained a number of small wires which could not be easily disentangled. In order to avoid the long delay which would be necessary to clear these by hand, the superintendent ordered the full 500 volts to be switched on the trolley wire. The *Electrical World*, in describing what happened, stated that a "brilliant pyrotechnical display followed, but the wires were cleared." Such a drastic step shows how highly the tramway engineers in the States value a continuous service, and that they do not hesitate to cause damage to the telephone undertaking in order to secure this.

The General Electric Report.—The annual report of the General Electric Company of America has just been issued. It shows an increasing prosperity in the business done, and also an increasing demand for motors, lamps, and general supplies. The report states that the profits for the year, after making all deductions, were about £1,095,800. After subtracting dividends, debenture interest, and reduction on patent account, the net addition to surplus account was about £440,000. The total sales for the year were about £4,475,000, the cost of the goods sold being about £3,714,000. The orders were increased by 51 per cent. on the previous year, over 142,000 separate orders being received in the supply department. The increased business has caused large additions to be made to the machine and engineering shops of the company at Schenectady, the total area of factory buildings being over 2,000,000 square feet, and the number of employés 12,000. The alternating generator of the revolving-field type has brought in orders up to over 200,000 h.p., and the air-blast type of transformer has been largely sold. The demand for specially designed electrical apparatus has largely increased, and the line of standard sizes is being increased to meet this demand. At the end of January the book value of the three factory plants owned by the company was nearly £800,000.

Tuberculosis.—The Crôtte method of electrically treating tuberculosis is described in a fully-illustrated article in the *Western Electrician*. The treatment consists of introducing antiseptic medicines into the diseased lung

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tissue by means of the electricity obtained from a static machine. With the aid of the electricity from this machine we are informed that a powerful germ-killing drug is driven right through the skin, flesh, and bone of the chest and into the diseased lungs. Once these germs are killed the patient gets better. The drug which is sent into the germs is what is called formaldehyde, which is said to be absolutely deadly to germ life. Static electricity was used in preference to dynamic, owing to the danger to the patient from the latter. The circuit is made by means of sponge contacts dipped in formaldehyde and pressed against the body of the patient. The machine used in the operation consists of eight cylinders of ebonite placed one inside the other, but turning in opposite directions, the turning being done by a 1-h.p motor. The voltage of the machine is said to be very high for such an instrument, while the current also is larger than usually obtained from static machines. We cannot quite understand Prof. Crôtte using the cylinder type of static machine instead of the Wimshurst type, which usually gives very much better results, unless his cylinders are equipped on the Wimshurst principle.

Heating Surface of Boilers.—We notice in *Dingler's Polytechnisches Journal* an article from the pen of Prof. Fr. Freytag on the actual heating surface of boilers. The writer insists that the surface of a boiler directly exposed to heat only should be recognised as its actual heating surface, nor is there any reason, in his opinion, why this rule should not be universally observed. The builders of fire-tube boilers might, indeed, object that the makers of water-tube boilers would derive all the benefit from this recognition, for with an equal number of tubes of the same length the actual heating surface of a water-tube boiler calculated on this basis figures out at 7 to 11 per cent. greater than that of a fire-tube boiler. This is certainly correct, continues the writer, but then the water-tube boiler is admittedly superior to the fire-tube type in this respect. In his calculations the writer does not give a definite value for the heat coefficient of the heating surface. On the other hand, it is sufficiently well known that the conducting power of one square foot of heating surface relative to one type of boiler may be double that of an equal area of surface in another type. The facility with which the heating surfaces may be cleansed of soot and ash is also a consideration, and here we find a reason why makers of fire-tube boilers need not fear the competition of the water-tube boiler, despite the somewhat smaller relative heating surface of the former type with the same number and length of a given sized tube.

Trusts.—We are receiving regularly from Chicago copies of a journal called *Public Policy*, which states in its headline that it is "a medium for diffusing correct economic instruction on questions of public policy." In its issue for April 14 there are some editorial comments entitled "The Truth about Trusts," and after reading this we rather doubt the correct economical instruction given by our contemporary. In dealing with the advantages which trusts have in the matter of transport, in consequence of the large business they do, the paper assumes that all these advantages in the way of rebates come to the consumer. An example is quoted of a dry goods merchant who was elected a member of the States Senate. He was enabled while in this position to do some favour for a railway company, in consequence of which the company carried his goods free. When certain of his constituents charged him with corruption he stated that he held his position in the Senate for the benefit of his constituents, and that he had given his constituents the benefit derived from the free transit of his goods. He is said to have added that the favour he had done to the railway company did not cost anyone a single cent. This is the kind of argument which is naturally used by those supporting trusts, and we are asked to believe that a railway company would really remit their dues in favour of certain men in consequence of a concession which was not remunerative. We should say that the truth of the above story would be that the member of the Senate in question had sold his constituents to the railway company, and that the major portion of the rebate received in consequence had gone into his own pocket. Our contemporary proceeds to discriminate between those trusts which are legitimate, in that they look for their profit from actual manufacture and supply, and those which are run chiefly as stock speculations. In either case, where the trusts are used to limit competition, the ultimate outcome cannot be for the good of the majority of the public.

Oscillatory Discharges.—A paper by Mr. G. A. Hemsalech, on the influence of an iron core on the discharge of a condenser which passes round an induction coil, was read before the Academie des Sciences last month. The author, in his researches on the spectrum from oscillatory discharges from condensers, remarked that the introduction of an iron core into a coil of wire through which a discharge was passing, made considerable changes in the character of the spectrum. In fact, the oscillatory character of the spark was often completely changed. He refers to a statement by Lord Rayleigh, that when the oscillations of the electric current are sufficiently rapid the iron is not able to be magnetised in a simple way, and in consequence only the exterior surface is affected. In such a case, instead of iron augmenting the self-induction of a circuit, it may even diminish it. The author proceeds to describe an experiment he had made by passing a discharge from a condenser of fairly large surface round a coil of wire of 1,200 turns. The length of the bobbin was 19·6in., and its internal diameter almost 2in. In charging the condensers by means of a Wimshurst machine, a spark was obtained from ·03in. to ·09in. long. He then made the current pass through a Geissler tube, which showed that the discharge was of an oscillatory character, as he was not able to distinguish any signs of distinct polarity at either electrode. If the iron core was introduced into the bobbin of wire, the oscillatory discharge diminished and finally disappeared. The author states that exactly similar effects were produced by introducing a water resistance in the circuit, and concludes that because the water resistance and the iron core acted in the same way it is not a self-induction effect, which alters the character of the discharge. It would seem to us that these assumptions need not necessarily be accurate, as a certain relation between capacity and the resistance, etc., of the circuit is required in order that the discharge can be oscillatory, and this balance can be upset either by adding more resistance or more self-induction.

Electric Lighting of Trains.—We notice in *L'Industrie Electrique* a description of the Vicarino system of lighting railway carriages by electricity. This system in certain details is like others which have been tried in England without much success. The designer provides a dynamo and battery of accumulators for each carriage, and arranges them together with an automatic switch so that the dynamo is only switched on to the lamps when its voltage reaches a certain predetermined limit. The dynamo is supported on the under side of the carriage, and is driven from a pulley of the axle by means of friction gearing. The machine is pivoted and held against the driving wheel by means of a strong spring. The chief interest in the apparatus centres round the means by which

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an approximately constant potential is obtained in spite of a large variation of speed, which is unavoidable when a car axle is used for driving. The field winding of the machine is so arranged that when running up to speed it is excited by a shunt coil from the battery of accumulators. There is also on the machine a series coil through which all the current generated by the machine has to pass. This acts in the contrary direction to the shunt winding, tending to demagnetise the machine. When the voltage at the terminals has reached the predetermined limit, the automatic switch connects the machine to the circuit, and at the same time introduces a resistance between the lamps and one terminal. The current generated then goes mostly through the lamps, but as the speed increases the field becomes demagnetised owing to the increase of current, and in this way it is claimed by the inventor that the slight increase which results is chiefly operative in charging the accumulators. A curve is given which shows that, whereas when the machine is first switched on the voltage is slightly over 30, with a speed of the train of about 12½ miles per hour, at a speed of 42 miles per hour the voltage is only 32. In the meantime the current from the machine is increased from about 2 amperes up to 15. The greatest objection to this system of regulation is that the small dynamos used are worked with their weakest field at their maximum load; or in other words, the machines have to be unduly large for their work. Otherwise the details seem to be well thought out, and it is merely a question of cost of upkeep. In the article now before us an estimate is given of this cost, but in these matters figures from actual experience are the only criterion. The apparatus in question is manufactured by the Compagnie Général de Nancy, and is being tried on a number of French railways.

Grisson Gear.—The *Elektrotechnischer Anzeiger* describes a form of gear recently introduced by Mr. Robert Grisson, of Hamburg, which is said to combine the advantages relative to other methods of high-ratio gearing hitherto in vogue without their attendant disadvantages. The gear has been designed for employment in cases where the application of ordinary methods of gearing is involved with difficulty for some reason or other, or is not practicable. The description in question is supplemented by several diagrams and photographs, from which it appears that the gear consists essentially of a cam wheel and a pin wheel ingeniously disposed. Upon its hub the cam wheel carries two crescent-shaped teeth, situated in two different planes at a relative angle of 180deg. to each other, which engage with the pin wheel. This latter wheel has three disc-like ribs, between which rollers are pivoted at equal distances from each other. The rollers on the one side of the centre rib are opposite the interstices between the rollers on the other side. In the case of large gears the ribs are supported from the hub by arms, while solid discs are provided for small gearing. One revolution of the cam wheel moves the roller wheel forward through an angle represented by the distance between two roller centres. Generally speaking, the cam wheel and pin wheel are employed as ordinary toothed wheels, since they are keyed to the shafts in the same manner. In fact, each cam on the cam wheel acts like a one-toothed pinion. It is claimed that the gear enables high ratios of gearing with small axial distances to be obtained, and further it ensures uniform running with freedom from concussion. The transmitting and counter shafts are parallel. To illustrate the practical application of the gear, one of the motors employed by the Union Elektricitäts-Gesellschaft, Berlin, for boring purposes is instanced. These motors run at 1,800 revolutions per minute, and formerly possessed the gear ratio 1 : 5½, which was the highest gearing between the motor and boring shaft which was possible by using toothed wheels with the axial distance available. In consequence of this, too great a speed was imparted to the boring implement, which, therefore, became quickly blunted when drilling hard stone. The toothed-wheeled gearing was therefore removed, and in its place a gear of the Grisson type of 1 : 10 substituted, whereby the revolutions of the borer per minute were reduced by one-half, and the efficiency of the motor correspondingly increased. Other examples are given of the practical application of this form of gear, all of which tend to show that the advantage claimed for it are based on reliable data. The question which arises is that of the surface required to transmit a given power by this gear, and the corresponding size of the same. From the drawings it would seem that there is little chance of it displacing spur gearing for large powers.

Saving Weight in Dynamos.—A paper by Mr. E. Rosenberg, reprinted in the *Zeitschrift für Elektrotechnik*, considers the various types of dynamo machines in vogue from the point of view of the relative economy in weight effected by the respective designs. Mr. Rosenberg also discusses the question whether any considerable economy in the weight of dynamos may be anticipated in the future. He observes that when the demand for lighter machinery made itself felt, recourse was had to the application of steel to tubular construction. But this construction does not apply in the case of dynamos. Waltenhofen, indeed, proved, with the aid of some interesting experiments, that with certain degrees of induction a tube might be more highly magnetised than a massive rod of equal volume; but this induction was below the value which obtained in practice. Nor does Mr. Rosenberg think that the application of aluminium is destined to effect any diminution in the weight of dynamo machinery. The use of alternative materials of greater electric or magnetic capacity than copper and iron, depends upon the discovery of plentiful supplies of materials which are at present very rare. By the progressive improvement of the materials now employed, by increasing the conductivity of copper, increasing the permeability and diminishing the hysteresis of the iron, further economy might be obtained, but it is safe to assume that no improvement of any moment in this direction is possible. On the other hand, there is ample room for the improvement of insulating materials. Space could be saved by the employment of a thin varnish-like coating of insulation, or, perhaps, by employing glass, whose fibres have proved themselves so remarkably adapted for certain insulating purposes. The thickness of the insulation on conductors, which at present constitutes a considerable portion of their total diameter, could thus be reduced to a minimum, and when, in addition, this insulation has been made sufficiently reliable to render further insulation of the coils and frames unnecessary, then the requisite winding room will have been greatly diminished, and at the same time a considerable reduction in the weight of the machine achieved. The successful elimination of the armature reaction is also destined to play an important part in lessening the weight of dynamo machinery. It is this problem that, through the different positions from which it is considered by individual designers, prevents the other factors determining the economy of a machine from being developed to their full extent. When this problem has been thoroughly solved, the dimensions of a machine will be governed entirely by the market price of copper and iron, and not according to the taste and technical fads of the designer. But it may be safely assumed that before this stage is reached a great advance in the progress of science, such as the discovery of a direct and economical method of generating electricity from coal, the invention of a

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commutatorless continuous-current machine, or an alternate-current accumulator, will have transferred the science of dynamo construction to another basis. We hardly agree with the author's conclusions, and think the designers of the future will be just as keen on reduction of the weight of copper and iron in a dynamo as those of to-day.

Rectification.—Mr. W. L. Hildburgh contributes to the number of the *Electrical World* for April 14 the first of a series of articles entitled "The Production of Asymmetrical Alternating Currents by Means of Electrolytic Polarisation." The articles in question are a condensation of a thesis prepared by the author when qualifying for the degree of Doctor of Philosophy at the Columbian University. The first article starts with a definition of terms, which we are obliged to refer to before giving the author's conclusions. Thus by "asymmetric efficiency" the author means the ratio of total to useful unidirectional current in an asymmetrical conductor. A single-cell rectifier is an asymmetrical conductor, each of whose similar parts consists essentially of a single electrolytic element. The useful part of an asymmetrically affected alternating-current wave is the larger part. The useful current flows during the time represented by that part of the wave, and in the useful direction. The useless part is the smaller part of the wave, and neutralises a portion of the work done by the useful. The author proceeds to describe some two-cell rectifiers and to give curves which he has obtained both from theory and practice from the use of these. The author's conclusions on the use of such rectifiers are briefly as follows: The smaller the passive plates the higher is the efficiency of the combination. On the other hand, the higher the total resistance the lower the efficiency. There is naturally a series of maximum values of efficiencies, one for each frequency in any particular rectifier, which are reached only when there is no external resistance. The author also finds that the higher the frequency, the lower the efficiency. When the frequency is very high in a theoretically perfect rectifier little effect is produced, but this effect is increased owing to the capacity of the passive plate becoming smaller as the frequency is increased. If the active E.M.F. be increased, the zero-line of asymmetry (the line representing the continuous current through the rectifier) will be shifted, and only the part of the "useless" projecting over the true zero-line will be choked, thus reducing the efficiency, though the amount of unidirectional current is increased. If the impressed E M.F. be kept low, asymmetry may cease completely. As long as the decomposition value is not exceeded, the author finds that in the passive cell the efficiency is independent of the E M.F. and of the shape of the E M.F. wave. The higher the frequency used, other conditions remaining the same, the greater is the quantity of direct current, as read on the ammeter, obtained from a rectifier. Thus the quantity also increases with the size of the plates. The author proceeds, in his conclusions, to refer to other small points of interest in the details connected with the working of such rectifiers, and reserves his final article for single-cell rectifiers. His conclusions, however, on the coupling of these two-cell rectifiers are of interest. These re as follows: "Rectifiers for high impressed E.M.F.'s may be formed by joining a number of two-cell rectifiers in series. If n rectifiers are put in series and the passive plates in each made n times as large as before, neither the internal resistance nor the efficiency will be changed, though the ability to asymmetrically affect an alternating E.M.F. n times as great as at first has been gained. If n rectifiers are put in series without changing the size of the plates, the efficiency will be the same as in a rectifier having plates $\frac{1}{n}$ the size of the plates in each. The number of rectifiers and the impressed E.M.F. should, for the best result, be proportioned to their circuit as primary cells are proportioned, each primary cell being represented by a rectifier and a certain fraction of the impressed E.M.F.

Light Railways.—The annual report of the Light Railway Commissioners, together with a covering report of the Board of Trade for the year ending Dec. 31, 1899, has just been published. The Commissioners state that in the year 1896-97, 56 applications for orders to authorise light railways were made; in the year 1897-98, 65 applications; and in the year 1898 99, 94 applications. In the month of November, 1899, for the first half of the year 1899-1900, 43 applications were made. Eighty-eight orders have been submitted (in respect of 91 applications) to the Board of Trade for confirmation, and about 20 others will probably be submitted in the early part of this year. From a classified list it appears 122 of the applications received since the Act came into force were for light railways resembling ordinary railways. Of these, 53 have already been sent to the Board of Trade, and represent a mileage of 611, and an estimated outlay of £3,380,167. Again, 133 of the applications comprised lines which the Commissioners describe as road or street railways. Of these, 34 have been passed to the Board of Trade, with a total mileage of 182, and involving an outlay of £1,282,878. Of the 94 applications for the year 1898-99, nine were withdrawn prior to and three were rejected without the holding of a local enquiry, leaving 82 to be dealt with. Up to Dec. 1, 1899, the Commissioners had held local enquiries as to 67 of these applications (47 being approved, two adjourned, one withdrawn, and 17 rejected), but 15 still remained for local enquiry. They proceed to report that further experience has verified the apprehension, expressed in the previous report, that it would prove impossible for them to deal with the great and increasing number of applications within the proper time for so doing. In the year 1897 there were held 48 local enquiries; in 1898, 54; and in 1899, 73, but arrears have nevertheless accumulated to the extent set out above. In holding such enquiries a considerable time is necessarily occupied in travelling to and from the localities, often in remote parts of Great Britain. The Commissioners are, therefore, compelled to point out that unless some fresh arrangements are made, there may be an increasing block of arrears detrimental to the working of the Act. The report of Sir Courtenay Boyle for the Board of Trade shows that very nearly all of the orders passed by the Light Railway Commissioners are confirmed by the Board. The confirmation of the Dundee and Broughty Ferry Light Railway Order was opposed by the Caledonian and North British Railway Companies, the owners of the Dundee and Arbroath Joint Railway, on the ground that the proposed undertaking would have so material an effect on the existing undertaking of the companies that the proposals of the promoters ought to be submitted to Parliament in accordance with the provisions of Section 9 of the Light Railways Act, 1896. After hearing the objections urged by counsel on behalf of the railway companies, the Board of Trade decided that the objection should be upheld, and they refused to confirm the order. Since the date of the last report, the Treasury have agreed to make the following advances in respect of light railways authorised by orders that have been confirmed by the Board of Trade: Dornoch, £5,000, in addition to £9,000 previously promised; Welshpool and Llanfair, £7,000; Wick and Lybster, £20,000. The Treasury have also conditionally agreed to advance £16,000 in the case of the Kelvedon, Tiptree, and Tollesbury order, still before the Board of Trade.

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AMERICAN CENTRAL-STATION DESIGN.

Under this heading in our issue for April 6 we gave a description of the boilers and boiler-houses of the new station of the New York Metropolitan Street Railway Company. We now propose to give a few details as to the dynamos, etc., in this station. Thus the central generating plant will consist, when completed, of 11 main engines, each coupled to a 3,500-kw. three-phase alternator. The machines will stand an overload of 33⅓ per cent. for four hours, which gives them a carrying capacity of 5,000 kw. The engines, as stated in our last article, are able to continuously stand this overload. These machines are of the revolving-field type, with external stationary armatures, and the field ring is mounted on a spider consisting of eight arms, which is cast in one piece with the hub. This casting is keyed to the 37in. compressed-steel forged shaft by means of two keys, 5in. by 2½in., placed 90deg. apart from each other. This arrangement can be seen by referring to Fig. 1. For the purpose of preventing any great rush of power from the flywheel rim to the field ring from passing through the shaft and straining the keys, the flywheel hub is bolted to the spokes of the field-ring spider at a distance of 4ft. from the centre of the shaft. We notice in the *Electrical World*, from whence we gather the information concerning this plant, a photograph of one of the huge spider castings used for the generators. In order to obtain a frequency of 25 cycles per second at 75 revolutions per minute, each machine has 40 poles, composed of sheet-steel punchings surrounded with an edgewise winding. The diameter at the air-gap is 16ft. 8in. The poles, in conformity with the usual General Electric practice, are bolted to a cast-steel yoke ring, which is bolted to the spokes of the spider. This yoke ring is built up of four sections, each of these being half the full axial width of the ring, and spanning half the circumference. This is clearly shown in Fig. 2. The rim tension of the sections is carried across the butt joints by means of double-headed keys, such as are usual in flywheels.

The exciting current is introduced to the revolving field through carbon brushes bearing on cast-iron rings, which are split so that they can be removed if necessary. The resistance of each field is one-third ohm, the necessary amount of exciting current to deliver full voltage—*i.e.*, 6,600 volts—from the armature at full non-inductive load is 300 amperes. For purposes of regulation the magnetism has been carried fairly high on the saturation curve, and the air-gap has been made very narrow. In this way very stiff fields are avoided in the machines.

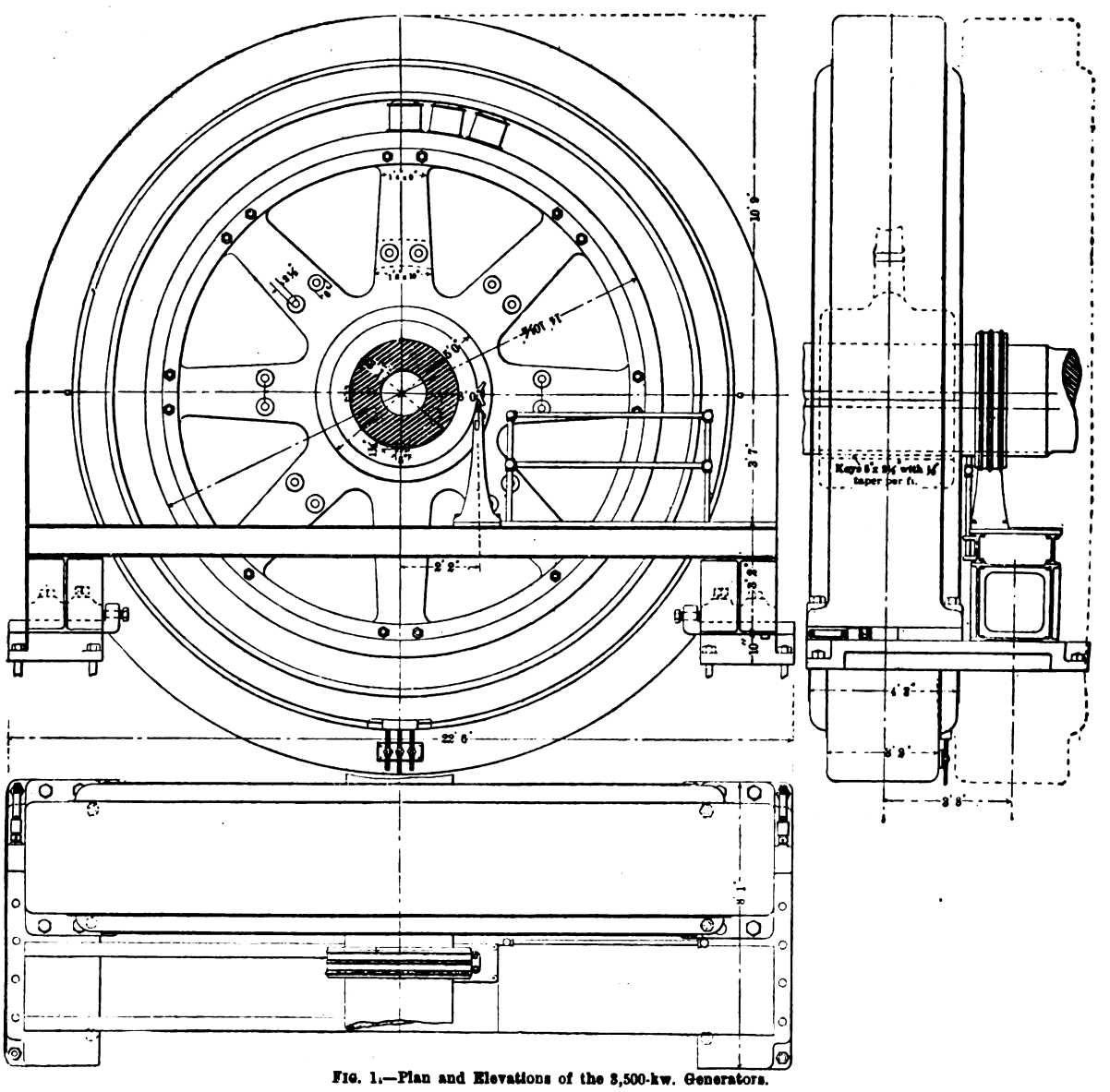

FIG. 1.—Plan and Elevations of the 3,500-kw. Generators.

Working at a high density, the magnetomotive force of the armature reaction cannot cause as great a change of the field strength as if the density were down on a steeper portion of the magnetisation curve, and on this account the throwing off of full non-inductive load causes a rise of voltage of only 5 per cent. above the normal 6,600 volts. The necessary field current for 6,600 volts varies from 275 amperes at no load to 300 amperes full load non-inductive. The pressure at the field terminals at full non-inductive load being obviously 100 volts, this gives a margin of 25 volts of the 125 generated by the exciters for overcoming the increased armature reactions due to lagging currents. The number of field ampere-turns are reduced by the small air-gap, the armature short-circuit current being directly proportional to these. The short-circuit current of these machines is less than 800 amperes per leg with

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full-load excitation, and the air-gap varies from $\frac{5}{16}$in. at the pole centre to $\frac{11}{16}$in. at the tips. In Fig. 3 may be seen the efficiency and no-load saturation curves. The frame of the outside stationary armature is of the usual type, with an external diameter of 21½ft., and it is mounted on sliding foundation-plates, so that it can be moved to clear the field. On account of the high potential of the armature currents, the winding is carried in a few large slots instead of in a number of small ones. There are six slots to each pole, each being about 1¼in. wide by 3¾in. deep. These slots contain former-wound coils, of which there are two per pole per phase. They are made of copper cable, and fixed in what is known as double-chain winding. In one of the galleries is mounted a 300-kw. step-up transformer, giving 20,000 volts, with which to test the insulation of the armature winding, etc., of the machines. The copper loss in the armature at 3,500 kw. is 26½ kw, the core loss being estimated at from 1½ to 2 per cent. of the rated output. Taking the mean between these two, the efficiency curve shown in Fig. 3 has been obtained. The efficiencies at various loads are as follows: at full load, 96·7 per cent.; at 1¼ load, 97 per cent.; at ¾ load, 96·2

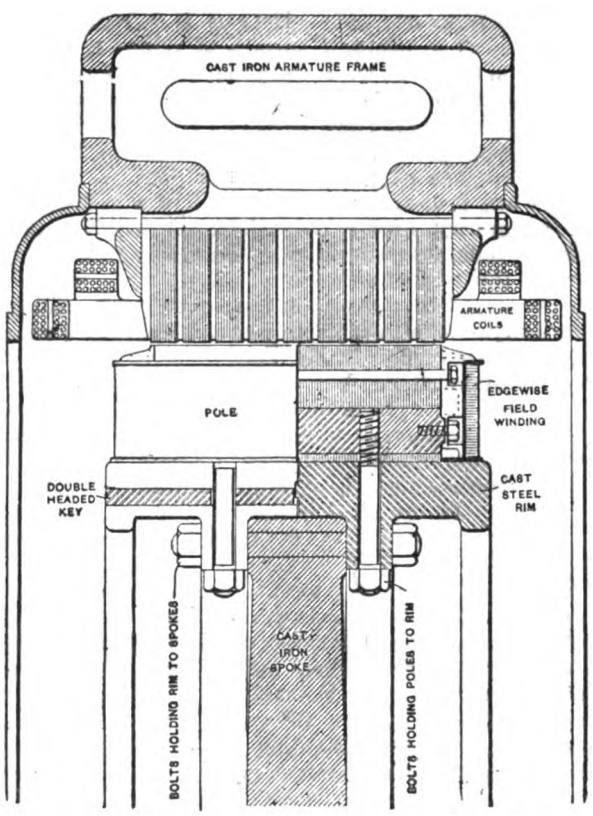

FIG. 2.—Axial Section through Field and Armature.

per cent.; at ½ load, 94·8 per cent.; and at ¼ load, 90·8 per cent. Each machine has a gross weight of about 130 tons, the rotating part being about half of this. A very characteristic feature of the high-tension circuits in this station and the sub-stations is the use of patent electro-pneumatic oil-break switches, no air-break switch being used. There are to be about 100 of these circuit breakers in the main station, all of the same size and differing only in current-carrying capacity. None of these will be of the hand-operated type and mounted on the back of the switchboard, as each is to stand alone on its own foundation, with its three phases in three different cells divided by brick walls. The circuit breakers are to be operated by pneumatic power, the compressed air forcing a piston up or down in a vertical cylinder above the top of the brick cell holding the live parts. The valve controlling the cylinder is worked by the one magnet with which the apparatus is fitted, this magnet on excitation pulling its armature down and working the valve. The valve is closed by means of a spring when the current is cut off from the magnet. The magnets are supplied with current at 110 volts from exciters at the main station. The compressed air for the pneumatic cylinders is supplied by motor-driven air-pumps with automatic controllers. The main position of the oil circuit breaker raises or lowers a metal cross-head carrying three wooden rods, which extend down into three cells, each containing the switching apparatus for one leg of the circuit. The cells being separated by brick partitions, a burn-out in one cell cannot spread to the others. As the opening of two legs breaks a three-phase circuit, an arc in one cell will not render the breaker useless. The circuit-breaking parts of the breaker consist of two brass cylinders for each phase, into the tops of which two copper rods extend from above, these two rods connecting the two cylinders together when lowered by the cross-head to which they are attached. The two brass cylinders in each cell are respectively mounted on copper castings, to one of which is connected the incoming lead and to the other the outgoing lead of the same phase. Each cylinder is nearly filled with transil oil, and is covered by a metal cap. When the three pairs of rods on one cross-head are lowered, their ends make contact with the copper castings under the oil and the circuit is closed. When the rods are lifted the circuit is broken under the oil at two points in each leg, or six points in each complete three-phase switch. The oil breakers are made in two capacities, one rated at 800 amperes and used for generators and groups of feeders, the

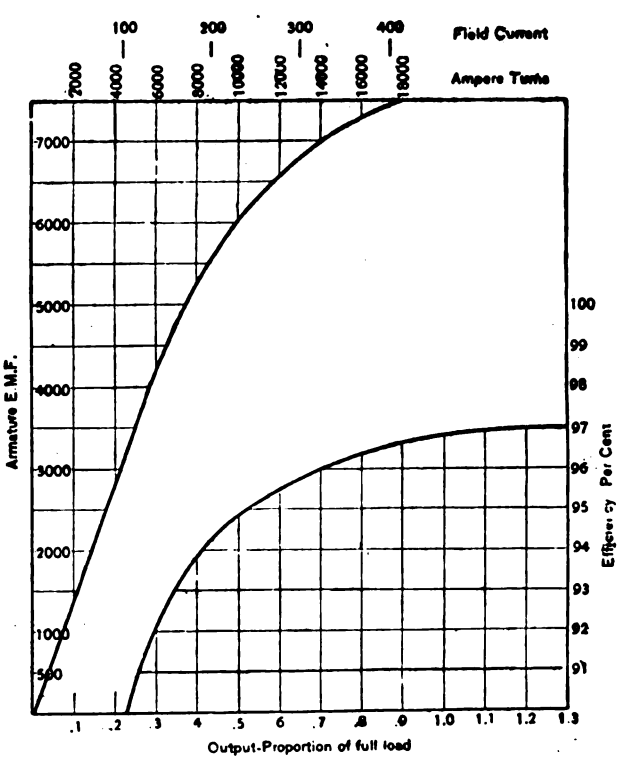

FIG. 3.—Efficiency and No-Load Saturation Curves.

other, rated at 300 amperes, being used for single feeder and sub-station high-tension work. These oil breakers have been subjected to the most severe tests, and have come through the ordeal exceedingly well.

ELECTRICAL UNITS.

The following is a communication by Prof. Emil Budde, of the well-known firm of Siemens and Halske in Berlin, on the proposals by Prof. Fessenden for altering the practical electrical units. As these proposals are likely to come before the congress at the Paris Exhibition in August, we think it well to print in full Prof. Budde's letter to the *Electrical World* of New York. The letter in question tends to confirm our opinion that the objections to the alteration of the present units would more than counterbalance any advantage to be derived from the change. Prof. Budde's letter reads as follows:

I have read with much interest an article by Prof. Fessenden on a proposed system of units. When the congress gathered in Paris to establish a system of

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practical units—the ohm, ampere, etc.—I considered the action premature. I myself was not a member of that congress, but talked over the matter with Prof. G. Wiedemann, who, while he shared my views and spoke in Paris against the introduction of the units named, was unable to overcome the majority in favour. I simply mention this in order to show to you that from the beginning I was not an uncompromising advocate of the present practical system.

My present view, however, after ripe reflection, is that I would consider any attempt to change the current system of practical units a serious error, because the great machinery of international agreements and national laws must not be treated like a toy. The law-giving bodies of the different countries which bound themselves to the results achieved in Paris and Chicago would rightfully reject any attempt to make a change at present in the international units as uncalled for, and electricians could not receive a more severe blow in the estimation of the public than if they should attempt at present, when the practical units are laws, to come forward with plans for changes. Both the law-makers and the public would characterise such an attempt as frivolous, and I do not see how electricians could well refute such a charge. Attention need be only casually called to the millions of measuring apparatus and the hundreds of thousands of contracts which would be affected by a change of units.

Through the laws of the several States not only the conceptions but the nomenclature of the practical units are fixed, and we cannot agree with Mr. Fessenden when he says that while electricians could sell electrical energy by the ampere and watt, they are not obliged to do so. In Germany it is forbidden by law to sell or measure electrical energy otherwise than by the ampere, watt, etc., and the public sellers of electrical energy are also required by law to use the names of ohm, volt, ampere, watt, coulomb, and farad.

With this situation in view, it is my firm conviction that the practical units, such as they have been determined by international agreement and national law, must remain as they are, and that neither their definitions nor their names should be interfered with.

Accordingly, the propositions of Mr. Fessenden, as far as they refer to purely electrical matters, including "capitat," are eliminated at the outset, and there only remains the proposition to introduce "permitat" in place of magnetic permeability. If, in accordance with Fessenden's proposition, we designate permeability by m and "permitat" by μ, the relation between the quantities would be $m = 4\pi\mu$. His reasons are supposed to be based upon the assumption that the introduction of permeability as a fundamental quantity is more nearly in accordance with the Maxwell theory, and its object is supposed to be the elimination of the 4π from the equation.

We will now see whether the object is attained. The formula in which the electro-technician comes most into contact with 4π is the Hopkinson equation for the ampere-turns necessary to drive N lines through a magnetic circuit. If we designate the number of ampere-turns by Z, the length of each part of the magnetic circuit by l, its cross-section by q, and the permeability by m, and if we furthermore distinguish the several parts of the circuit by 1, 2, 3, etc., we have the Hopkinson formula:

$$Z = \frac{10}{4\pi}\left\{\frac{N_1 l_1}{q_1 m} + \frac{N_2 l_2}{q_2 m_2} + \frac{N_3 l_3}{q_3 m_3} + \ldots\right\},$$

or, if the induction $\mathfrak{B}$ is introduced,

$$Z = \frac{10}{4\pi}\left\{\frac{B_1 l_1}{m_1} + \frac{B_2 l_2}{m_2} + \ldots\right\}.$$

According to Mr. Fessenden's proposition, "permitat" is now to be introduced. If this is done, by means of the equation $m = 4\pi\mu$, the formula becomes

$$Z = \frac{10}{16\pi^2}\left(\frac{B_1 l_1}{\mu_1} + \frac{B_2 l_2}{\mu_2}\right),$$

that is, we have no longer 4π, but $16\pi^2$ in the formula. It is suspected that this is not the result desired by Mr. Fessenden. In order to avoid the undesirable result, we must not use $m = 4\pi\mu$, but $\mu = 4\pi m$. Then, indeed, the 4π would disappear in the Hopkinson formula. But there would not be much of a practical gain, because in practice there are more or less air-gaps usually in the magnetic circuit. For this we retain in the denominator the permeability of the air, and as this is already 4π, we must, as before, make a division with 4π, and the whole difference is that this 4π now has the name of "permitat of the air."

Further, in order to absolutely establish the equation $\mu = 4\pi m$, we must assume that the number of lines of force which come from one magnetic unit pole are $16\pi^2$, and this $16\pi^2$, or at least one of the two 4π's composing it, would make itself felt in a most disturbing manner in all theoretical calculations in which the Hopkinson unit pole enters. The student, under these circumstances, would probably be compelled to exert himself mentally more upon the 4π than he does to-day.

If Mr. Fessenden's proposition fails so signally in its object, it is proven that something in connection therewith has been overlooked. The fact is that the quantity π does not appear once, but twice in electrical science. It appears first in the determination of the number of lines of force which go from one pole. Here it is introduced by the integration of a spherical surface of radius 1, comes into connection therefore with the number 4 and represents a surface integral in the case of the magnetic pole as well as in the case of an electrical point.

The quantity is again met with if, according to the Biot-Savart law, one expresses the work done by a magnetic point when it encircles a current. Here π is the result of the integration over a circumference. This second π is radically different from the first. Both play their particular parts in theory, and as is to be inferred from what I have already stated, they cannot at the same time be shut out of the theory. At all events, I cannot see that the 4π creates as much mental effort as Mr. Fessenden says it does. The pages in Maxwell on this subject can be readily mastered in one hour by anybody of mathematical attainments, and even while one may change the definitions at will, the student must nevertheless work through these pages in order to become thoroughly acquainted with the theory of electricity. In my opinion, therefore, there would be no lightening of his task by attempting to dislodge the old units.

Perhaps, however, the burden which, according to Mr. Fessenden's idea, is imposed upon the student by the present status of the theory is artificially produced, and is due to the use by teachers and writers of inaccurate or wrong definitions. Mr. Fessenden, for instance, says "the henry is 10^9 lines and not 10^9 units of magnetic quantity." In reality, the henry, according to the Chicago definition, measures neither a magnetic line nor a magnetic quantity, but is a unit (in the electromagnetic system) of the coefficient, L, in the equation

$$R\,i + L\frac{d\,i}{d\,t} = E$$

for the relation between current, i, and E.M.F., E, is a circle containing resistance, R, and self-induction, L. The henry in its nature, therefore, is a length of 10^9cm.

Besides this, Mr. Fessenden confuses in the well-known Maxwell equation, $B = H + 4\pi T$, the quantities H and T, and makes other like errors. These classes of errors increase the difficulty of understanding the subject.

In conclusion, I wish to call attention to a simple method of removing the little difficulties attending the division by 4π. The electrician is never in a position to have every piece of tin or iron with which he works inspected as to its permeability. He, in fact, depends upon the permeability of the material which he receives from trustworthy dealers. A dozen measurements are taken in connection with this permeability, and then the $\mathfrak{B}$ used in practice must be interpolated. We must also make graphic tables of these permeabilities, and there is but little work necessary, if instead of a graphical demonstration of these permeabilities, m, the curve at once gives the value $\frac{10}{4\pi m}$, or, better still, the logarithm of this quantity. Then it is clear that further calculations are very simple.

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INSTITUTION OF ELECTRICAL ENGINEERS.

On Distant Electric Power Transmission.

BY PROF. GEORGE FORBES, F.R.S., MEMBER.

(Concluded from page 625.)

I now turn to the second portion of this paper dealing with some of the problems which, I suppose, have been threshed out independently by each one who has had to carry out any large transmission scheme. I wish to draw attention to Lord Kelvin's law of economy, to the use of boosters and phase rectifiers, to the relative merits of different kinds of polyphase systems, to overhead and underground conductors, and to the use of aluminium.

Kelvin's Law.—I should like to see an accurate volume published on the correct use and development of Kelvin's law of economy. Here I must condense. The data on which we choose our current density by this law depends on (1) price of copper; (2) price per annum of the horse-power; (3) interest on price of copper. I desire to draw attention to the meaning of (2) and (3). When using water power which is unlimited compared with the demand, (2) is the price per annum of generating the power. When the water power is limited and the demand unlimited, (2) is the selling price of the power. If the copper be mortgaged, (3) is the interest paid on the mortgage, say 4 per cent. If the copper is paid for out of capital, (3) is the interest to be paid in dividends on the capital, say 15 per cent. I do not think that attention has been explicitly directed before to these points.

Boosters.—Lord Kelvin's law as he announced it was only true if the electric power measured at each end of the line was approximately the same; in other words, if the percentage drop in volts was small. Ayrton and Perry showed that Lord Kelvin, through neglect to notice this, was led to deduce wrong conclusions as to the economical current density to transmit power from Niagara to New York. But by using boosters along the line the drop in volts can be corrected. Take as example an ordinary transmission line of 40 miles, in which the ohmic loss in power and volts is 40 per cent. Divide the line into four sections of 10 miles with a loss of 10 per cent. in each. Now place alongside of it a booster line. At the 10-mile station increase the volts to the original amount by a booster at the expense of 10 per cent. of current. In the second section there is only 90 per cent. of the current, so if the conductor is the same sectional area throughout, the second section of the booster line may be 11 miles before losing the same as any section of the non-booster or ordinary line. The third section will have a length of $1{\cdot}1 \times 1{\cdot}1 \times 10$ miles $= 12{\cdot}1$ miles; the fourth has a length of 13·31 miles. Thus, on the booster line the total loss of 40 per cent. is reached only after traversing a distance of

$$10 + 11 + 12{\cdot}1 + 13{\cdot}31 = 46{\cdot}41,$$

instead of 40 miles without boosters, and with the same sized wire. If instead of keeping the wire of constant section in the booster line we had kept the length of sections each of 10 miles, and had kept the current density constant, the sectional area of the conductor in the four sections would have been in the ratios 1·0, 0·9, 0·81, 0·729, whose sum is 3·439. The weight of copper on the booster system would be thus reduced in the ratio 3·439 : 4, while the efficiency would be 65·61 per cent. instead of only 60 per cent. without boosters; or, to put it in another way, the same loss at 40 miles would be obtained on the booster line with a reduction in weight of copper in the ratio of $34{\cdot}4^2 : 40^2$, which requires only 74 per cent. of the copper. In this example the loss in the booster has been neglected for simplicity of description, but would be taken account of in practice. If the efficiency of the alternating-current booster is 98 per cent. on one-tenth of the power, the total loss in the booster is 1·50 × 1·10 = 1·500 of the power, which may well be neglected in a general statement of results. The effects of capacity and self-induction (if alternating currents be used) have also been omitted in this description, and if not nullified the usual corrections must be made.

Table I. gives the weight of copper per horse-power and kilowatt delivered at the receiving end of a transmission line 100 miles long with 10,000 volts at the generating end without boosters—*i.e.*, in one section. Tables II., III., and IV. give the results with boosters when the line is divided into two, three, and four sections respectively. Corrections must be made for capacity, self-induction, temperature, and sag. Another way of working the booster system is to add to the distance already covered a new section of the same length as previous ones, with the current density calculated by Lord Kelvin's law. In this case the cost of power must include the cost of copper up to the commencement of the new section. We may start with one section and with power costing nothing. In this case Kelvin's law gives the economical inefficiency = 2 (see my paper before the Society of Arts, November, 1898).

TABLE I.—100 Miles; 10,000 Volts. One Section. e = Inefficiency. E = Efficiency.

e.	E.	Tons of copper per KW. delivered	Tons of copper per H.P. delivered.	e.	E.	Tons of copper per KW. delivered.	Tons of copper per H.P. delivered.
1·00	—	—	—	1·46	·685	·72800	·54309
1·01	·990	16·0258	11·9553	1·47	·680	·72230	·53884
1·02	·980	8·1726	6·0968	1·48	·676	·71689	·53480
1·03	·971	5·5555	4·1444	1·49	·671	·71179	·53100
1·04	·962	4·2480	3·1690	1·50	·667	·70695	·52739
1·05	·952	3·4641	2·5842	1·51	·662	·70236	·52396
1·06	·943	2·9420	2·1947	1·52	·658	·69801	·52072
1·07	·935	2·5695	1·9169	1·53	·654	·69388	·51763
1·08	·926	2·2905	1·7087	1·54	·649	·68997	·51472
1·09	·917	2·0739	1·5471	1·55	·645	·68624	·51194
1·10	·909	1·9009	1·4181	1·56	·641	·68271	·50930
1·11	·901	1·7594	1·3125	1·57	·637	·67936	·50680
1·12	·893	1·6422	1·2251	1·58	·633	·67617	·50442
1·13	·885	1·5430	1·1511	1·59	·629	·67316	·50218
1·14	·877	1·4584	1·0880	1·60	·625	·67030	·50004
1·15	·870	1·3852	1·0334	1·61	·621	·66756	·49800
1·16	·862	1·3212	·9856	1·62	·617	·66499	·49608
1·17	·855	1·2650	·9437	1·63	·614	·66254	·49426
1·18	·847	1·2153	·9066	1·64	·610	·66021	·49252
1·19	·840	1·1709	·8735	1·65	·606	·65801	·49088
1·20	·833	1·1311	·8438	1·66	·602	·65592	·48932
1·21	·826	1·0953	·8171	1·67	·599	·65393	·48783
1·22	·820	1·0628	·7929	1·68	·595	·65206	·48644
1·23	·813	1·0334	·7709	1·69	·592	·65028	·48511
1·24	·806	1·0065	·7509	1·70	·588	·64860	·48386
1·25	·800	·9819	·7325	1·71	·585	·64702	·48268
1·26	·794	·9593	·7156	1·72	·581	·64551	·48155
1·27	·787	·9385	·7001	1·73	·578	·64409	·48049
1·28	·781	·9192	·6875	1·74	·575	·64276	·47950
1·29	·775	·9014	·6724	1·75	·571	·64149	·47855
1·30	·769	·8849	·6601	1·76	·568	·64031	·47767
1·31	·763	·8697	·6488	1·77	·665	·63919	·47684
1·32	·758	·8554	·6381	1·78	·562	·638148	·476059
1·33	·752	·8421	·6282	1·79	·559	·637170	·475329
1·34	·746	·8297	·6190	1·80	·556	·636255	·474646
1·35	·741	·8180	·6102	1·81	·552	·635401	·474009
1·36	·735	·8072	·6022	1·83	·546	·633870	·472867
1·27	·730	·7970	·5945	1·85	541	·632559	·471889
1·38	·725	·7874	·5874	1·87	·538	·631452	·471063
1·39	·719	·7783	·5806	1·89	·530	630536	·470380
1·40	·714	·7698	·5743	1·91	524	629798	·469829
1·41	·709	·7618	·5683	1·93	·518	·629228	·469404
1·42	704	·7542	·5626	1·95	·513	·628813	·469094
1·43	699	·7472	·5574	1·97	·508	·628544	·468894
1·44	·694	·7404	·5523	1·99	·503	·628416	·468798
1·45	·690	7340	·5475	2·00	·500	·628400	·468786

The weight of copper for this section per kilowatt delivered $= 4 \times 1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2$. In any other section, the n^{th}, let

e_n be inefficiency of that section;

$1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2 c_n$ be weight of copper for ,,

E_n be accumulated inefficiency of n sections;

$1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2 C_n$ be accumulated weight of copper

(In Table VI. I call c_n and C_n the copper factor);

then $e_n = 1 + \frac{1}{\sqrt{c_{n-1}+1}}$; $c_n = \frac{e_n^2}{e_n - 1}$;

$E_n = e_1 \cdot e_2 \ldots e_n$; $C_n = e_n C_{n-1} + c_n$.

TABLE II.—100 Miles; 10,000 Volts. Two Sections.

Efficiency.	Inefficiency.	Tons copper per horse-power delivered.
·017	59·17	2·27
·12	8·27	·504
·32	3·13	·333
·61	1·63	·395
·92	1·09	1·451

Table VI. gives the values of these quantities for 24 sections of equal length, uncorrected for capacity and self-induction. If, now, we wish to use this table for other cases where the cost of power is C_r, which corresponds in Table VI. to an inefficiency E_r; then the economical inefficiency, say, for eight sections is $\frac{E_{r+8}}{E_r}$, and the economical weight of copper per kilowatt delivered is $1{,}571 \left(\frac{\text{Miles}}{\text{Volts}}\right)^2$. $(C_{r+8} - C_r)$. In this way Table V. has been computed. Tables I. to VI. embody some of the best results of my study of the booster method from the year 1894 up to to-day. The curves on Fig. 2 show the tons of copper required for each horse-power delivered at different inefficiencies.

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TABLE III.—100 Miles; 10,000 Volts. Three Sections.

Efficiency.	Inefficiency.	Total copper per horse-power delivered.
·07	13·5	·488
·09	11·0	·435
·11	9·2	·393
·13	7·7	·361
·15	6·5	·335
·18	5·5	·315
·21	4·8	·300
·24	4·1	290
·28	3·6	·283
·32	3·2	·280
·36	2·8	·280
·40	2·5	·285
·45	2·2	·295
·51	2·0	311
·56	1·8	·336
·62	1·6	·375
·69	1·5	·437
·76	1·3	·545
·84	1·2	·766
·92	1·1	1·441

TABLE IV.—100 Miles; 10,000 Volts. Four Sections.

Efficiency.	Inefficiency.	Tons copper per horse-power delivered.
·10	9·8	344
·21	4·8	·267
·38	2·7	260
·63	1·6	·365
·92	1·1	1·435

TABLE V.—100 Miles; 10,000 Volts. Eight Sections of Different Current Densities.

Efficiency.	Inefficiency.	Tons copper per horse-power delivered.
·53	1·9	·396
·50	2·0	·348
·45	2·2	·330
·42	2·4	·303
·37	2·7	·273
·31	3·2	·241
·23	4·3	·207
·13	7·8	·141

TABLE VI.

Section.	Efficiency of section.	e_n Inefficiency of section.	c_n Copper factor for section.	E_n Accumulated inefficiency.	C_n Accumulated copper factor.
1	·5000	2 0000	4 0000	2 000	4 000
2	·6909	1 4472	4 6832	2·894	10·472
3	·7721	1·2952	5·6820	3·749	19 245
4	·8181	1·2223	6 7223	4 582	30·245
5	·8482	1·1789	7·7687	5·402	43·425
6	·8696	1·1500	8·8147	6·212	58·754
7	·8854	1·1294	9 8601	7·016	76·217
8	·8978	1·1138	10 901	7·815	95·792
9	·9078	1·1016	11 939	8 608	117·463
10	·9158	1·0919	12·976	9·400	141·226
11	·9226	1 0839	14 011	10 188	167 091
12	·9284	1 0771	15·042	10·974	195·012
13	·9334	1·0714	16·071	11 757	225·001
14	·9376	1·0665	17·099	12 539	257·059
15	·9414	1·0623	18·128	13·320	291·198
16	9447	1·0585	19·152	14·100	327·382
17	·9477	1·0552	20 177	14 878	365 627
18	·9504	1 0522	21·199	15·654	405 909
19	9527	1 0496	22·222	16·431	448·265
20	·9549	1 0472	23·244	17 207	492 664
21	·9569	1·0450	24·264	17 980	539 094
22	·9588	1·0430	25·281	18·754	587·551
23	·9604	1·0412	26·300	19·527	638 060
24	·9619	1·0396	27 322	20·300	690 652

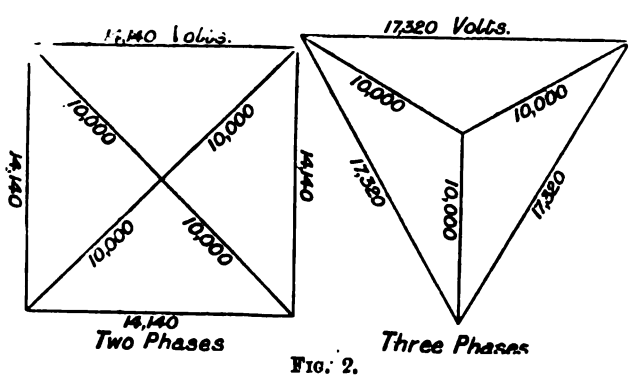

FIG. 2.

It will be seen from them that by the booster method I am able to reduce the weight of copper (by putting in more turbines and dynamos) in some cases to less than one-half of what was possible by the old system. The chief advantage of using boosters is to save copper at the cost of power generated where the latter is cheap and the distance very great. In a paper before the Society of Arts in November, 1898, it was shown that in the ordinary method of working there is no saving of copper when the efficiency is below 50 per cent. But if we wish it, we can save copper still farther by making the efficiency still lower, and using the method now indicated. Fig. 3 explains the action of boosters (1) for single or two phase, (2) for continuous current, (3) for three-phase. I believe that Mr. Gisbert Kapp was the first to construct an alternating-current booster as here shown. Mr. Scott, of Pittsburg, is the only person I know of who has published anything bearing on this; but his published statements are arithmetically erroneous, and so misleading, and he does not appear to have noticed the possibility of being able to save copper by reducing the efficiency below 50 per cent.

Induction Factors and Phase Rectifiers.—The low power factor of induction motors, which lies commonly between 0·6 and 0·8, must be carefully taken into account when designing any power scheme where these are used. Synchronising motors can be adjusted so as to be without either lag or lead. But they have not been so largely adopted as they might have been but for the necessity of this adjustment. The Oerlikon Company have used synchronous motors, doing no work, in parallel with the inductive load to furnish what has been called the wattless current. In this case the synchronous motor is excited so as to act as a condenser, and is placed at the receiving end of the line. There are other methods by which idle synchronous motors may be used to overcome self-induction, and this becomes an important matter in long-distance transmission. The self-induction of the line has to be taken into account, and I would have added to this paper the tables necessary for working out all the effects, and which I have used for many years, were it not that this would alter the character of the paper. Table VII. has been inserted, however, to give some notion of the magnitude of the effect, and it shows at a glance the factor by which the ohmic drop of volts must be multiplied in order to give the true drop due to induction and resistance, with different frequencies, and with different diameters and distance of wires, with single phase. Distance of transmission does not affect this factor. I ought to state that an American wire gauge is used in Table VII. only because the table was completed when I was working in the United States on the Niagara scheme. When dealing with parts of the world free from telegraphs and telephones, the beginner is apt to lay undue stress on the advantages of using an earth return with single or two phase transmission, and overhead wires. So soon as he calculates the effects of induction he generally finds that the benefit is not what he thought. Take the case of the Niagara-Buffalo line, with cables 0·6in. diameter and 30ft. above ground and using a frequency of 25 cycles per second. The impedance is the same as with similar cables (go and return) 60ft. apart, and the factor is prohibitive.

Choice of Polyphase Systems.—In choosing a polyphase system we may use two-phase, or three-phase star, or three-phase mesh. Three-phase star cannot well be used if any consumer's plant uses only one-phase, as was proved from actual trials in a paper I read before this Institution in 1893. For these cases two-phase or three-phase mesh must be used. Three-phase mesh subjects the transformers to 1·7 times the electric pressure experienced by three-phase star, or two-phase, each earthed at the centre of the electric system. The principal advantage of the two-phase is that the two circuits may be electrically disconnected, either always or else during tests. This facilitates the detection of troubles and gives far greater security, as I have convinced myself beyond doubt in actual practice. It has been generally assumed that, using the same electric pressure, the three-phase system uses only three-quarters of the copper required for the two-phase. This is founded purely on the convention adopted in defining the electric pressure. In Fig. 4 a three-phase star and a two phase system are represented, each with 10,000 volts between any one wire and the middle of the electric system, which may be conveniently earthed; and the two systems represented require the same weight of copper to give the same effect (though not the same number of insulators). The volts between neighbouring wires in these cases are 17,320 with the three-phase, and 14,124 with the two-phase; yet the convention is to speak of these cases as being 17,320 with three-phase and 20,000 with two-phase. This might be an unobjectionable convention if the trouble arising from high electric pressure was due to risks of sparks passing from wire to wire. I doubt if anyone with practical experience of the troubles that do arise could support this view. Nine-tenths of the troubles come either from accidental or malicious short-circuits, or else from leakage of two conductors to earth. The former cause produces a breakdown in any case. Hence leakage to earth is the only factor to be considered in this connection, and in the cases shown in Fig. 2 the security, as measured by electric pressure on insula-

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tion, and the weight of copper are the same for three-phase and for two-phase.

Overhead and Underground Conductors.—The choice between bare overhead conductors and insulated cables underground has generally to be decided upon considerations other than economy or effectiveness. In this country insulated cables will generally be employed. In this case self-induction of the line, which we know how to compensate in any case, can be got rid of. But the effects of capacity, which are more troublesome to deal with, are much increased. The electric pressure to be selected on an underground transmission depends almost entirely on the financial side of the question regarding relative costs for insulation. The Rheinfelden plant was the first case where the electric pressure was selected solely with a desire to obtain the best economy. In almost all other cases the pressure has been chosen by rules which depend on the timidity or rashness of the engineer, and occasionally on his past experience. We have not yet reached such pressures as require account to be taken of electric air convection or brush discharge from surfaces of small radius of curvature, except for temporary experiments.

Aluminium Conductors.—A few words must be said about the use of aluminium as a conductor. The weight of aluminium required is almost exactly one-half of the copper which would produce the same effect. The diameter of cable is 28 per cent. in excess of one made of copper, and the cost of insulation for an underground cable is increased in about the same proportion when we pass from copper to aluminium. Aluminium is not a pleasant metal to deal with, but its high conductivity will make it invaluable for overhead transmission. It is true also that the weight to be supported on posts is half of copper, but the surface exposed to the wind is greater and its strength is not great. The chief drawback to its use, especially overhead, is its liability to become rotten. This defect does not exist if the metal be pure, and especially if free from sodium. But exposure to the atmosphere, especially near the sea, induces deterioration. The fact that aluminium is easily oxidised ought not to condemn it. The same is true of iron and steel, and yet we do not hesitate to place structures of these metals in exposed positions. Only we paint them, so I propose that we paint or varnish our aluminium conductors wherever necessary. We have had little experience in this direction. I laid out a few hundred yards of ¼in. aluminium wire on a Scotch estate a year ago, and am watching the effects of weather.

Having now dealt almost entirely with the work of foreign manufacturers, I should like to suggest that a British type of power transmission might be worked out differing in some details from what is becoming the normal arrangement. But it would be an impertinence on my part to appear to suggest to manufacturers how best to look after their own interests. The reason why I venture to broach this question is that I notice in the many tenders that come under my notice for power transmission a tendency to crystallise the proposals and to settle into grooves which do not seem always to be the best. This stereotyped character has lately forced itself on my attention in connection with the proposed Mysore development of water power and electric transmission over 90 miles. I received five tenders from the firms most experienced in this work in Europe and America. The most remarkable feature was their great resemblance to one another except in certain details. They all used three-phase alternating currents generated at an electric pressure between 2,000 and 3,000 volts. The units varied from 1,000 h.p. to 1,333 h.p. Three used mesh connections, and two used star connections. The frequency varied from 25 to 40. All used separate turbines for exciters. All had turbines and dynamos on the same horizontal shaft. The electric pressure used for transmission varied from 23,800 to 30,000 volts. Three preferred oil cooling for transformers, one air blast, and one natural ventilation. The line construction varied considerably, so did the working of the distant transformer station. It is not desirable to go further into details, but it may be said that in every case two complete and independent sets of conductors were proposed. Also the loss allowed on the line was not determined by Lord Kelvin's law, but generally on the basis of enabling the proportioning of volts to load to be capable of adjustment without altering the speed. Most of the arrangements now mentioned are admirable, and their similarity shows that there is a consensus of opinion in their favour.

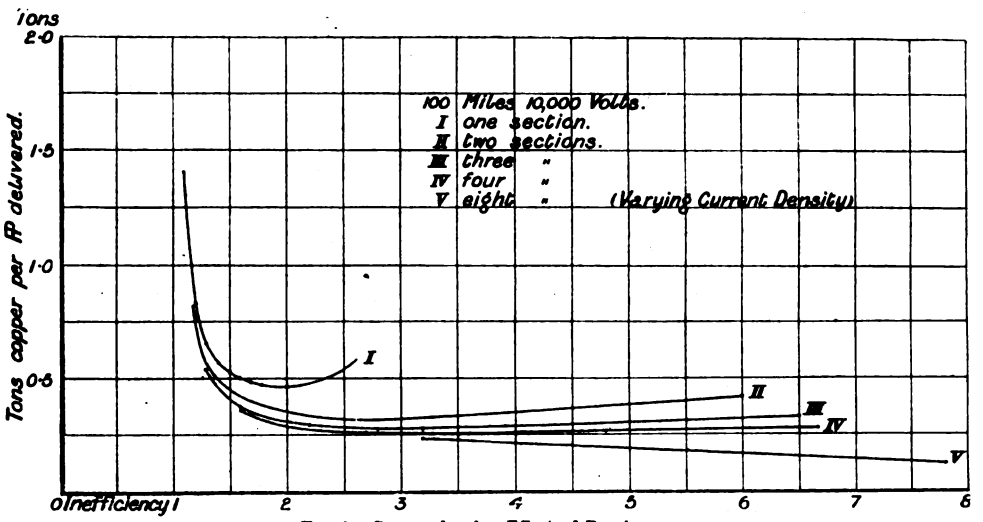

FIG. 3.—Curves showing Effect of Boosters.

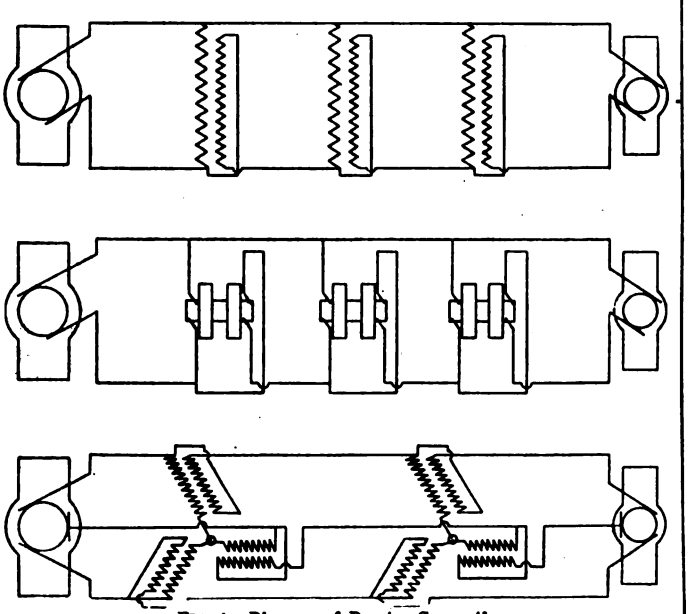

FIG 4.—Diagram of Booster Connections.

I would suggest as subjects worthy of your consideration the following points: (1) the arrangement which suits a transmission line which is also a distributor of power does not necessarily yield the best results for a plant transmitting the whole power to a long distance; (2) the high-pressure continuous-current system is very suitable for certain cases, as worked out at Genoa; (3) the two-phase alternating current is to be preferred over the three-phase in many cases, and especially where an earth return can be used; (4) the horizontal shaft for turbine and dynamo which is so much in vogue, might well be replaced by a vertical shaft, as at Niagara, Rheinfelden, and other places. I should like to mention other matters, but do not consider the time opportune. Some, no doubt, will be spoken of during the discussion, and any remarks from others who have had experience of these matters will be of value. Most of what has been said in this paper has reference primarily to cases where water power is used, and generally to countries where bare overhead conductors are permitted. But generally the same considerations have a bearing upon cases where the power is generated by steam and where the cables are underground, although the distinctive characters of the two cases are very marked. With insulated cables the cost of installation takes away from the superiority of two over three phases, except perhaps when a common return is used. The same cause acts against the use of aluminium in place of copper underground. Again, in cases of generating power at the coal-pits, the transmission line generally becomes also a distribution line and militates

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against the use of known methods for increasing the power factor. But the most important difference between an underground and an overhead transmission must be noticed—viz., that induction in one case, and capacity in the other, is the trouble that demands the most careful attention.

TABLE VII.—Impedance Factors.

Dia.* and gauge.	Distance, 6in. Factor.	Distance, 12in. Factor.	Distance, 24in. Factor.	Distance, 48in. Factor.
	Frequency, $f=15$.			
1	1·842	2·182	2·535	2 904
¾	1·387	1·546	1·720	1 903
½	1·111	1·157	1 210	1 267
0000	1·085	1 120	1·167	1·203
000	1·057	1·081	1·108	1·137
00	1·038	1·054	1·068	1·090
0	1·0264	1·036	1·048	1 061
	$f=20$.			
1	2·291	2·771	3·261	3·768
¾	1·624	1·863	2 116	2 378
½	1·190	1 263	1 351	1·441
0000	1·146	1 206	1·271	1·341
000	1·100	1 139	1·184	1 233
00	1·067	1 093	1·123	1 155
0	1 046	1 063	1 084	1·106
	$f=25$.			
2	7·7638	10 37	12 912	15 55
1½	5 014	6 454	7 831	9 017
1	2 7654	3·3826	4 012	4 642
¾	1 889	2·209	2·543	2 885
½	1 285	1·393	1·513	1 637
0000	1 222	1·3068	1 3996	1 498
000	1·152	1·2104	1·2763	1 345
00	1·1034	1·1422	1·1876	1·235
0	1·0710	1 0973	1 1277	1·160
1	1 0478	1 0676	1·0853	1·108
2	1 0324	1·0443	1 0583	1·071
3	1·0216	1·0293	1 0384	1 048
4	1 0142	1·0191	1·0247	1 031
5	1 0094	1 0126	1 0162	1·0203
6	1 0063	1 0084	1 0107	1·0134
7	1·0042	1·0055	1 0070	1 0087
8	1 0027	1 0035	1 0045	1 0056
9	1·0018	1 0023	1·0029	1·0036
10	1·0011	1 0015	1 0019	1 0024
	$f=33$.			
1	3 51	4·381	5 221	6 081
¾	2 338	2·781	3·237	3 700
½	1 462	1·625	1·803	1·982
0000	1·362	1 495	1·634	1·780
000	1 252	1 344	1 445	1·551
00	1·173	1 238	1·311	1·384
0	1·121	1 165	1·215	1·268
	$f=40$.			
1	4 2447	5·2661	6·2961	7·3302
¾	2 7520	3·3072	3·8719	4 4428
½	1 6342	1·8480	2 0726	2 3050
0000	1 5033	1·6753	1·8579	2 0480
000	1 3566	1·4808	1·6136	1·7553
00	1·2493	1·3371	1 4326	1 5354
0	1·1747	1·2345	1·3023	1·3756
	$f=60$.			
1	6 2681	7·8194	9·3778	10 938
¾	3 9738	4 8334	5·6995	6 5698
½	2·1817	2·5365	2·9009	3 2718
0000	1 9583	2·2505	2 5527	2·8614
000	1 7002	1·9194	2 1480	2·3838
00	1 5040	1·6651	1·8352	2·0134
0	1 3593	1·4763	1 6019	1·7627
	$f=80$.			
1	8·3108	10 387	12·474	14 557
¾	5·2244	6·3840	7·5478	8 7151
½	2·7720	3·2649	3·7339	4 2722
0000	2 4577	2·8683	3 2873	3 7119
000	2 0884	2 4024	2 7249	3 0536
00	1 8011	2·0376	2·2825	2 5355
0	1·5833	1 7597	1·9451	2 1373
	$f=100$.			
1	10·362	12·919	15·573	18·182
¾	6·4873	7·9445	9 4039	10 869
½	3·3829	4·0118	4·6474	5·2874
0000	2 9793	3·5060	4 0400	4 5787
000	2·5064	2·9078	3 3225	3·7426
00	2 1227	2·4341	2·7528	3·0794
0	1·8316	2·0679	2·3130	2 5642
	$f=130$			
1	13 444	16·832	20·227	23·623
¾	8 3925	10 295	12·191	14·104
½	4·3185	5·1487	5 9842	6 8233
0000	3·7828	4·4814	5 1860	5·8942
000	3·1426	3 6878	4 2387	4 7939
00	2 6316	3 0529	3·4808	3·9161
0	2 2328	2 5567	2 8898	3 2283

To find true drop in line, multiply ohmic drop by factors in these tables. * Diameter in inches, gauge Brown & Sharp.

It has been my desire in this paper to disclaim all idea of teaching the members of this Institution anything about their profession. This is not a classroom. The object of this paper is only to put down a few of the ideas about electric transmission that have occurred to me in practice during the last 10 years, and which seem to be the most important at this date to draw attention to, and to ask other men of experience in this work to tell us some of the results that they have obtained.

At the extra meeting of the Institution, held at the Institution of Mechanical Engineers on the 3rd inst.,

The PRESIDENT (Prof. S. P. Thompson) stated that, in accordance with their articles of association, the Council had chosen as an honorary member Mr. Joseph W. Swan, F.R.S., their past-president. This gentleman had signified to the Council his willingness to accept the honorary membership. The President also stated that the annual conversazione would be held on June 26.

Mr. H. M. Sayers then read his paper on "The Calculation of Distributing Systems of Electric Traction under British Conditions."

The following were the candidates balloted for at the meeting:

Members.—E. S. Jacob, 16, Victoria-street, Westminster, S.W.; F. T. Trouton, Caerleon, Killiney, co. Dublin.

Associate Members.—P. K. Higgins, 527, Lockerbie-street, Indianapolis, Ind., U.S.A.; B. Leslie, 36, Victoria-street, Westminster, S.W.; H. M. Sillar, 1, Torriano-cottages, Camden-road, N.W.

Associates.—R. G. Allen, 7, Longwood-avenue, S.C.R., Dublin; W. J. Blenheim, Faraday House, Charing Cross-road, W.C.; S. Flower, Middle Hill, Broadway, Worcester; F. M. Hartley, Station-grove, Wembley, Middlesex; F. J. Lowe, 28, Hanover-street, Leeds; D. H. Patrick, Earlsdon, Coventry; J. F. J. Reynolds, 47, Victoria-street, Westminster, S.W.; H. E. Thompson, 15, Falcon-road, Birkenhead.

Students.—A. H. Bennett, R. W. Penny, and R. Westbrook, Faraday House, Charing Cross-road, W.C.; G. E. Turnbull, 3, Oakley-crescent, Chelsea, S.W.

THE ELECTRIC POWER BILLS.

The hearing of the evidence on the Durham Electric Power Bill was resumed on Friday morning, and at the opening of the proceedings the CHAIRMAN made the following statement: "I think it would be convenient that I should state that, having before us the report on electric energy, generating stations, and supply, we adopt certain of the conclusions of that report. We accept the recommendations contained in the report of the Joint Committee of 1898 on electrical energy in the following respects—namely, compulsory powers for acquiring sites for generating stations and lands or easements for pipes and mains therefrom and other works, whether within or without the area of supply, may as a principle be granted, but they are prepared to hear petitioners who object to the particular sites selected by the promoters. In the case of powers being given for the erection of generating stations outside the area of supply, powers may be given for laying mains in streets leading from the generating station to the boundary of the area of supply, the local authorities having the option of breaking up and reinstating the streets at the undertakers' expense, but the committee are prepared to hear petitioners who allege that they are under special disadvantages arising from the Bill before them. I make no reference to the other paragraphs of the report, though the committee reserves to itself the right of considering those."

Mr. FERRANTI was then cross-examined as to why Chester and Southport were omitted from the list of towns and costs, these comparatively small towns producing electricity at very low rates. Mr. Ferranti said he did not draw up the list, and was not, therefore, responsible for it. It gave, he believed, the average results obtained in a certain number of towns, and if the lowest and highest figures were taken, about the same average would be arrived at. The population of the district in which they proposed to supply was 400,000. The transmission of power was cheap now, and the expense of long mains to the southern part of the district was merely a not very serious question of money. The people on Tyneside

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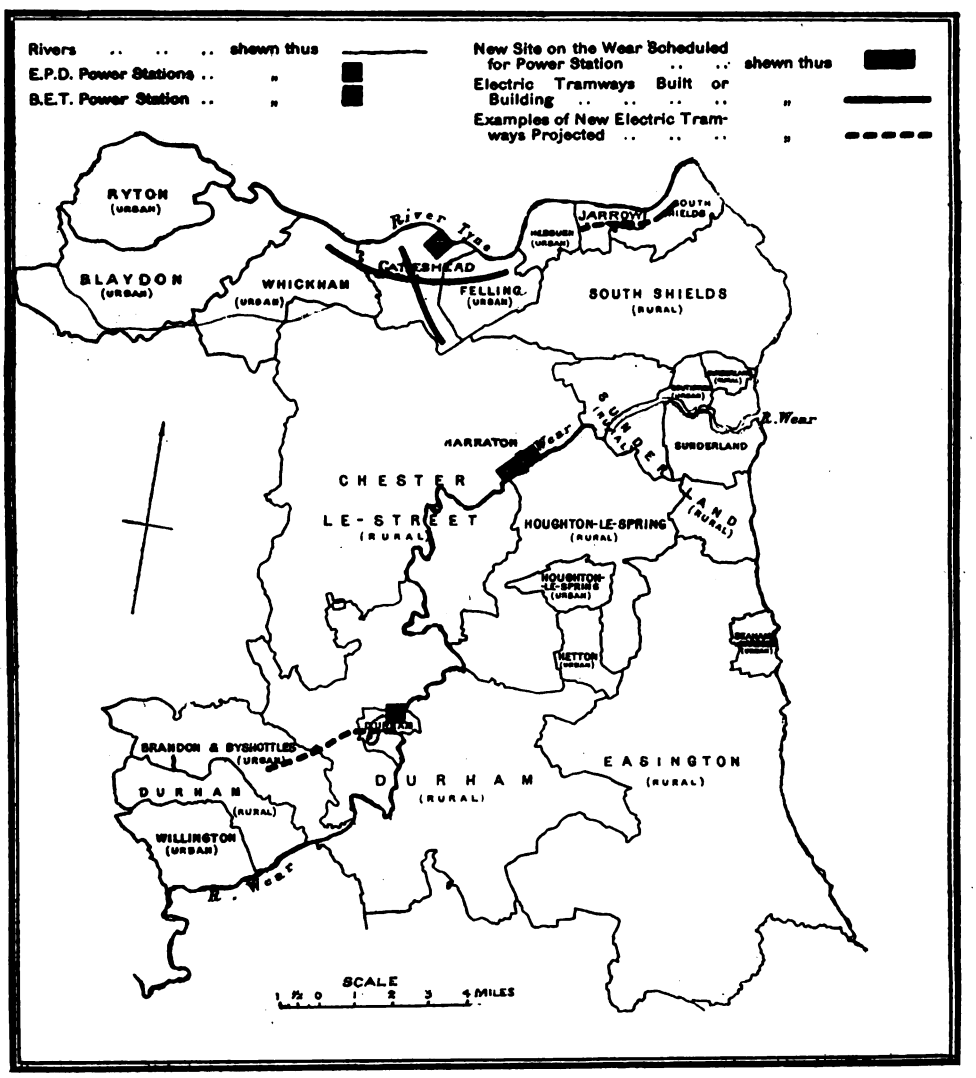
would not suffer in increased price from that fact. Mr. Ferranti could not answer the question as to whether the Durham Company proposed to make any reductions in the price when certain dividends were paid. As to what was reasonable competition, he said he should not call it reasonable competition for another power company with exactly the same powers, and doing the same business, to come into their district. It would be disastrous to both undertakings. He thought it would be disastrous if Whickham, for instance, should have the power to choose whether it would take its power from the Tyneside or Durham Company. He thought that wholesale competition could not be done at the price proposed if two companies were in one district.

Examined by Mr. Moon, he said the figures in the table were put in to represent the average case. It had been suggested that there was no use for electric power south of the Tyne, but it would be greatly used in coalpits. The supply to the people south of the Tyneside district would make it cheaper to the people at the Tyneside. Competition would be bad for both companies, as it tended to raise the cost of production. It would certainly reduce the load factor, which increased the cost of production. In answer to the committee, as to the American power distribution schemes, it was not steam power of which he spoke, but water power, the two being very different. The 8 per cent. mentioned was the estimated profit on the 20,000,000 units. He had not considered whether, having obtained this 8 per cent., a sliding scale of prices would be arranged. As to who bore the cost of the transformers, his company contracted to supply to the consumer the special kind of current necessary at the required voltage, and, therefore, the transformers to effect this were the company's property. To a certain extent, the more capital there was invested in mains, the less was the loss of energy. It was easy at the present date to balance the extra cost in mains against the loss of energy. The 20,000,000 units were simply a start, and they hoped to have in a few years' time considerably more than this to supply. Unless these districts had this cheap power, they would be heavily handicapped with respect to other countries. The power would be supplied without favouring anyone. The greatest distance to which power could be conveyed economically was settled by many factors. Load factor was a very important one. If they went farther than the area, the Board of Trade regulations would have to be altered to meet the new case. Under favourable conditions, 50 miles was the radius to which power could be transmitted economically. The figures as to costs were not made by him originally, but were corrected by him, and were figures which represented, he thought, the fair average price. If the two companies went into the district, there would probably be no real competition, as an understanding would be come to between them. The price would also rise owing to the smaller load factor. The price in that case also could not be further lowered. The cost of production was not likely to decrease so much in the future as in the past few years, but if the Board of Trade regulations were modified respecting insulation and size of mains, something, at any rate, might be done. He should not like to say whether it would be possible to make an initial sliding scale of prices. The cost of production in small works was large, and the cheap power supply would greatly benefit the small trader. Manufacturers in towns would be enabled to go into the country if they could there get a supply of power cheaply.

Sir F. BRAMWELL was then called, and said that he had had the fitting of the Birmingham trams with compressed air under his charge. Compressed air was good if nothing else could be got. The non-condensing engines usually employed by manufacturers were the most wasteful there were. The consumer of this cheap power would naturally



Map of the Proposed Area of the County of Durham Electric Power Company.

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only pay for the power he used. If this power were available, electricity could be used for many purposes for which it was not now used in this country. Thus motors could be used for driving machinery instead of engines, which would result in great economy. There would be a large demand for power at this cheap rate. He thought a load factor of 25 per cent. was reasonable. The Westminster Electric Supply Company, which supplied almost entirely power for lighting, had only a load factor of 12½ per cent.

Cross-examined as to the question of whether the power station would be better on the Wear than at Gateshead, he stated that the power station need not necessarily be placed in the centre of the supply. It might be more convenient to place it where there was the greatest demand for power.

The CHAIRMAN of the Electric Light Committee of Durham said that in a colliery the cost per unit for generating power was from 4d. to 6d. The population of Durham was 15,580. There were plans for an electric tramway in that town now before the Light Railway Commissioners. This supply would be of great use in the district, and a great number of local authorities would take advantage of it. It was, in his opinion, unfair that the Tyneside Company should be allowed in the Durham Company's district. There were a great number of diverse industries in the district.

Mr. GRAY, deputy mayor of Durham, said that in the coal famine of 1873 many small manufacturers were ruined owing to their inability to keep going because of the high price of coal. If this kind of scheme had been in operation, it would probably have saved most of them.

Alderman SCOTT, of Gateshead, was then called and cross-examined, and said the town had made an arrangement with the Durham Company. The alkali works were amongst their largest ratepayers, but were not the largest. The Corporation of Gateshead thought it would be unfair for another company to come into the Durham Company's district.

An ALDERMAN of Gateshead said the population of the town was about 110,000. The town was ready for expansion on the south side, and this scheme would materially help that expansion. The Town Council had entered into a provisional agreement with the company. They had considered the question of breaking up the streets.

Alderman ARMSTRONG, of Jarrow, on examination, said shipbuilding was the main industry of the town. They wanted in Jarrow to have a supply of electricity on favourable terms. There was a densely-populated district lying in the three-quarters of a mile between the railway and the river. If they had tramways supplied with cheap power this portion of the town could be stopped from becoming more densely populated, as the town would then extend southwards. A cheap means of transit would be a great improvement.

In cross-examination, he said that Palmer's Company, one of the largest in Jarrow, were in favour of the Tyneside Bill, but one of their directors was also on the Board of the Tyneside Company.

Mr. STEPHEN SELLON said the extension of tramways in general had been extraordinary since the introduction of electricity for working them. With it they were able to have a much quicker and cheaper service, and thus to carry a large number of workmen, which would have been impossible under the old procedure. There were required 700,000 units for the Gateshead tramways. There were also proposed tramways for Durham, Jarrow, and South Shields. These tramways could not be constructed unless a central generating station were authorised. There were a number of local authorities in the district generating electricity, but he preferred the cheaper supply offered by the company, and the price suited him, which that of the local authorities did not.

Cross-examined, he stated that the total estimated quantity of electricity for the whole of the tramway schemes was about 2,500,000 units. The load in a central station should be distributed evenly over the day. If a night consumption from large chemical works was given, it would tend to economical production by increasing the load factor.

Mr. W. L. MADGEN was then called, and stated that he was one of the promoters of the scheme. He had had a good deal to do with the determining of the proposed area. The North-Eastern portion of England offered great commercial possibilities for power. The only way the Tyneside towns in the area could extend was southwards. The best part of the district lay along the Tyne, but there were a large number of industries in the body of the area, such as at Birtley. The population of the district was in 1891 400,000. All the local authorities favoured the scheme, except the two small ones of Felling and Hebburn, the population of these being 34,000. With a central generating station and a large area the price tended to non-uniformity. The Jarrow people did not want a generating station in their area, but would not mind a sub-station, from which there would be no smoke and ashes. Their intention was to supply to other undertakers for supply purposes. If anyone only wanted a stand-by supply, the price would be settled by arbitration.

The committee then adjourned until Monday.

MONDAY.

On Monday, May 7, Mr. W. L. Madgen, recalled, was further examined by Mr. J. D. Fitzgerald as to the connection between the County of Durham Electric Supply Company and the promoters of the British Electric Traction Company. He admitted that the Gateshead Tramway Company and the County of Durham Electricity Supply Company belonged practically to the British Electric Traction Company's group, and, in answer to the Chairman, said that the subsidiary companies and the promoting company were working in alliance with the British Electric Traction Company. The Electrical Power Distribution Company would distribute the power supply to them in bulk through the County of Durham Electric Supply Company, and would obtain an independent profit. He did not consider that this profit and the profit obtained by the County of Durham Company would take away all the advantage from a consumer. The distribution company proposed to supply in Jarrow at the same rate as applied in Brighton—*i.e.*, 7d. for the first hour's actual consumption of the maximum demand and 1d. afterwards. He knew that Hebburn had practically got a provisional order, and that Felling would apply for one in the next session, but he still wished these two districts to be included in the Bill, so as to be able to supply tramways in the district. Assuming that these were allowed, and that permission to carry mains through the district were granted, as stated by the committee, the only other object in retaining them in the Bill would be that the local authority might change their views and wish to take a supply in bulk from the company. They were quite prepared to accept a clause not to supply in Hebburn and Felling except to authorised undertakers. He considered that the connection of the British Electric Traction Company would greatly strengthen the position of the Durham Company in obtaining the requisite capital. The prices mentioned in the Jarrow order, according to the Brighton scale, were the maximum rates, and would be liable to reduction according to the conditions found afterwards. He was not prepared to accept a clause reading as follows: "Notwithstanding anything contained in this Act the company shall not directly or indirectly supply energy within or for use within the districts of Felling or Hebburn without the consent of the Felling and Hebburn Urban District Councils under their respective common seals." Such a clause would prevent them supplying authorised undertakers. He was then questioned as to the number of provisional orders which had been granted, and which were not afterwards used, and gave instances of towns owning gasworks, the corporations in which had obtained electric lighting provisional orders with the sole object of keeping out electrical undertakings. As regards the guarantee of capital, they proposed to insert the Lands Clauses Acts, which would prevent the works being started until the capital had been issued and one-fifth paid up. A sliding scale was not included in the Act, and he did not think it would be wise to fix the limits of this sliding scale until more practical experience on the subject had been obtained.

Mr. SYDNEY MORSE was then examined by Mr. Balfour

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Browne as to the financial standing of the company. The capital of the County of Durham Electric Power Supply Company was to be offered to the public, and all not subscribed for would be taken up by the British Electric Traction Company and the Brush Electrical Engineering Company. He proceeded to quote financial statistics of these two companies, and gave particulars as to the directors of the same.

In cross-examination by Mr. Fitzgerald, Mr. Morse stated that there was no underwriting profit in the agreement between these two promoting companies and the Durham Company. The capital not taken up by the public would be taken up wholly for cash by the British Electric Traction Company and the Brush Company. The policy of these companies was that it was better to look for profit eventually due to the increase in value of the shares than to weight the undertaking with promotion profits.

Cross-examined by Mr. H. Lloyd, Mr. Morse said he had no knowledge as to the financial position of the promoters of the Tyneside Bill. He had not sought to attack these promoters, and believed they were substantial people anxious to carry out an important undertaking.

In answer to questions put by the committee, Mr. Morse explained that the nuisance clause in provisional orders was not included in the Bill because the promoters were applying for compulsory powers to obtain lands. The owners of the adjacent sites had in this way full opportunities for raising objections, which was not the case when the land was obtained by private treaty under the ordinary provisional order. While they proposed to supply at a uniform rate throughout the districts, the clauses providing that 20 per cent. of the cost of laying mains to any one district should be guaranteed by the district before the mains were laid, should be adhered to.

The committee then adjourned for lunch.

On resumption, Mr. J. D. FITZGERALD stated his case on behalf of the Urban District Councils of Felling and Hebburn, the population of which he stated was about 40,000. These districts concluded that they could do much better for themselves by remaining out of the Act and generating their own supply. He complained that while other objecting areas, such as the Hartlepools, Sunderland, and South Shields, had been struck out, they had been kept in. The clause defining whom the company might supply was an exceedingly wide one, as it included all authorised undertakers for supplying electricity. This would include railway companies and others working under Acts of Parliament, and it was difficult to see what limit might be put in the future to companies working under Acts of Parliament, and any of these might be supplied by the promoting company. In the House of Commons, while these Bills were being referred to the committee, the President of the Board of Trade had stated that the company did not seek power even to distribute in bulk without the consent of the local authorities.

It was here interposed that this statement was made with reference to the South Lancashire Bill, but Mr. Fitzgerald insisted that Mr. Ritchie had conveyed the impression to the House that all the Bills were to proceed on uniform lines. There were two courses open, either to omit Felling and Hebburn from the Act or to insert clauses to give effect to the assurance of the President of the Board of Trade. Mr. Fitzgerald proceeded to criticise the evidence of Mr. Ferranti as to the influence of the output from an electric station on the cost of the same. If Southport, Whitehaven, and Worcester had been included, the average works cost of these small places would be found to be 1·59d., or less than those of Manchester, Liverpool, Edinburgh, and Glasgow. The case of the St. James and Pall Mall Company in London, and of the Metropolitan Electric Supply Company, showed that for a small compact area electricity could be manufactured much more cheaply than with a large distributed area. The output of the Metropolitan Company was twice that of the St. James and Pall Mall Company, and the respective works costs were as follows: St. James's Company 1·2d. per unit, and Metropolitan Company 2·57d. per unit. He urged that the tramway company could be supplied even if the area of Felling were not included.

Mr. T. H. MAJOR, the chairman of the Felling Urban District Council, was then examined by Mr. J. D. Williams. He gave evidence as to the population of Felling, estimated at some 22,000, and to the effect that they had engaged Messrs. Handcock and Dykes to report to them on the electric lighting of the district. This report was received and adopted by the Council. They preferred to keep the electric supply in their own hands.

Cross-examined by Mr. Moon, Mr. Major stated that they had a strong objection to the company coming into their district, but might consider taking a supply from them if they found they could get it cheaper than they could generate it for themselves. It was his idea that the Bill authorising the company to supply the Felling district if they required it, and not otherwise, would be competition with the Urban District Council.

Mr. J. SMAILES, examined by Mr. J. D. Williams, said he was chairman of the Hebburn District Council, and also connected with the Hebburn Colliery Company. They had also retained Messrs Handcock and Dykes, and had received the report from them dated April 25, which had been adopted by the Council. The witness then handed in a list of the ratable values of the works in the district, which amounted to £36,330.

Cross-examined by Mr. Moon as to whether he, as a business man, would agree to buy from the company if he found it cheaper to do so, Mr. Smailes stated that he thought he could generate it cheaper. It was on this ground that they opposed the Bill.

In answer to questions from Colonel Long, the witness showed that he still feared competition in spite of the fact that the company could not supply for electric lighting purposes in the district without the consent of his Council.

Mr. H. W. HANDCOCK, examined by Mr. J. D. Williams, said that he had carefully examined the districts of Hebburn and Felling and found them favourable for the establishment of electricity works. There were a large number of public lamps, a good private load, and then, again, there would be the load due to supplying works. He understood that when any district required to take power from the Durham Electric Power Supply Company a separate feeder would be run to that district, which would only be laid down on a guarantee of 20 per cent. of the cost. This would preclude certain districts from taking a supply. His objection to the Bill was that it would enable the company to take some of the most remunerative consumers of electricity, such as the tramway companies, light railway companies, etc. He thought it should be made clear that the company could not come in without the consent of the Council.

Cross-examined by Mr. Moon, Mr. Handcock stated that the cost of the Hebburn installation proposed by him would be £21,538. While not supplying the whole district, this would enable the profit earned to be sufficient to justify more expenditure. With this expenditure plant for 258 kw. would be provided, with 100 kw. as a stand-by. It was impossible to come to any conclusion as to the comparative cost of supplying from small generating stations and large generating stations. With large generating stations the increased cost of copper might more than counterbalance the saving in coal. He granted that, apart from the distribution, it was cheaper to produce on a large scale. He thought Hebburn was one of the worst places in the country in which to try to save in cost of coal by the expenditure of copper. He did not feel sure that the Durham Company would be able to supply current more cheaply than the Hebburn local authority, because the company had also to supply a widely scattered district, and the cost of mains to these districts would have to be borne partly by the Hebburn district. He feared that the company would supply in Hebburn without the consent of the Hebburn Council by utilising wayleaves over private land in order to reach important works. When asked to explain how the striking out of Hebburn would prevent this, Mr. Handcock agreed that the desired relief would not be given by this means. He asked that a clause should be inserted that the company should not supply either directly or indirectly in the Hebburn district.

Questioned by Sir Andrew Scoble, Mr. Handcock stated that they estimated public lighting to bring in £2. 12s. per annum per 16-c.p. lamp, and they proposed to charge for

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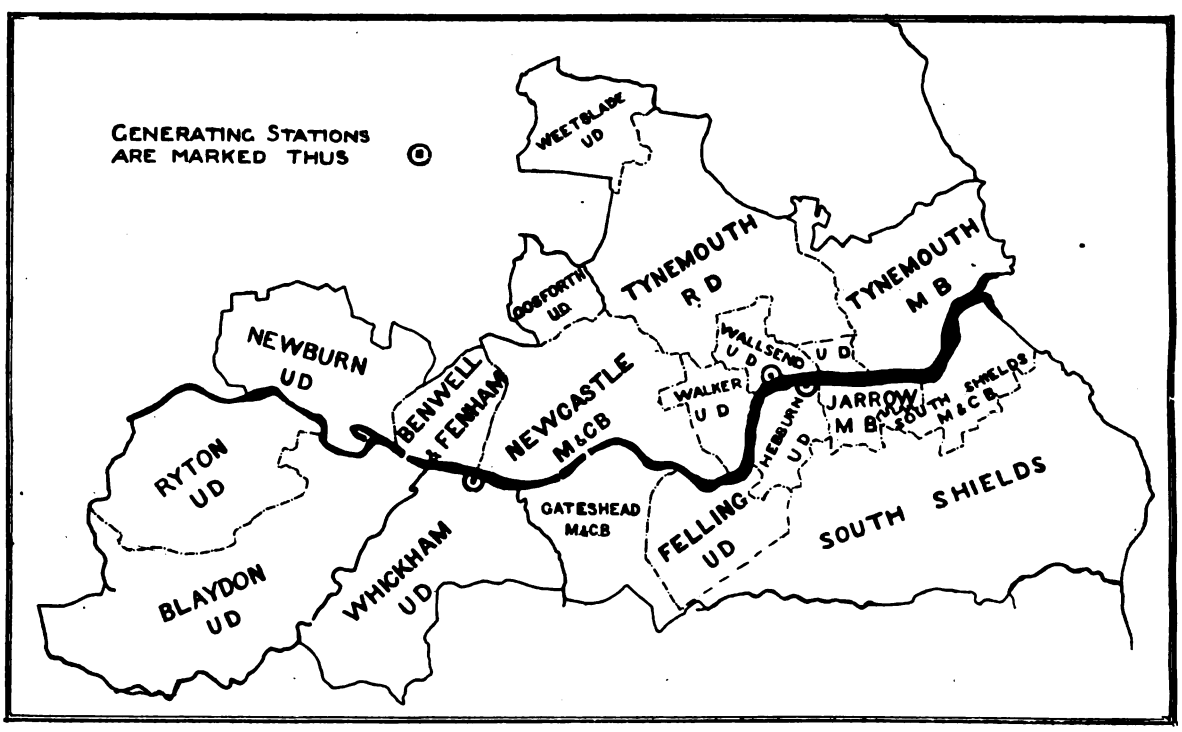
public lighting on a basis of 5d. per unit for the first 100 hours at the maximum demand and 2d. for all further consumption. Power loads would be supplied at 3d. per unit for the first 100 hours and 9d. per unit afterwards. He assumed that in Hebburn the power factor would be as high as 18 per cent. Provided that half of the horse-power in the five largest works in Hebburn was supplied by electricity, about £150,000 to £180,000 capital would be required. The horse-power of these works was about 6,000, and if a small 500-h.p. station were remunerative, he thought that there would be no difficulty in extending to meet the subsequent demand.

TUESDAY.

On Tuesday Mr. BAGGALLAY opened the case for the Tyneside Power Bill. He explained that the Bill he was bringing forward differed essentially from the Durham Bill, both in the area to be supplied and the object aimed at. He believed that the main object of the Durham Bill was to give a supply in bulk to authorised undertakers only where these authorised undertakers were local authorities or another company who would afterwards obtain powers from Parliament. He gave as an example the tramways and electric lighting areas already controlled by the Durham Company. From this it was seen that the supply of lighting and traction undertakings was the leading idea of the promoters of that Bill. The area chosen by the promoters of the Tyneside Bill lay equally on both sides of the Tyne, and included a most important industrial district. The primary object of the promoters was to give a cheap distribution of electrical energy in order to assist the trade and manufacturing industries of the district in which they were largely interested. He considered that the question of the advantage to trade should be put in the forefront, as any advantage derived from the use of tramways and electric lighting could only be realised providing the trade in the district was preserved. The object of the promoters was to enable the local industries on the Tyne to compete with others, chiefly in foreign countries, where cheap water power was abundant. Again, if this cheap supply were given to the trade, the supply of electrical energy for lighting and traction purposes could also be given. Criticising the County of Durham scheme, Mr. Baggallay pointed out that the promoters had struck out the important trade areas of South Shields, Sunderland, and the Hartlepools. But for these omissions the River Wear would have been the most advantageous place for the power station, which would then have been in the centre of the district to be supplied. The promoters now sought to fix the generating station on the Tyne, where some of their own concerns had to be supplied. He contended that the Tyneside promoters were earlier in the field than those of the Durham Company. It was most essential to the economical supply of a district that the generating station should be placed in the centre of what one witness had termed the power-taking area. Another distinction between the two Bills was that while the Tyneside Company proposed, like the Durham Company, to supply in bulk all authorised undertakers, with the consent of the local authorities, they also proposed to supply without the consent those large consumers whom they could reach without the breaking up of streets. In this way they would give a supply in any general supply district only with the consent of the local authorities, except in those cases of large consumers accessible by private wayleaves. He knew this proposal had raised serious opposition on the part of the local authorities. One of the large undertakings in London, the Charing Cross and Strand Electricity Supply Corporation, had commenced business in the way suggested, and connected up its first consumers by means of private wayleaves. The Tyneside Company therefore only asked that the right inherent in such undertakings should not be taken away by Parliament. He considered that this supply to large consumers was not only in the interests of the locality, but a question of high policy affecting the whole country. He proceeded to give the names of some of the promoters and their local interest to show how largely they were bound up in the successful working of the undertaking. Each of them wished to supply their own businesses and also those of others on the Tyne. He argued that, in spite of the assurance of the County of Durham Company that uniform charges would be made throughout their district, the guarantee of 20 per cent. of the cost of the mains required to reach the farthest places was practically equivalent to a differential rate. At the same time, the authorities near the central station would not get their electricity so cheaply as they should do, in consequence of the extended area of supply. The chemical industries of the Tyneside, which were not in a prosperous condition, might be revived by the application of cheap electrical energy. The Tyneside Company were not afraid of opposition, and did not mind at all if the County of Durham Company were allowed to supply on the south bank of the Tyne. The objections to competition in this case did not apply as when supplying in bulk the main would only be laid when a contract had been entered into. Thus the objection to competition in distribution, that two sets of mains had to be laid down, did



Map of the Proposed Area of the Tyneside Electric Power Company.

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not hold. The petitions of the various local authorities against their Bill disclosed three items of objection. The first was to the breaking up of the streets, which, he thought, was practically disposed of; the next that they thought there would be competition; while the third objection was that the local authorities wished for the profit arising out of the supply of large consumers. He would bring evidence to show that the great traders of the district objected to taking their power from local authorities.

Sir ANDREW NOBLE, the chairman of Messrs. Armstrong, Whitworth, and Co., was then examined by Mr. Frere. He stated that electric power was most economical for driving large works, as it saved space. The works he was interested in had their own system of electric power distribution, and he was not prepared to say that they would have their electricity from the Tyneside Company. If, however, the Tyneside Company could at once supply power to their new works at Scotswood, they would at once take a supply. It was, of course, a question of cost coupled with the space saved by doing away with generating plant. Of course, with such large works as those of Messrs. Armstrong, Whitworth, and Co., it was more difficult for an outside company to give a supply, but the small manufacturing firms could be well served. He also represented the Employers' Federation, who were in favour of this scheme. The chemical works had almost disappeared as a profit-earning industry on the Tyne. He did not know that the local electric companies in Newcastle were supplying power to them, but was aware that the Newcastle-on-Tyne Electric Supply Company were proposing to largely extend their generating plant by erecting new works at Walker.

Cross-examined by Mr. Fitzgerald, Sir A. Noble said that he understood that the Walker Gas Company had obtained a provisional order for Wallsend and Willington Quay, and that they were erecting works. Without more knowledge of the circumstances, he could not express an opinion as to whether it was reasonable to give competing powers in these districts. He knew there were two companies supplying in Newcastle, and both had rights over the whole of the town, but they had arranged to split the district in two to avoid duplication of mains. He did not know that if the present Bill were granted, the Newcastle District Company could authorise the Tyneside Company to supply in the area of the Newcastle-on-Tyne Electric Supply Company.

In answer to the CHAIRMAN, Sir A. Noble estimated that three-fifths of the large industries were situated on the north bank of the Tyne and two-fifths on the south bank. He thought a more economical supply could be given if both sides of the river were included in the district of one company. With respect to competition between the two companies, he thought there would be an advantage derived in cheapness. In reply to a question as to whether it was just, expedient, and advantageous to grant both these companies rights on the south side, Sir A. Noble said that depended on the advantages of competition against the advantages of supply from one large station.

Mr. A. A. CAMPBELL SWINTON, examined by Mr. H. Lloyd, gave evidence that he was connected with the Parsons Steam-Turbine Companies, and was managing director of the Cambridge and Scarborough Electric Supply Companies. He was also electrical adviser to Messrs. Armstrong, Whitworth, and Co., Limited. He knew that the Tyneside Power Company were really the first in the field. He then proceeded to descant on the chemical industries of the district. He was interrupted by the Chairman, who said they were prepared to admit the advantages to be derived from the distribution of cheap electrical energy. His company asked for no monopoly. They proposed to charge for electrical energy at the following maximum rates: for the first 200 hours per quarter, 5d. per unit to the ordinary consumer and 4d. if supplied in bulk; for the supply from 200 to 400 hours per quarter, 3d. per unit per quarter for the general supply and 2d. per unit in bulk. Above 400 hours the charges would be 1½d. per unit for the general supply and 1d. for supply in bulk. They proposed a sliding scale reduction, commencing when the 10 per cent. dividend so obtained. As regards the proper selection of areas for the supply of electric power he would point out that there were now manufacturing centres for miles north of the Tyne, and that the next group of manufacturing industries to the south side of the Tyne were placed round the Wear, where they thought a supply station should be established. He considered it a right principle to put a station in the centre of the manufacturing districts. He thought that local authorities would only give a supply on a large scale after it had been proved indisputably to have been a financial success, and that might mean a 10 years' delay. At the present time he looked upon such undertakings as legitimate speculation for private capitalists.

Cross-examined by Mr. Balfour Browne, Mr. Swinton said his position as managing director of the Cambridge and Scarborough Electric Supply Companies was not incompatible with the proposals now before the committee. Cross-examined as to the comparative price proposed in the Tyneside Power Bill and the Jarrow electric lighting provisional order promoted by the County of Durham Company, Mr. Swinton admitted that for the five hours' supply his company would charge a maximum rate of 3½d., whereas in the Jarrow order, with the Brighton charges, the cost would be 2½d. per unit.

Cross-examined by Mr. Fitzgerald, he said the number of stations they would put down in the area depended on the developments, but they had scheduled three sites—at Wallsend, Willington Quay, and Hebburn. It would be quite possible to get from the Willington Quay station a considerable distance by means of wayleaves along the railways. They would in this case pick up large consumers, who might otherwise take a supply from the Wallsend Gas Company. As regards the sliding scale, he thought that under the proposed terms they could pay 15 per cent. by reducing the initial price for supply in bulk from 4d. to 3d. By reducing it from 4d. to 2d. they could pay 20 per cent., and from 4d. to 1d. 25 per cent. He was not aware that in the Walker Gas Company's Bill they could only pay 11 per cent. dividend by charging 1d. per unit. He was not aware that the new Bill of the company was to authorise an expenditure of a quarter of million pounds for electrical purposes.

Cross-examined by Mr. Pemberton on behalf of the Newcastle Corporation, Mr. Swinton said that, while there were three directors of the Newcastle Electric Supply Company who were promoters of the Tyneside Bill, the scheme did not originate with that company.

He was further examined as to what would prevent the Tyneside Company from acting as agents of the Newcastle Company in supplying the whole of the Newcastle area. The provisions of the Electric Lighting Clauses Acts were not inserted, because equivalent ones had been put in.

Cross-examined by Mr. Rickards on behalf of the Newcastle Electric Supply Company, the question of the probable demand was being gone into, when the committee adjourned.

(Continued on page 667.)

THE DYNAMICABLES.

Last week a dinner of this society was held at the Whitehall Club, under the presidency of Mr. Rawortb. After the dinner Mr. Madgen, in a very able manner, introduced for discussion the subject of the "Power Bills" now before a committee of the House of Commons. Mr. Hammond, Mr. Campbell Swinton, Mr. Garcke, and Mr. Holroyd Smith conversationally discussed the question, and together inaugurated a renewal of those extremely interesting and instructive debates which in years gone by so greatly assisted in determining technical public opinion. Subsequently Mr. W. W. Beaumont shortly addressed the members upon the possibilities of electrically equipped motorcars. It may be well to state here that Prof. Perry suggested a meeting in Paris during the Electrical Congress next August.

Iron and Steel Institute.—The meetings of this institute, held in London on Wednesday and Thursday last, have been well attended, and most practical discussions followed the reading of the various papers.

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SUPPLY IN BULK.

The progress of the Power Bills, which have now been under consideration by the House of Commons Committee for over a week, is somewhat slow, for two reasons. The first is that so many local authorities are opposing the Bills, and they, being individually represented by counsel, expect an individual hearing. This privilege Sir J. Kitson is curtailing as much as possible by accepting certain propositions without further evidence. The first two Bills on the list—the County of Durham Power Bill and the Tyneside Power Bill—have also to be considered conjointly, as they both ask for powers in the district abutting on the southern bank of the Tyne. The committee have already agreed to recognise as proved the advantages of comprehensive systems of electric distribution of energy, and will hear no further evidence on that point. They have also agreed that powers to lay trunk mains through one district not requiring a supply in order to reach districts beyond shall be granted. In such cases the local authority whose district is traversed is to have the right to choose the route, subject to appeal to the Board of Trade, and also the right to open up and make good the streets affected. The real fighting issue, apart from the competition between the above two companies, is as to whether supply may be given in bulk to large consumers without the consent of the local authority. This point is raised so far by the Tyneside Bill only, the promoters of which ask that the right already existing to supply whom they like by private wayleaves shall not be taken away. The large works on the Tyne are so interconnected by railways that practically all of them can be reached from the proposed site without opening up any public street. This proposal is said by opposing counsel to be contrary to an undertaking given by Mr. Ritchie in the House of Commons respecting the Lancashire Power Bill, that supply even in bulk should not be given without the consent of the local authority. This undertaking did not apply to the present Bill, and it is well to consider on broad lines whether it is really advantageous to the large users of power and to the local authority. If the opposition of these authorities succeeds, the large works on the Tyne will be dependent on the local authority for the supply of electrical energy, unless they lay down their own plant. In common fairness, then, these authorities should be compelled to provide the convenience which they have prevented a company from doing. Taking, then, the case of Felling, where, under expert advice, an expenditure of fifteen thousand five hundred pounds is to provide plant and mains for the district. This amount will not give more than the toy station so often seen in the early days of electric lighting in towns. If the manufacturers are to be supplied, the ratepayers must be responsible for at least five times that amount. After this has been spent, the establishment of a new chemical factory in this district might demand a further outlay of a quarter of a million, and when the supply from the Felling station had proved the electro-chemical process a success, the chemical company may find it economical to lay down their

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own plant. The result would be that the local authority would be crushed under the financial burden of an unproductive expenditure undertaken for the benefit of a private firm. The most ardent supporters of municipal trading could not claim that it is the business of municipal authorities to finance private undertakings, but this is the logical conclusion of the opposition. As regards the profits to be made out of the supply to large consumers, these are much over-rated by local authorities. The distribution of power scheme is weighted by the cost of the mains, and supply can only be profitably given if the generation of electrical energy is carried out on a very large scale and under most economical conditions. Otherwise competition with a private plant is not possible, in view of the good load factor which is found in manufacturing work. In other words, small municipal authorities cannot economically supply large power users, and their opposition to schemes for so doing is against the direct interests of their districts. As regards the competition between two power companies in one district, this is said to be advantageous to the consumer, but we believe that the keenest competition will be between the power distribution company and the private plant. This competition will keep prices low, and to enable low prices to be charged duplication even of trunk mains is to be deprecated. It will be quite open to grant competition when a company is found to give a poor supply or to charge too highly. A new industry will be created if the committee as business men pass the preambles of the Bills, and the ultimate advantage of the individual will be better served than by preserving to local authorities exclusive rights which they have not exercised to supply power in bulk.

FORTHCOMING EVENTS.

FRIDAY, MAY 11.

Royal Institution.—At 5 p.m., discussion on Prof. Lodge's paper "On the Controversy Concerning Volta's Contact Force."

SATURDAY, MAY 12.

North-East Coast Institution of Engineers and Shipbuilders.—At Newcastle-on-Tyne, graduates' meeting.

MONDAY, MAY 14.

Society of Arts.—At 8 p.m., Cantor lecture on "The Incandescent Gas Mantle and its Use," by Prof. V. B. Lewes. Lecture II. of three.

TUESDAY, MAY 15.

Institution of Electrical Engineers.—At 7.30 p.m., students' meeting, at Finsbury Technical College. Paper on "Hertz Waves and Wireless Telegraphy," by Mr. R. P. Howgrave-Graham.

WEDNESDAY, MAY 16.

Society of Arts.—At 8 p.m., ordinary meeting. Paper on "A National Repository for Science and Art," by Prof. Flinders Petrie.

THURSDAY, MAY 17.

Institution of Electrical Engineers.—At 8 p.m., at Institution of Mechanical Engineers, paper on "Alternating-Current Induction Motors," by Mr. A. C. Eborall.

Royal Institution.—At 3 p.m., Lecture IV. on "A Century of Chemistry at the Royal Institution," by Prof. Dewar, M.A.

FRIDAY, MAY 18.

Royal Institution.—At 9 p.m., discourse on "The Structure of Metals," by Prof. J. A. Ewing, M.A.

Institution of Junior Engineers.—At 8 p.m. Paper on "A Short Review of the Motorcar Industry," by Messrs. Basil H. Joy and C. H. Rush.

North-East Coast Institution of Engineers and Shipbuilders.—At Newcastle, closing meeting.

SATURDAY, MAY 19.

Manchester Society of Junior Electrical Engineers.—At Manchester. Paper on "The Application of Accumulators to Telegraphy and Telephony," by Mr. T. E. Herbert.

THE ELECTRIC POWER BILLS.

(Continued from page 665.)

WEDNESDAY.

Mr. A. A. CAMPBELL SWINTON, again cross-examined on behalf of the Newcastle-on-Tyne Electric Supply Company, said he was aware that the Corporation had power to supply their trams and their public lighting, but did not know they could supply the cranes on the quay. He understood that the Newcastle-on-Tyne Electric Supply Company were applying for a provisional order for Gosforth, and also had a Bill for the supply of Long Benton, which was not opposed. He knew that the Walker Urban District Council had a provisional order, but was not aware that they had handed it over to the supply company for 10 years. He took it from the Council that an agreement had been entered into with the Walker and Wallsend Gas Company whereby the districts of Wallsend and Willington Quay would be supplied in bulk from the same station. This arrangement would conduce to economy in working. Of the 19 local authorities mentioned in the Tyneside Company's Bill, 12 had petitioned against the Bill, while seven had consented to it. The company could not supply without the consent of the local authorities, but Mr. Swinton was not clear as to how far the Bill compelled the company to ask for this consent. He was further cross-examined with a view of showing that the central station at Wallsend would be a considerable distance from those areas by which the Bill was not opposed. He was aware that the Newcastle-on-Tyne Electric Supply Company had also scheduled the ground at Wallsend, but considered that this site was more suitable for the purposes of the Tyneside Company. The system of distribution would be either the two or three phase at 10,000 volts. If a continuous current were wanted, the consumer could get it by transformation. Mr. Campbell Swinton was then severely cross-examined as to the operation of the proposed sliding scales for reducing the price when certain dividends had been paid, but no clear ground on which this reduction was to be made was deduced. He considered that the Newcastle Company could not legally obtain wayleaves over private ground owing to their statutory powers.

Cross-examined by Mr. Moon on behalf of the County of Durham Electric Distribution Company, Mr. Campbell Swinton said they would not compete with the company in Jarrow without the consent of the local authorities. They would, however, supply such large consumers as they could reach without breaking up streets. They would be quite prepared to supply the Jarrow Company, but there was nothing in the Bill to prevent them supplying a large consumer at the same rate as the company. He agreed that the Electric Lighting Act provided against undue preference being given. The same also applied at Gateshead, where they would supply large consumers by private wayleaves. He thought it was to the advantage of the consumer, as he would save middleman's profits.

Cross-examined by Mr. Squarey, on behalf of the borough of Tynemouth, Mr. Campbell Swinton said that area was not scheduled for a general supply. At present there was no area beyond Tynemouth to which mains would have to be taken. He would not agree to strike out Tynemouth, which town had had a provisional order since 1891 without yet giving a supply!

Cross-examined by Mr. Morton-Smith, for the Walker Urban District Council, the question of the rate of charges was gone into. It was stated that in December last the company had offered to supply the Council at the rate of 5d. per unit for the first 100 hours per quarter at the maximum demand, 3d. for the next 100 hours, and 1½d. for the balance. He did not agree that the proposal of the company to supply large consumers by private wayleaves had been kept back. It was included in the Bill, which could be read by all interested.

Cross-examined by Mr. H. Hamilton, on behalf of the South Shields Corporation, Mr. Campbell Swinton said that Mr. Ritchie's undertaking that supply should not be given even in bulk without the consent of the local authority interested was made for the Lancashire Bill. He did not consider his company bound by that statement, or by the further

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undertaking of Mr. Ritchie to use his influence to secure that all the Bills should proceed on the same lines. In answer to one of the committee, Mr. Campbell Swinton said he did not consider the promoters of the Tyneside Bill to be under a moral obligation not to supply in bulk without the consent of the local authority in consequence of Mr. Ritchie's statement in the House. He was quite prepared to risk the chance of the Bill being thrown out at the third reading on account of the fact that it did not conform to Mr. Ritchie's undertaking. The decrease in cost with the increase of size of plants was not so marked after a certain high limit had been reached. He did not think a lighting station would ever be able to supply power cheaply enough to induce large manufacturers to come on. As to the power demand on the north of the Tyne, this might provide a paying load in two years, and there might be sufficient demand in from six to ten years to employ all the capital of the company.

Mr. J. C. WORTH, examined by Mr. G. Wick, said he was the managing director of the Acetylene Illuminating Company. The consumption of calcium carbide per annum was worth over £50,000. This quantity required 327 million units per annum for its production. The works at the Falls of Foyers produced for his company some 3,000 tons of carbide per annum, requiring 20 million units. Further demand would require new works, and this might be equipped with steam plant, but must be laid down on a very large scale. The Tyneside was a favourable site for such works. He had been in treaty with the Tyneside Company for the supply of proposed works on the Tyne with a minimum demand of 5,000 h.p. That would represent 32 million units per annum.

In cross-examination it was brought out that this supply would be charged at a little over half a farthing per unit by the agreement. It would be a constant load—24 hours per day.

The Hon. C. A. PARSONS, examined by Mr. Frere, gave evidence as to the plant the company would use. The first cost would be kept down by using large steam-turbines. The following estimates of cost were then given:

Capital Cost of 10,000-kw. Plant; 180,000lb. of Steam per Hour.	
Thirty-five boilers (five as spare)	£35,000
Superheaters and economisers	8,000
Five turbo-alternators of 2,500 kw., with condensers	80,000
Piping, cranes, and erection	15,000
Land and building	26,000
Transformers	13,000
Working capital	50,000
	227,000
Thirty miles of 1,000-kw. trunk main	60,000
Thirty miles of distributors	30,000
10,000 kw. of step-down transformers	20,000
	£337,000

Estimates were also given as to the cost of generation and supply with different average hours of use per day. Thus with 24 hours per day and 300 days per annum the units generated would be 72,000,000, the cost per unit generated ·245d., with 90 per cent. efficiency of distribution. The cost per unit sold would be ·272d. With a six-hour day and 300 days per annum the figures were:

Units generated	18,000,000
Cost per unit generated	·68d.
Efficiency of distribution	80 per cent.
Cost per unit sold	·85d.

With four hours per day and 300 days per annum:

Units generated =	12,000,000
Cost per unit generated	·944d.
Efficiency of distribution	75 per cent.
Cost per unit sold	1·25d.

If, however, as in a chemical works, the supply was taken continuously for 24 hours per day, 365 days per annum, the cost per unit would be ·1704d., or £4. 12s. 9½d. per horse-power per annum.

Cross-examined by Mr. Rickards, the Hon. C. A. Parsons said Mr. Worth was not quite accurate in his figures as to the charge for power proposed to the Acetylene Company. It would be £6 per horse-power per annum.

Cross-examined by Mr. Forbes Lankester, the witness said the Newcastle and District Electric Supply Company had not opposed the Bill of the Walker Gas Company last year. The areas over which the alliance with the Newcastle-upon-Tyne Electric Supply Company were preparing to supply was a large one. He thought that competition over this district was advisable.

THURSDAY.

The Hon. C. A. PARSONS was asked to explain the working of the sliding scale in connection with the Bill of the aforesaid power company. He explained that as regards the maximum demand they would fix both a meter and a maximum demand indicator on the consumer's premises, or at the point at which the supply was given in bulk to a local authority or to a company. The amount to be paid would then be estimated according to Schedules A, B, and C in the Bill. The application to the sliding scale would be equal to all these rates. For instance, if the company were to pay a dividend of 15 per cent., they would have to reduce the rates by 5 per cent. for every 1 per cent. dividend beyond 10. This was equivalent to a 25 per cent. reduction. Thus, under Schedule A, the supply for the first 100 hours would be reduced from 5d. to 3·75d. to a consumer and from 4d. to 3d. to an undertaker. Under Schedule B, for the consumption over the 100 hours the reduction would be from 3d. to 2¼d. and from 2d. to 1½d. respectively. Under the Schedule C, the reduction would be from 1·5d. to 1·025d. and from 1d. to ·75d. He understood that the reduction had to be made before the dividend could be paid. He thought that if the profit at the end of the year was found to be high, they could carry forward and reduce the price and pay a higher dividend.

The Hon. C. A. Parsons was cross-examined by counsel representing various local authorities as to the working of the sliding scale, and as to the meaning for each rate not in the sliding-scale clause. He considered the proposed reduction was fair to all consumers, because when the company was able to pay a higher dividend than 10 per cent., all would share in the reduction of the rates.

Examined on behalf of the Newcastle Corporation, he stated that he was aware the streets in Newcastle were crowded with pipes, and did not think they were more crowded than other towns. There were two electric companies, two telephone undertakings, and the electric tramways all having their mains into the streets as well as the gas, water, and sewers. In answer to the counsel for South Shields, witness explained that they proposed to dredge a deep trench in the river bed in which to bury the cable. This would be filled in by rubble, which would protect the cable. They would not make this cable in the river at Shields part of that to be considered when asking for 20 per cent. guarantee before giving supply.

In answer to Mr. Morton-Smith, representing the Walker Urban District Council, he was not aware that his company had approached his Council with respect to supply in bulk last December, and that the Council had found the terms offered by the Newcastle-on-Tyne Electricity Supply Company more favourable. They did expect to supply the factories in the Walker district, without the consent of the local authority, by means of private wayleaves.

On behalf of the Gosforth District Council, Mr. Parsons was cross-examined as to the reason for coming to Gosforth, where there was practically no factories, and in view of the fact that the Council opposed. He explained that it might be advantageous to take the mains through Gosforth to get to Newburn; although the route was longer, the cost might be less. In answer to Sir J. Kitson, Mr. Parsons considered that the supply of cheap electric power in Gosforth would encourage industries. He expected these to increase largely on the banks of the Tyne. He would not give a general supply in any district without the consent of the local authority. In Newcastle the load factor was not now so good as formerly, owing to the number of offices using the electric light.

Mr. DAVIDSON was then examined, and stated that he was managing director of the United Alkali Company, which had works, two in Gateshead, one at Hebburn, and one at Jarrow. The chemical trade was much smaller than formerly. The various processes were at present carried out by steam power. The population of Gateshead was rapidly on the increase. There were large

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areas on the Tyne banks adapted to the establishment of new works. He thought cheap power would strengthen the position of the chemical works, and would encourage other trades to come to the district. His own works were all on the south side of the district. He thought the Tyneside Company the best suited to supply on the south side of the Tyne. There were no alkali works on the north side of the Tyne.

Cross-examined for the Durham Corporation, he stated that his reason for preferring the Tyneside to the Durham Company was that he knew that the promoters of the former were all men who understood the wants of the Tyneside district, and were capable of carrying out their promises. He had absolute faith in these men.

In answer to the Chairman, he stated that no understanding existed between the Tyneside Company and the United Alkali Company. The price he reckoned on getting power for was somewhere about ¼d. per unit. The works were not situated so that they could be reached by private wayleaves.

Mr. NORMAN COOKS stated that he was principal owner of the largest leadworks in the district. He was also one of the promoters of the Bill. He thought it desirable that only one company should supply on both banks of the Tyne, as those companies whose works lay on both sides would not otherwise feel the benefit of taking a large supply spread over both works.

Cross-examined by the counsel for the Wallsend and Walker Gas Company, he said that if the Walker Company could give a cheaper and more reliable supply, it would be to his interest as a consumer to take such a supply.

Cross-examined further, he said he knew that Tynemouth Corporation started to lay its mains and erect plant before this Bill was promoted. In reply to the committee, he said a large amount of power would be required for work now done by small isolated plants.

Sir BENJAMIN BROWN was then called, and said he was the chairman of Messrs. R. and W. Hawthorne, Leslie, and Co., shipbuilders, whose works were on both sides of the Tyne. He certainly should take a supply from the company in Hebburn, but in Newcastle he should obtain it from the local companies. He did not favour local authorities supplying power, and it was usually done much better by a company. He had negotiated with the two companies in Newcastle for a supply of power for his works.

Cross-examined as to his opinion as to the fairness of the Tyneside Company competing with the Walker and Wallsend Company, he would not give any direct opinion.

In answer to the Chairman, he said they had not in Newcastle yet supplied for light and power. In his works about 600 h.p. was wanted. Electricity was especially adapted for shipbuilding work owing to the distance it was necessary to take tools from the source of power, and the inconvenience sometimes experienced in the working.

(To be continued.)

A NEW TROLLEY DEVICE.

We notice in a recent number of the *Street Railway Review* a description of a device which is to secure the trolley wheel from leaving the wire. The device consists of a harp with sufficient spread to take a spindle 12in. long and ½in. diameter. On this is a steel tube 1in. in diameter, and having ball bearings at each end between it and the spindle. The trolley wheel is loosely mounted on the steel tube, and on each side of the wheel are brass spiral springs, which hold the wheel in position in the centre. Thus, when rounding a curve, the spring gives way to the side pressure, and the wheel slides along the tube in the direction of the pressure, thus giving time for the trolley pole to turn without forcing the wheel off the trolley wire. The apparatus is said to also lessen the wear on the wire and trolley wheel, owing to the smaller side pressure. After passing the curve, the wheel, of course, comes back to the central position. The wheel on being tried on a trip on which ordinary trolley wheels left the wire four or five times, did not do so once. This device, although, perhaps, very suitable to American practice, would not, we should think, be such a success in England. For instance, when rounding a curve, with two cars passing each other, with these broad trolley harps we should expect the two ends of the trolley poles would sometimes foul each other, and do much damage. We also very much doubt whether good electrical contact will be obtained by the wheel being let to run loosely on the steel tube, as grit and dirt getting on the same would soon spoil the bearing surface and the electrical contact.

ELECTRICITY APPLIED TO MINING.*

BY HAROLD BENTHAM.

The subject of electricity applied to mining will perhaps be a subject which is quite foreign to many present. It is, however, a very important branch of electrical engineering which is increasing by leaps and bounds, and I have not the slightest doubt that at no distant date the largest and most important collieries will be equipped throughout with motors for all power purposes. Improvements are being gradually made in electric mining machinery, chief of which is the totally enclosed type of continuous-current motor and the three-phase induction motor. I have assumed in the following paper that the plant to be dealt with is of the continuous-current type, owing to the three-phase system applied to mining being as yet in its experimental stage. These experiments have, however, up to the present time been a great success, the three-phase induction motor possessing a great advantage over the continuous type due to the total absence of a commutator, thereby doing away with the necessity for a totally enclosed and airtight motor out in the workings of the mine. The power required for mining work has greatly increased of late years. This is due partly to the enormous increase in the tonnage or output of coal per day and partly on account of the demand for different qualities and sizes of coal, thereby necessitating various improvements in the methods of dealing with and handling the same.

I have divided the paper into two sections for convenience: Section 1—power, being the utilisation for power at the mine; Section 2—lighting, which includes the lighting of the various works in and about the mine. Section 1 I am taking as follows: (*a*) the advantages and disadvantages of steam and electricity as motive power for mining purposes; (*b*) description of plant required; (*c*) comparison of first costs and efficiencies, and also comparative working costs for one year.

Section 1(a).—Power.

It is quite evident that whatever motive power is used, it must be capable of withstanding sudden heavy loads. It must not be affected by dirt or grease, and it should be built to work under very trying conditions and general rough usage. At every new colliery it is the rule to put down an electrical hauling plant; why not, therefore, at the same time drive all the screening plant, coal-washing machinery, the fan for ventilating the mine, boiler pumps, joiners' and fitting shops, and any other auxiliary machinery by motors. It is quite obvious that the cost of running a small station for part of the works would be practically the same as for a larger station to run the whole works.

It would hardly be feasible to substitute the main winding engines by a motor, as the engines employed for this work are never less than 1,000 h.p. The steam-engine in this case would be more economical in first cost, as well as showing slightly greater efficiency. Excepting the winding engines, however, none of the other engines or sets of engines range over 200 h.p. or 300 h.p. It will therefore be economical to substitute electrical for steam power in all other cases. Take the case of a colliery having an output of 2,000 tons per day when working two shifts per day. It is not at all unusual to find as many as four separate sets of steam-engines for driving the screening plant at a modern colliery, and owing to the engines being fixed on the structure work of the screens, there is a very decided

* Paper read before the Manchester Society of Junior Electrical Engineers.

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oscillation or vibration which cannot altogether be avoided, as the framework of the screens must be designed to allow railway wagons to pass underneath in every direction. There is also to each engine the necessary range of steam-piping, which, when subjected to vibration, is very apt to leak. The losses due to condensation of steam in the steam-pipes vary from 25 to 50 per cent., this enormous loss being a constant quantity, independent of the number of hours the power may be required, as the steam-pipes in most cases are never allowed to cool down, except for repairs, thus accounting for the large losses above mentioned. The engines, being of the open type, are also subjected to the grinding action of the dust and dirt, which works into all the bearings, the engines, therefore, needing constant attention and repairs.

By electric driving all these objections are dispensed with. The motors, owing to their rotary motion, will not require such heavy foundations, and for the same reason the oscillation of the structure work will practically be reduced to nil. The range of steam-piping, with its attendant troubles, is also absent, and the motors being enclosed with self-oiling bearings, it is impossible for the dirt to get into the bearings. By substituting electric power for steam on all surface machinery, the following advantages accrue: lighter foundations, greater efficiency, less attention and repairs, all of which are points in favour of electric driving.

For underground haulage and other power purposes in the mine, electricity has already asserted its superiority. In some steam hauling plants the engines are on the surface, in others they are underground. When the steam plant is on the surface, the ropes are run down the pit shaft in wood or iron pipes. Fig. 1 shows a diagrammatic sketch of rope driving by steam-driven plant on the surface. This method of driving necessitates at least one length of rope in the shaft, and in the case of endless or main and tail haulage, there are two lengths of rope in the shaft. This rope is not only a dead loss of capital, but is also a great addition to the working load, thereby reducing efficiency. Another disadvantage of this system is that when a rope becomes worn and a strand breaks, the pipes have sometimes to be removed in the shaft to find the faulty part and afterwards remedied. This means either stopping the winding of coal for an hour or two, or shutting that part down which is controlled by the rope. Again, if the engines are in the pit bottom, steam must be obtained from the surface. This means a length of steam-pipe from the top to the bottom of the pit, which in the case of a mine from 600 to 700 yards deep is not only a very expensive undertaking, but an extremely wasteful method. The exhaust steam from the engines, though assisting in the ventilation of the mine, renders the shaft into which the steam is exhausted practically useless for purposes other than ventilation. All the above objections apply to compressed-air haulage with the exception of the last one.

In the case of motor-driven hauling plant, the cables are run down the pit shaft and from there to the motors, the motors being placed in the most convenient situation. Electrical haulage will show greater economy, in addition to being more cleanly and convenient, also overcoming all the above objections. Steam is never used for coal-cutting machinery, compressed air being the only rival to electricity for coal-cutting purposes. Electricity is gradually being substituted for compressed air, chiefly on account of the greater efficiency and cheapness in first cost. Neither class of machines, however, are very extensively used at present,

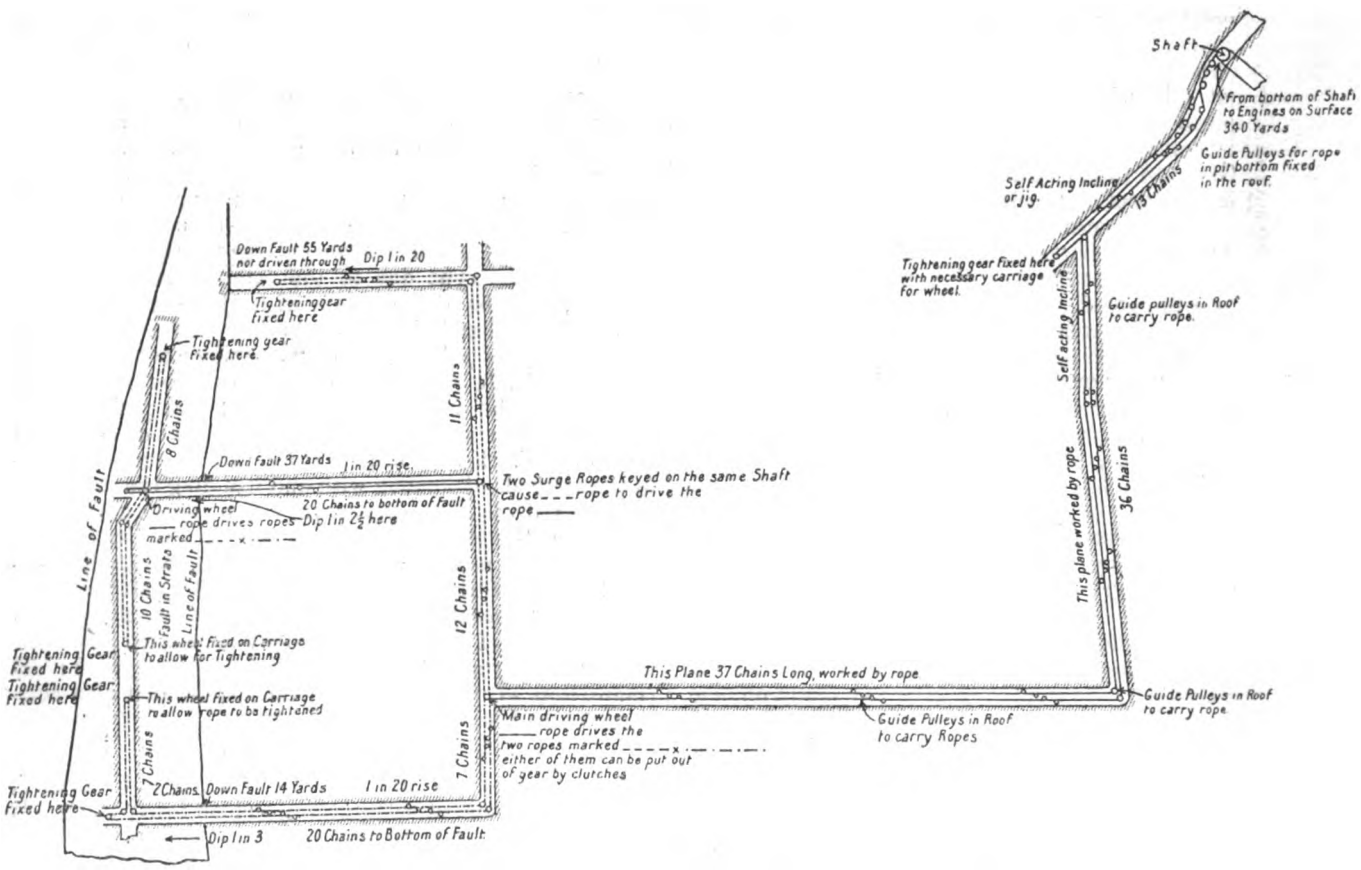
Shaft
From bottom of Shaft to Engines on Surface 340 Yards
Guide Pulleys for rope in pit bottom fixed in the roof.
Self Acting Incline or jig.
15 Chains
Tightening gear Fixed here with necessary carriage for wheel.
Guide pulleys in Roof to carry rope.
Self acting Incline
This plane worked by rope
36 Chains
Down Fault 55 Yards not driven through
Dip 1 in 20
Tightening gear fixed here
Tightening gear fixed here
8 Chains
11 Chains
Down Fault 37 Yards
1 in 20 rise.
Two Surge Ropes keyed on the same Shaft cause ___ rope to drive the rope ___
Driving wheel ___ rope drives ropes marked ---x---
20 Chains to bottom of Fault
Dip 1 in 2½ here
Line of Fault
10 Chains
Fault in Strata
Line of Fault
12 Chains
This wheel Fixed on Carriage to allow for Tightening
Tightening Gear Fixed here
Tightening Gear Fixed here
This wheel fixed on Carriage to allow rope to be tightened
This Plane 37 Chains Long, worked by rope
Guide Pulleys in Roof to carry rope
Guide Pulleys in Roof to carry Ropes
Main driving wheel ___ rope drives the two ropes marked ---x--- either of them can be put out of gear by clutches
7 Chains
7 Chains
2 Chains
Down Fault 14 Yards
1 in 20 rise
Tightening Gear Fixed here
Dip 1 in 3
20 Chains to Bottom of Fault

FIG. 1.—Diagram showing the Winning of the South Side Coals by Endless Haulage at Thrybergh Hall Colliery, Rotherham.

as they require certain conditions in the mine to ensure favourable result. For instance, the longwall system of working must be adopted and the roof good, otherwise the machinery very often buries itself. Where these conditions exist, coal-cutting machinery, when driven by an electric motor, has proved itself decidedly superior to compressed air or manual labour.

The advantages of motors in a mine are that they do not require so much attention as the same number of steam-engines. The self-oiling bearings and a general examination being required once a day. Down the mine a boy is employed to start and stop the motor as required by the signals. All motors, except the one for driving the fan, must be enclosed, as they are exposed to dirt, damp, grease, or explosive gases. All motors out in the workings of the mine must be totally enclosed and airtight.

The power required on the surface is as follows: 100 b.hp. for driving the screening and coal-dressing plant, which will be split into several units; 200 b.h.p. for driving the coal-washing plant, consisting of several units; 100 b.h.p. for driving fan direct-coupled; 25 b.h.p. to drive joiners' shop, including circular saw, band saw, planing machine, etc.; 25 b.h.p. for driving fitting shop; 50 b.h.p. for driving

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feed pumps, etc.; 50 b.h.p. for draining the mine, giving in all 550 b.h.p. for driving the requisite surface plant.

The power required for underground haulage purposes, taking as an instance a colliery of my acquaintance (which, by the way, is steam-driven), is equal to 400 b.h p. divided into three units, one of 200 b.h.p., and two of 100 b.h.p. each. I should also allow 50 b.h.p. for electrical coal-cutting, making a total of 450 b.h.p. for underground use, or a grand total of 1,000 b.h.p. for all power purposes.

Section 1(b).

As 550 b.h.p. is required for surface work, and 450 b.h.p. is required for underground work. I should select the plant as follows:

Engines, etc.—One unit of 600 h.p., one of 300 h.p., and one of 200 h.p.; engines to be of the slow-speed direct-coupled type, and particularly well governed. The reason for this division of plant is that when the mine is working all the three sets would be required, but on Sundays and holidays one of the smaller sets would be sufficient to drive the fan, pumps, etc. The engines would obtain steam from the same range of boilers as the winding engines, the boiler pressure usually ranging from 80lb. to 100lb. per square inch. The engine-room must be as near as possible to the centre of its work on the surface, and as close to the boilers as practicable. The engines usually work non-condensing, owing to the coal being so cheap and the water costing practically nothing.

Dynamos.—The generators (supposing it is a continuous-current station) must be multipolar machines, very strongly built, with toothed armatures and carbon brushes, which should not require shifting from no load to full load. They should be wound to give 600 volts at the terminals, which voltage may be varied within certain limits by regulating the speed of the engine.

Switchboard.—I should arrange the switchboard similar to Fig. 2. It will be noticed that there is no provision on the board for ascertaining the voltage by means of pilot wires at any distant points on the feeders, this being thought quite unnecessary at a colliery power station, as the voltage, though fluctuating a great deal, is not so important on a power plant as it would be at a lighting station. There are three positive and three negative 'bus bars, which may be run at different voltages, so that all motors can work at approximately the same pressure. The machines by this method in some cases might be made interchangeable. Another advantage of this arrangement is, supposing there was a short-circuit on one particular feeder, by this method it might prevent the failure of the whole plant.

Mains, etc.—The feeders should be all designed so as not to exceed the fire office rule of 1,000 amperes per square inch, and, as shown on the switchboard diagram, I have arranged for five feeders to feed as follows: 100 h.p., screens, No. 1 feeder; 200 h.p., coal washer, No. 2 feeder; 100 b.p., fan, No. 3 feeder; 250 h.p., joiners' shop; 25 h.p., fitting shop, 50 h p., draining mine, 50 h.p., feed pumps, No. 4 feeder; 50 h.p, coal cutting, 400 h.p., hauling, No. 5 feeder. The feeders should be run underground to the various parts of the works in wood troughing filled in with insulating compound.

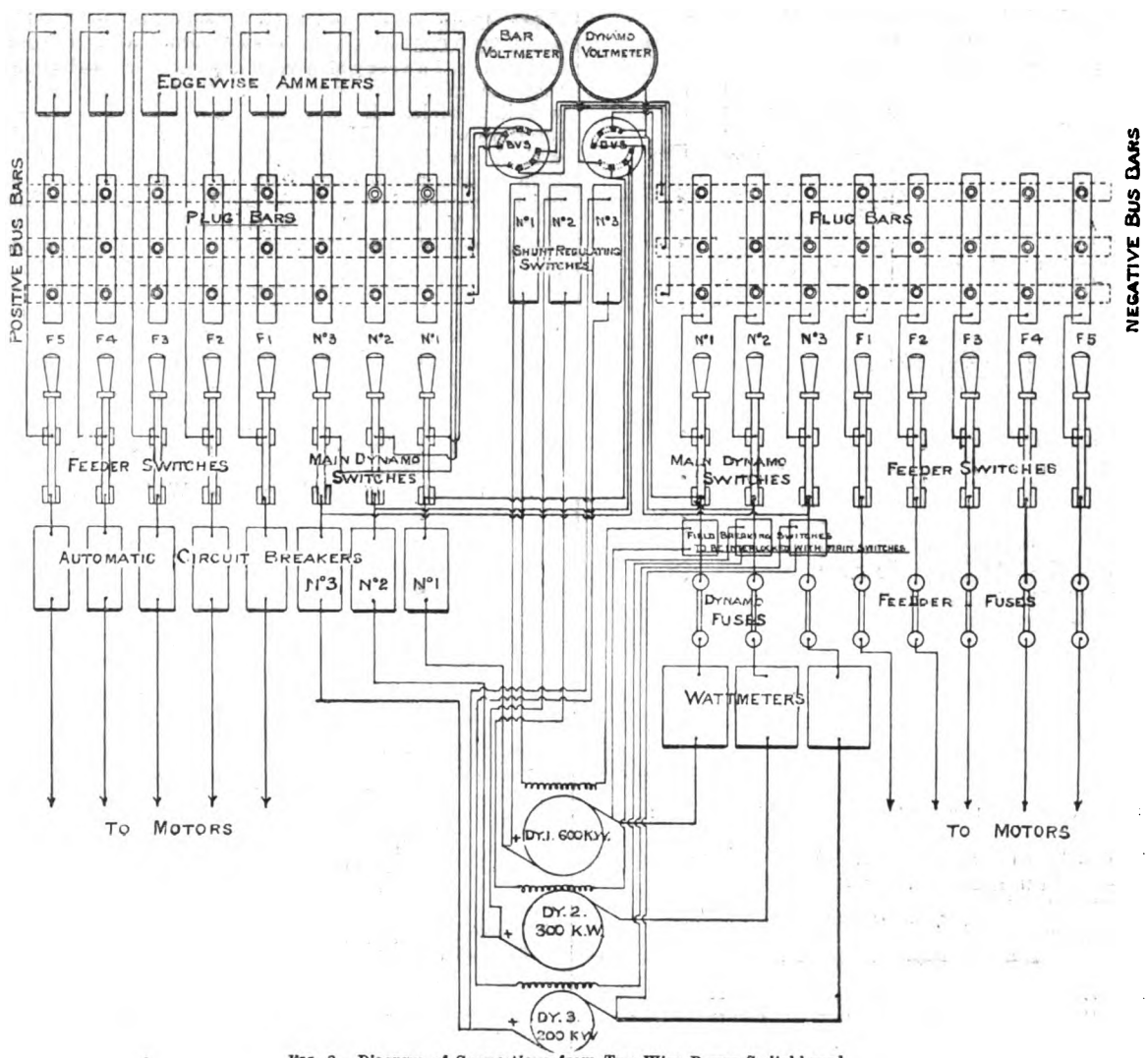

FIG. 2.—Diagram of Connections from Two-Wire Power Switchboard.

Fixing Cables in Shaft.—Various methods are employed for fixing cables in the pit shaft, depending mainly on the class and size of cable. Sometimes they are ordinary cable, at other times concentric cable may be used. If the cable is a large one, it is always lead-covered and armoured, and in that case clamps are placed about 30 yards apart, so that when the cable is clamped in position it hangs from 4in. to 6in. clear of the shaft side, in order to prevent the water from running down the cables. Fig. 3 shows the section of a patent oil insulator used for suspending ordinary vulcanised-rubber cables from the top to the bottom of the mine without any intermediate support. In this method the cables hang from 4in. to 6in. clear of the

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wall (for reasons above mentioned) and about 1ft. from each other, the cable hanging clear of everything from the top to the bottom of the pit; cables hung in this manner seem to give a very satisfactory result, and are not expensive in first cost. That part of the cable in the insulator clamp is bared, and served with fine binding wire, so that there may be no chance of the cable slipping in the clamp. The insulation on each side of the clamp must be carefully wrapped with tape, etc., to prevent moisture penetrating between the conductor and insulator. The cables when suspended from the top must be of hard-drawn copper, in order to secure greater tensile strength. Another method is to run the cable in casing, the grooves in the casing being cut to fit the cable fairly tight, and in this

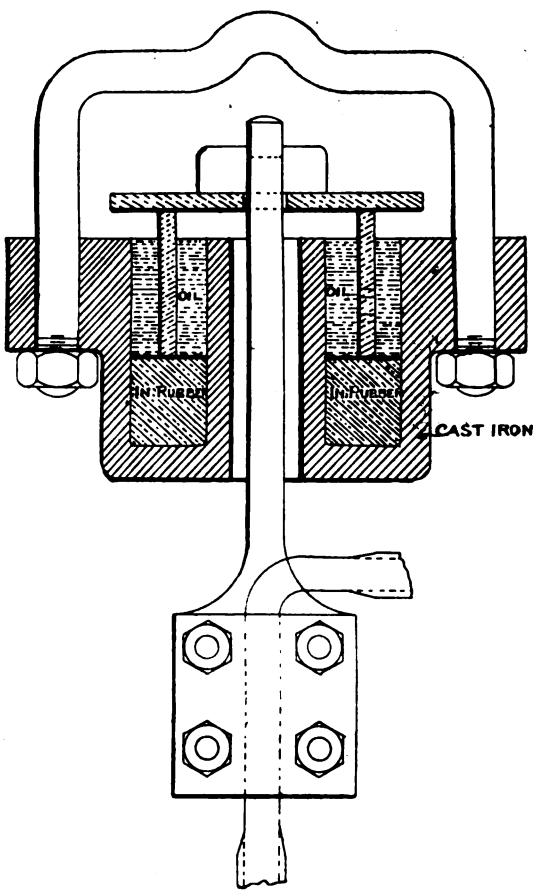

FIG. 3.—Section of Oil Insulator for Suspending Cable in Pit Shaft.

manner to sustain its own weight. All the above methods are at present in use, and give good results.

(To be continued.)

MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

A committee of the House of Commons, which consists of Sir J. Kennaway (chairman), Mr. Nussey, Mr. Wrightson, and Mr. C. Douglas, on Tuesday began the consideration of the Manchester and Liverpool Electric Express Railway Bill.

Mr. BALFOUR BROWNE, Q.C., opened the case for the promoters, and said the Bill authorised the incorporation of a company for the construction of a high-speed railway commencing in the centre of Manchester and terminating in the centre of Liverpool. There would be no intermediate stations on the proposed line, and the competition with existing railways would be solely for through traffic. The principal opposition came from the three railways running between Manchester and Liverpool—the London and North-Western, the Lancashire and Yorkshire, and the Cheshire Lines. It was believed that on the line between Manchester and Liverpool a speed of 120 miles an hour could be attained with perfect safety. Some of the most influential men in the district were taking a financial as well as a general interest in the scheme. Continuing, he stated that Mr. Behr and his friends had spent over £200,000 to establish the feasibility of the system. It was proposed to run the trains at the rate of about 110 miles an hour, the journey between Manchester and Liverpool being accomplished in 20 minutes. The two risks were collision and derailment. It could be shown that there was no risk of derailment; and as to the danger of collision, there was to be a separate up line and down line, without any junctions, stopping places, or level crossings, and the only possible danger was of one car overtaking another that had stuck on the road. By a system of automatic signalling this danger would be absolutely averted. The central station would be at Warrenton, the energy being generated at 10,000 volts, and being transformed down to 500 or 600 volts. The length of the line, which was double, would be 34 miles, the cost being estimated at £1,750,000. The cost of working per mile would be much lower than on ordinary railways. The Corporations of Manchester and Liverpool were practically with them in the scheme.

In reply to a question put by one of the committee to Mr. Hawkshaw, the engineer of the line, Mr. Balfour Browne said the railway passed round by Eccles and Barton rather than following the Cheshire Lines Railway, because of the Manchester Ship Canal, over which they would have had to have swingbridges, which would not have been safe at the proposed speed.

Mr. BEHR, promoter of the scheme, examined, said he had spent £200,000 on experiments with the mono-rail system. He had invented a very efficient air-brake, which was much better than the ordinary friction brake. With his system, derailment was impossible. He did not believe that his project would interfere with the Mersey Docks and Harbour Board if they wished to make docks at the south end of Liverpool. He had been willing to do everything he possibly could to meet the objections of the Mersey Docks and Harbour Board and the Lancashire and Yorkshire Railway, and had made a deviation in the neighbourhood of St. Michael's Station which he thought would meet their views. He was afterwards informed that he had failed to satisfy either the Board or the railway company. His project would not do any harm to the undertakings of the London and North-Western Railway Company or the Cheshire Lines Committee. He expected to carry about 7,500 passengers per day. Questioned as to the voltage he wished to use, he said it must be a question of settlement with the Board of Trade, but he wanted 1,000 volts. He would undertake to deposit £100,000 as caution money as a guarantee of his going over 100 miles per hour.

The committee then adjourned till Wednesday.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

269. What is the best practical method of measuring the power absorbed in a three-phase circuit?—T. B.

270. What advantage does the electric welding process possess over ordinary forge welding? Describe some form of electric welder.—A. S. L.

ANSWERS.

Question No. 264.—What error could be introduced in the case of an alternating supply, supposing the cost were calculated in B.T. units on the amount of electricity passed? Give an example and describe a good alternating-current meter.

Best Answer to No. 264 (*awarded* 10s.).—One measures "quantity of electricity" in coulombs, or ampere-seconds. The commercial unit is the ampere-hour, and is measured by an ampere-hour meter. Now, there are two objections to the use of the readings on an integrating ampere-hour meter as a basis for calculating the cost of power supplied by means of an alternating current: (*a*) It is taken for granted that the effective E.M.F. is constant in value throughout the time of supply. This is by no means a safe assumption to make, for (1) the regulation of pressure

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at the generating station may not be all that could be desired; (2) a certain variation due to drop in mains between light and full load is almost unavoidable. (*b*) No allowance is made for phase difference between current and E.M.F. Any magnetic apparatus for the utilisation of alternating-current energy has a "power factor" which is expressive of the cosine of the angle of lag of current behind impressed E.M.F., due to the retarding effects of induced E.M.F.'s; in other words, of the total current given to the apparatus (and, therefore, measured by the ampere-hour meter) a component only is used in combination with the E.M.F. as a watt-current, while the other component in quadrature with it (or wattless current) is merely useful in balancing the action of induced E.M.F.'s.

The power factor for transformers, alternate-current motors, etc., may be roughly taken at from 75 per cent. at light load to 85 per cent. at full load. These figures vary to some extent with type and size of the apparatus. For arc lamps the power factor is rather higher. Now, by definition a Board of Trade unit is 1,000 watt-hours. Hence, if we assume that the whole amount of current is a watt-current, we shall be overcharging the consumer by some 10 to 25 per cent. if he is running a motor or transformer load. The only case in which this method of charging is correct (assuming constant voltage) is when the load is entirely non-inductive, such as an incandescent lamp load. If the load is partly inductive, partly non-inductive, the overcharge will be reduced as the proportion of the inductive to the whole load is brought down.

Let us take as an example a workshop lit by 100 16-c.p. 220-volt incandescent lamps, and also by four 10-ampere 50-volt arc lamps in series, with a steadying choking coil for general lighting. A 5 b.h.p. alternate-current motor is also driven from the same (220-volt) mains, and runs for a day of 10 hours. A 16-c.p. lamp will absorb 60 watts, or $\frac{60}{220}$ amperes. And assuming that the lamps are run on an average four hours per working day, ampere-hours per year equal

$$\frac{60}{220} \times 100 \times 4 \times (365 - 52) = 34{,}180 \text{ (about)} \quad . \quad (1)$$

Assume, also, that the arc lamps burn for the same time per day. If the lamps and choking coil were non-inductive, ampere-hours per year would equal

$$10 \times 4 \times 313 = 12{,}520 \quad . \quad . \quad . \quad . \quad (2)$$

But this circuit, including choking coil, will have a power factor of about ·85; therefore, effective ampere-hours will be

$$\frac{12{,}520 \times 85}{100} = 10{,}650 \text{ (about)} \quad . \quad . \quad . \quad (3)$$

Now, the efficiency of a 5-b.h.p. alternate-current motor will not be more than 88 per cent., so that electrical horse-power required will be

$$\frac{5 \times 100}{88};$$

therefore, current used will be

$$\frac{5 \times 100 \times 746}{88 \times 220}.$$

∴ Ampere-hours per year equal

$$\frac{5 \times 100 \times 746}{88 \times 220} \times 313 \times 10 = 60{,}315 \quad . \quad . \quad (4)$$

assuming that there is no loss due to lag. But the power factor of such a motor would be, say, ·8 at full load. Therefore, effective ampere-hours equal

$$60{,}315 \times 0{\cdot}8 = 48{,}250 \text{ (about)} \quad . \quad . \quad . \quad (5)$$

Now total ampere-hours charged for during the year if an ampere-hour meter is used would be

$$34{,}180 + 12{,}520 + 60{,}315 = 107{,}015,$$

while ampere-hours usefully employed would only be

$$34{,}180 + 10{,}650 + 48{,}250 = 93{,}080,$$

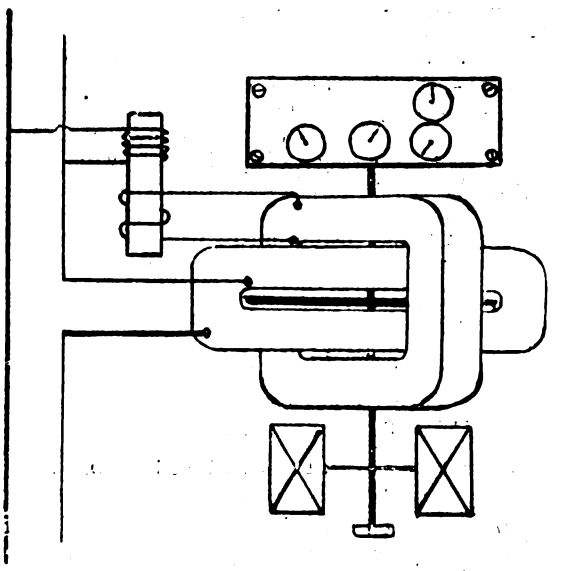
giving an excess charge for

$$107{,}015 - 93{,}080 = 13{,}935 \text{ ampere-hours,}$$

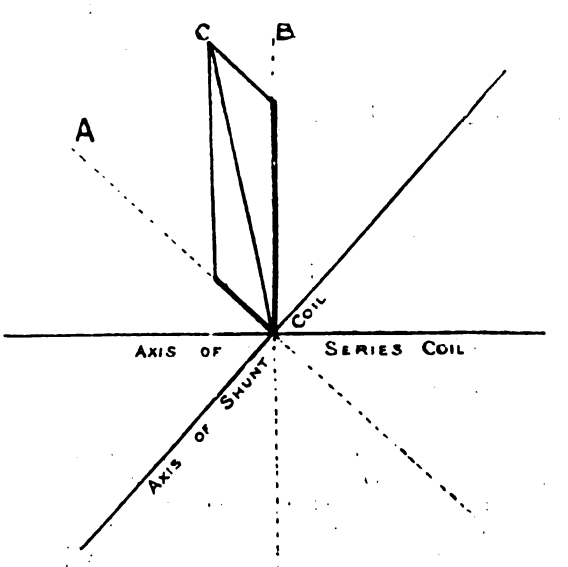
being a 15 per cent. excess charge.

At the rate of 4d. per unit, this would correspond to an excess charge of $\frac{13{,}935 \times 220}{1{,}000 \times 60} = £52$ (about) per annum, assuming that the voltage at the meter has been kept constant.

One of the best types of meter for measuring alternating-current power is the Shallenberger wattmeter, made by



the Westinghouse Electric Company, as it takes into account the phase difference between E.M.F. and current. It consists of two coils placed at an angle to each other, one being placed in series with the circuit on one main, the other being in the low-tension secondary circuit of a small transformer, the primary of which is placed across the mains. The angle between the two coils can be adjusted, and upon it depends the calibration of the instrument. An aluminium disc is carried on a vertical spindle, the two bearings for which are hardened and polished so as to reduce friction to a minimum. The disc revolves in the central plane of the coils at right angles to their windings. The registering device is the usual geared train and dials. The alternating current in both the series and shunt coils produces a magnetic field varying in strength, but constantly at the same angle to the flux due to the other coil. Owing to the impedance in the shunt transformer and coil (which, it should be noted, is constant at all loads), the shunt magnetic field differs in



phase from the series magnetic field. It will be seen that a compound field will be formed, and that as the A and B components (see diagram) vary in relation to one another, the direction of this compound field will swing from A to B. This magnetic field induces currents in the aluminium disc such that an attraction is set up between the magnetic field produced by these induced currents and the compound field above referred to. As there is a slight time lag

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between the impression of the E.M.F. on the disc and the production of the magnetic field, the compound field will always have a slight forward lead on the induced magnetic field. A force of attraction being set up, the disc will tend to turn so as to bring these fields into coincidence. The force which rotates the disc is proportional to the square of the effective current passing through the meter (for $E C = C^2 R$). It is therefore necessary to use a retarding device in which the retardation shall vary as the square of the speed. A light aluminium fan is adopted for this purpose, as shown above, or a disc revolving between the poles of a set of permanent magnets can be employed. Since the meter depends on the magnetic effect of an alternating current, a change of periodicity will affect the readings. As the meter, however, is encased in iron, no external magnetic force will affect it; no ordinary temperature change will appreciably affect it. The current enters no moving parts. The meter can be compensated against "creeping." The shunt transformer is arranged so that it acts a "choker," and the shunt watts used are very few.—J. A. S.

[N.B.—In the above answer the method of estimating the motor load is incorrect. The effective ampere-hours per annum, 60,315, is 80 per cent. of the ampere-hours metered, which would be $\frac{60,315}{80} \times 100 = 75{\cdot}3 = 94$.—ED. *E. E.*]

Answer to No. 264 (*awarded* 5*s.*).—The meaning of this question is not quite clear. If by the amount of electricity

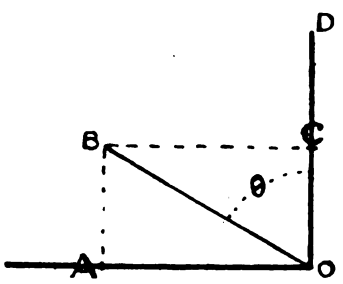

FIG. 1.

passed the amount of current passed is meant, a very serious error could be introduced. If the current taken by a motor, say, was measured by an ampere-hour meter, it would be very easy to get three or four times more units recorded than had actually been used. In calculating the watts consumed by a piece of apparatus supplied with an alternating current, the formulæ amperes × volts × the cosine of the angle of phase difference between the current and the E.M.F. should be employed. Fig. 1 will make it quite clear why we multiply by the cosine of the angle of phase difference. If O B represents to scale the amount of current registered by an ammeter which is in circuit with a motor, and θ represents the angle of lag between the current, O B, and the supply E.M.F., O D, then the current O B can be split up into a working component in phase with the E.M.F. and a wattless component 90deg. behind the E.M.F. in phase by constructing the parallelogram A B C O, O C being the working current and O A the wattless or magnetising current. Now, the cosine of θ is $\frac{O C}{O B}$ and $O B \times \frac{O C}{O B} = O C$, which is the portion of O B which is in phase with the E.M.F. Fig. 1 is drawn to represent an actual 2-h.p. motor on one-quarter full load. O B represents 15 amperes and O D 100 volts, to a different scale, O B lags 60deg. behind O D, and O C, the working current, scales 7·5 amperes, which multiplied by 100 volts = 750 watts. If we multiply 15 amperes by 100 volts and by the cosine of 60deg., we get the same result. The cosine of the angle of lag or lead is called the power factor. The power factor of small motors varies from about ·25 at light load to about ·75 at full load.

The best alternating-current meter known to the writer is the Shallenberger integrating wattmeter. Fig. 2 shows diagrammatically the general arrangement and connections of the meter. B B_1 are the series coils; G is a light aluminium disc mounted on a spindle; A is the shunt coil which is in series with the choking coil, C; E is a laminated iron core for adjustment purposes; D is the recording mechanism; and F F F are the terminals. There are also two permanent magnets (not shown in the figure) which act as a brake. The action of the meter is, roughly, as follows: The current through the shunt coil is practically 90deg. behind the E.M.F. in phase, due to the effect of the choking coil. If the main current flowing through the series coils is supplying a non-inductive circuit, it will be in phase with the E.M.F., and will, in conjunction with the shunt coil, set up a rotating field from B to A and A to B, etc. This will induce eddy currents in the disc, and cause it to revolve.

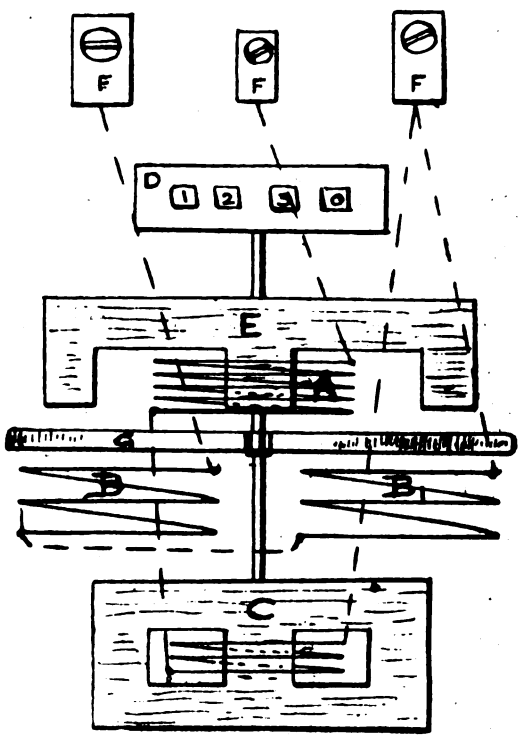

FIG. 2.

If, however, the main current is supplying an inductive circuit, it will lag behind the E.M.F., and the difference between the phases of the main and shunt currents will be less than 90deg. This will not produce such an effective rotating field as in the former case, and the disc will revolve slower for an equal amount of current. When the main current lags nearly 90deg., the main and shunt currents are nearly in phase, and practically no rotating field is set up, and the disc hardly moves. It is immaterial which way the series wires are joined up, as the meter registers correctly whichever way the disc revolves. Any adjustment that may be required is effected by raising or lowering the laminated core, E. The meter is enclosed in a strong cast-iron case with a rubber joint and a good arrangement for sealing. A test made on a meter of this type of 2,000 watts capacity showed the greatest error on an inductive load to be 1·58 per cent., and the meter started with ·05 ampere at 200 volts.—J. R. P. L.

LEGAL INTELLIGENCE.

JANDUS ARC LAMP AND ELECTRIC COMPANY, LIMITED, v. JOHNSON.

This action, tried before Mr. Justice Farwell on May 4, 5, and 7, was for the recovery of royalties.

Mr. Moulton, Q.C., M.P., Mr. T. Terrell, Q.C., Mr. J. G. Graham, and Mr. A. J. Walter (instructed by Messrs. Faithfull and Owen, agents for Messrs. Payne, Galloway, and Payne, Manchester), appeared for plaintiffs, and Mr. Bousfield, Q.C., M.P., and Mr. J. Hunter Gray (instructed by Mr. George Whale), for defendant.

The plaintiffs licensed the defendants to manufacture lamps under certain patents. The defence was substantially that the lamps claimed for were not made under the patents, hence no royalties were due. The defendants counterclaimed for misrepresentation, and claimed the recision of the agreement. It is not necessary to record this action at length, as the result depended

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a good deal upon legal subtleties which the lay mind will not appreciate. In the first place, the learned judge held that the licensees were not entitled to question the validity of the patents. Then, upon the question of misrepresentation, he decided in favour of the plaintiffs. The judgment indicates clearly the restricted field of the arguments. It was as follows:

Mr. Justice Farwell: I think the defendants in this case have raised every conceivable objection that is possible or could possibly be raised. The first point made by Mr. Bousfield was on the construction of the agreement. He says that there is an interest there recited to be believed to be in the Electric Arc Light Company, and that is not got rid of. It seems to me the short answer to that is that I have here the Patent Office register, which shows that the Jandus Company are registered as sole proprietors under an assignment from Marks, and were so registered on May 16, 1893. The second point which he takes is this: He says that agreement is *nudum pactum*, because in effect the Jandus Company took from Marks and not from the Electric Arc Light Company. I can only say that so far as *nudum pactum* is concerned, I do not really follow it. Marks executes a memorandum at the end of the agreement, in which he says: "I personally agree to carry out the provisions of this agreement so far as relates to matters in my control, as though I had been an original party to this agreement." That agreement contains, amongst other things, a provision that "The purchaser company will pay to the vendor company a further sum of £1,500 upon the vendor company assigning or obtaining an assignment the purchaser company of the said Howard patent." How it can be said to be a *nudum pactum* when it is in effect an agreement by Marks in consideration of the payment at his request to the Electric Arc Light Company to assign or procure to be assigned the patent, I fail to see. That point seems to me to come to nothing. Then there was an ingenious point suggested, that this was an agreement of which you could not get specific performance, and therefore it was said if you could not get specific performance you did not get the equitable title at the date of the license, because it is by reason of your being able to get specific performance that equity considers that that is done which ought to be done so that the equitable title passes. Mr. Bousfield pressed upon me that this was really an agreement to give services, and not an agreement to assign the patent. If I could hold that that was the true construction of the agreement, that would be so, but I cannot shut my eyes to what is the true intent of Clauses 2 and 3, which Mr. Bousfield read, of the agreement, although there is this to be said in Mr. Bousfield's favour that the parties for some inscrutable reason have not gone on in terms to say that if and when the Electric Arc Light Company do get that Howard patent they will assign it, but I find those words, by implication, in Clauses 2 and 3. If I could not find them there might be a difficulty about it, but inasmuch as the argument pressed upon me was this, that it would be only damages and not specific performance, that argument in itself assumes a contract to assign, because you could not get damages for breach of a mere agreement to do the best you could, if you had actually done the best you could and got the assignment, and therefore the only matter for which damages could be recovered would be for not assigning the patent when you got it. That is, to my mind, the true meaning of the agreement, and if that be so, if it be the fact, as Mr. Bousfield put it, that you could only get damages, it is fatal to him, because whether the remedy be damages or specific performance the right of action is the same, although the remedy may be one thing in one court and another thing in another. That leads me to the point of substance in the case, which is the question whether the article made by the defendant infringes the invention of the plaintiff so as to be really made within the license. Now I have had an argument which would have had very considerable force if it had been addressed to the validity of the patent; but that is not open to the license, and the whole of the struggle was to get in evidence by putting in former specifications, and the struggle to put in evidence which I have overruled, and to which Mr. Bousfield returned again and again, is entirely with a view of showing that this patent is not good. Over and over again, in the course of the witnesses' evidence, and in the course of Mr. Bousfield's address to me, it was plain that what he was striving for was to do that. Now, that is not open to him. He is bound to admit that the patent is good, and, that being so, I am proposing to construe this patent simply and solely by the words that the parties have used, as contained within the four corners of the specification. I quite agree that Mr. Bousfield is entitled to refer to what I may call the recital part, and so far as the recital part points to previous knowledge, of course he is entitled to refer to that. Further than that I said, and I allowed him to do it, he was entitled to say that certain things were common knowledge, and that I am to regard myself as now adjudicating on the construction of a patent having regard to what was common knowledge in the year 1893. All that I fully accept. But then, what I have to consider is whether, on the fair meaning of this patent, the defendants' lamps are an infringement or not. Now, to my mind, on the evidence that I have here, leaving out Mr. Wunderlich, as to whom I have already made some comments—and I do not like to say a thing of that sort twice over—on the evidence as it stands it seems to me that there is no dispute really. First of all it is, "An arc lamp having its arc enclosed in a transparent or translucent envelope closed airtight at all points below the arc." Now, the difference in opinion is solely and entirely in what the meaning of "closed airtight" is. Everybody agrees that it is not hermetically sealed, inasmuch as I have had explained to me the object on one side of preventing a current of air so as to avoid, as far as possible, the contact with carbon, and on the other side to allow some escape of the hot gases which otherwise might cause an explosion. I have got, what is reasonably plain on the face of the specification, a provision by which you cannot have an hermetically sealed enclosure, nor can you have one, nor do you desire to have one, which is open to all the winds of heaven. The invention is of something which answers the purpose, and which gives you the mean between those two. I was invited to say that "closed airtight" meant so airtight at all points below the arc as to necessitate the provision of a plug at the top. I do not think that is the fair construction. The recital part of the specification shows that although he deals partly with arc lamps with enclosures and with valves, he also deals with those where there may be an opening not by means of a valve. It was said, moreover, by one of the witnesses that, "provided with a plug at the top," would not apply to D C.1. On the evidence, I find that it does. I disregard that particular item of evidence, and I understood Mr. Bousfield to admit it, or, at any rate, whether he did or not, I think it is so. Then we have some little light thrown on the meaning of closely fitting by the next words, "having a closely-fitting feed opening for the positive carbon." It is plain to me, as Mr. Bousfield pointed out, that "closely-fitting feed" there refers back to the closely-fitting feed mentioned on p. 2, line 25, which is a comparatively close fit. So I have words which I am, by all the rules of construction, entitled to read as a comparatively close fit, and if I may put in the word "comparatively" it seems to me that *a fortiori*, or with equal force I may say that wherever I find "closely fitting" and the reason of the thing showing that it does not mean hermetically closed, I am entitled to say that it means what I think all the witnesses agree that it means—comparatively closely fitting. To my mind, D.C.1 comes within Claim 6, and it is said it comes within Claim 12. I do not propose to go through the evidence in detail. It will be convenient to refer to it in another place if necessary because it is all in print, but I should like to point out that Prof. Thompson certainly does agree with my view. He says: "Having regard to the point that D.C.1 is closed at the top, the bottom of D.C.1 may be tight enough to prevent such a circulation as would defeat the object of Howard." Then he says also as to Fig. 5, "that the pressure inside is the same as outside while the lamp is burning, and, therefore, there is no tendency, apart from diffusion, for the intrusion or escape of gases. This is enough for the practical purpose of making the lamp as described in Howard. The joint in D.C.1 is good enough in the defendants." He also said "D.C.1 is practically closed on all sides so far as protecting is concerned. It has better ventilation than Howard," and then he says it was common to any arc lamps. That is again going back to a reason why this patent should be held bad, which I have said is not open to the defendant. It seems to me a plain case of infringement if they were not licensed, and, therefore, there must be the order as asked.

CHAMBERLAIN AND HOOKHAM, LIMITED, v. THE MAYOR AND CORPORATION OF BRADFORD.

In the Chancery Division on Tuesday, before Mr. Justice Farwell, the hearing of the action of Chamberlain and Hookham *v.* the Mayor and Corporation of Bradford was commenced. Plaintiffs sought an injunction to restrain the Bradford Corporation from infringing the plaintiffs' patent for an electric meter, for measuring the amount of electricity used, and for the delivery up or destruction of the infringing meters. The counsel for the plaintiffs were Mr. J. Fletcher Moulton, Q.C., M.P., Mr. A. J. Walter, and Mr. Gray (instructed by Messrs. Field, Roscoe, and Co.). The counsel for the defendants were Mr. C. A. Cripps, Q.C., M.P., Mr. Bousfield, Q.C., M.P., and Mr. J. C. Graham (instructed by Messrs. Ashurst, Morris, Crisp and Co.).

In his opening speech, **Mr. J. Fletcher Moulton** explained that the case was similar in many respects to the one brought by the plaintiff against Messrs. Johnson and Phillips, and which had been successful. The meter which it was alleged infringed the plaintiffs' patent was the Thomson-Houston meter. The learned counsel proceeded to give a clear explanation of the subject generally to Mr. Justice Farwell; in so doing an ample use of models was made, and cross reference to the above historical fight were frequent. He argued that the defendants' meter was an infringement, because a constant field was employed, as also because of the permanent magnets used as brakes. He claimed that Mr. Hookham was the first to disclose the essential conditions to be observed to obtain an accurate meter.

Mr. George Hookham was then examined by Mr. Walter as to the construction of his meter and also that of the defendants.

Mr. Cripps cross-examined Mr. Hookham at length in order to show the essential differences between an energy meter and a current meter.

The examination was still proceeding when the Court adjourned.

On Wednesday the case was continued, and the plaintiffs' case was concluded yesterday. Mr. Cripps then opened the defendants' case.

FRANKENBERG v. GREAT HORSELESS CARRIAGE COMPANY.

In the Court of Appeal on the 7th inst., before Lords Justices A. L. Smith, R. V. Williams, and R. Romer, the appeal of one of the defendants (Mr. Salter) a director of the company, came on for hearing.

Mr. Pollard said there was an appeal pending to the House of Lords by other defendants in the action, and his client desired to

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have the proceedings in the present case stayed till that appeal had been determined.

Lord Justice Smith said the appeal would not be heard for a year, and if this application were granted the case would be in the same position as to-day. The Court would not stay the proceedings. Defendant must abide the result of the trial, and then appeal, if he thought fit.

The application was then dismissed, with costs.

TRAMWAY ACCIDENT.

At the Liverpool Assizes on Saturday, before Mr. Justice Phillimore and a special jury, John McLaren, a child of three years, sued by his next friend, his stepfather, John Power, against the Blackpool and Fleetwood Tramroad Company, Limited. On Aug. 13 last the plaintiff was crossing the line when an electrical tramcar from Blackpool came up at an alleged speed of 20 miles or more per hour. The little boy was dragged under the wheels of the car. One leg had to be amputated, and there were other injuries. The child had, however, made a good recovery. An offer of £300 and costs was made and accepted.

SHADDICK v. LONDON ELECTRIC SUPPLY CORPORATION.

Failure of Supply.

At Greenwich, Mr. Kennedy on Friday gave judgment in this case, in which there were seven summonsee. When the case was before the Court on April 24 the default was admitted, the defence being practically a plea of *force majeure*, that it was essential that some part of the company's district should be cut off because the supply was deficient owing to unavoidable causes, and that Deptford was cut off as causing the least public inconvenience. Mr. Kennedy held that *force majeure* did not apply. He doubted whether the company allowed sufficient time to overhaul the boilers, especially when they knew of the hardness of the water and that the boilers would not last many weeks. He did not, however, rest his judgment so much upon that ground as upon their taking Mr. Shaddick as a new customer when they knew that, through the failure of the Colchester firm to supply new boilers and their inability to overhaul the old, it was, to say the least, doubtful whether they could adequately supply Mr. Shaddick with the electric light. The company were fined 40s. in each of the seven cases with 20 guineas costs in the first case and 2s. costs in each of the others, making £35. 12s. in all.

NATIONAL FREE ELECTRIC WIRING COMPANY v. COLLINS.

This case came before his Honour Judge Lumley Smith, Q.C., in the Westminster County Court on May 3. The plaintiff company sought to recover £4 in respect of extra work done to the order of the defendant, a licensed victualler carrying on business at Blackheath-hill. The defence was that the extra work for which the plaintiffs were seeking to charge was brought about owing to the faulty manner in which it was carried out in the first instance.

In giving judgment, his **Honour** said he was not satisfied that the work was badly done, and he thought the extra work such as ought to be paid for; therefore judgment would be for the plaintiffs for the amount of their claim (£4) and costs.

ISLE OF MAN TRAMWAYS.

In the Manx High Court on the 7th inst. several suits against the Isle of Man Tramways and Electric Power Company, Limited, were down for hearing, but all with one exception were withdrawn.

The case of Knowles *v.* Isle of Man Tramways and Electric Power Company, Limited, in which plaintiff, late engineer to the company, sought to recover £1,183, which he alleged was due as salary and commission, was commenced, and after some evidence had been heard, the hearing was adjourned.

COMPANIES' MEETINGS AND REPORTS.

SUBMARINE CABLES TRUST.

The annual meeting of this Company was held on Tuesday at the offices, Winchester House, the Marquis of Tweeddale presiding.

The **Chairman** stated that the income for the past year had amounted to £24,789. The apparent increase of £3,333 was due to the receipts of a full year's dividend and bonus on the shares of the Eastern Extension Telegraph Company, whereas last year only three full quarters and the balance of the December quarter of 1897 were carried to the credit of revenue. After deducting expenses, there was an available balance of £23,601, which had been sufficient to pay two coupons of £3 each, due on Oct. 15 last and on the 15th ult., and to leave a balance of £3 315. The trustees had drawn 27 certificates for redemption on the 27th ult.

The report was adopted, as was also a motion confirming the unanimous resolution of the trustees to invest the produce of the sale of £1,200 Anglo-American Telegraph Company's preferred stock in the purchase of 66 shares of 100dol. each of the Commercial Cable Company, and £15 ordinary stock of the Eastern Telegraph Company, Limited.

WEST COAST OF AMERICA TELEGRAPH.

The general meeting of this Company was held at Winchester House on Tuesday, Mr. J. Denison Pender presiding.

The **Chairman** said that the receipts for the year ended Dec. 31 last amounted to £28,347, an increase of £3,267 over 1898, due to increased traffic and the rise in exchange. During the 12 months the repairing ship had been out more than usual, and therefore the cost of insurance had been considerably greater, to say nothing of the increased cost of coal. They had paid 4 per cent. interest on the income bonds, not having paid anything for the previous 10 years. They had closed one of their offices, having taken the cable out at Caldera as it had lately not paid its expenses. They had every reason to hope that the present satisfactory figures, compared with previous years, might be even more satisfactory in the future.

The report was adopted.

LONDON PLATINO-BRAZILIAN TELEGRAPH.

The general meeting of this Company was held on Tuesday at Winchester House.

Mr. W. S. Andrews, who presided, said that the income for 1899 was £29,643, or £6,645 less than that of 1898. There was an increase in the cable receipts last year of £660, but there was an apparent decrease in land line traffic receipts of £7,328, owing to the payment in 1898 by the Government of £5,000 for night service performed during the disturbances. The expenses for 1899 were £6,832, or a net decrease of £1,480, owing to the amalgamation of the Company. The profit in 1899 was £22,531, a decrease on 1898 by £5,052. The amount available at Dec. 31 last, after paying the usual debenture interest, was £19,380 An interim dividend of 4s. 6d. a share was paid in respect of the June half of 1899, and the directors proposed a further dividend of 2s. 6d. a share, making the same distribution for last half-year as for 1898.

The report and the payment of the dividend recommended, making 3½ per cent. for the year, were agreed to.

GREAT NORTHERN TELEGRAPH.

The general meeting of the Great Northern Telegraph Company, Limited, of Copenhagen, was held at Copenhagen on the 28th ult., the chairman and managing director (Commodore E. Suenson) presiding.

The **Chairman** referred to the great number of interruptions which had occurred in their cables during the last half of the year 1899. Their cable steamers had been employed on an aggregate for 286 days. The number of telegrams forwarded from Vladivostock showed an appreciable increase. Their Danish concessions for the establishment and working of cables connecting Denmark with Norway, Great Britain, and Russia had been extended to Jan. 1, 1911, and to Dec. 31, 1912, respectively. At the meeting of the International Meteorological Committee at St. Petersburg, as at several previous meteorological congresses, the Iceland cable scheme had been favourably received. A special resolution having been passed urging the Danish Government to continue their efforts in this direction, the Danish Government had not been able to induce the Peace Congress at The Hague to deal with the question of the legal status of submarine cables in time of war. The Chinese Government had also extended their concession up to 1911. The Japan traffic showed an increase. The directors proposed the same extra dividend as last year—viz., 7½ per cent. (making 12½ per cent. in all for the year).

HAMPSTEAD ELECTRIC SUPPLY.

The annual meeting of this Company was held on Monday at the Hampstead Conservatoire, Mr. Edward T. Read, F.R.G.S., presiding.

The **Chairman** said the actual amount of capital issued was £145,480, to which must be added the mortgage and debenture capital, amounting to £35,000, making the total purchase price £166,085. The Company had to take over the assets of the Hampstead Battery Company. Over £16,000 had been expended in increasing their plant, and they had increased their customers by some 200 houses, including the large stores in Finsbury-road. The total number of lamps connected there was equivalent to 44,000 c.p., in addition to which they had provided the motive power for the lifts. That business having only been in full swing since Easter, the full benefit of the transaction did not make itself felt as yet. They had still 500 houses under contract, which they were connecting at the rate of three or four a week. For the 13 months ending Dec. 31 last the profit on electric lighting had been over £5,000. He could honestly say they had a sound and progressive business, which, if properly managed and provided with the sinews of war, as it would be presently, should make a profit of anything between £10,000 and £15,000 within a very short period. They had to omit the dividend for the six months ending Dec. 31 last, but that dividend was simply postponed, as the shares were cumulative, and therefore these shares were now worth 2s. 6d. more than they would have been if they had had the dividend. The business was increasing so rapidly that they had not sufficient money to push it along, but the directors were taking steps in order to meet that necessity.

The report and accounts were adopted after a proposal to appoint a committee of shareholders to investigate the affairs of

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the Company had been negatived. Messrs. Hart Bros., Tibbets, Heiron, and Co. were re-elected auditors, and a vote of thanks to the chairman closed the proceedings.

WINCHESTER ELECTRIC LIGHT AND POWER.

Directors: Mr. T. F. Kirby, chairman; Major-General Montgomery; Captain Clayton Mitchell, R.N.; Mr. Francis Edward Gripper; Mr. A. R. Dyer. Resident engineer and secretary: H. N. Warburton.

In the report for 1899 the directors state that the contract with Messrs. Edmundsons for the running of the works terminated on July 1 last, so that the accounts do not represent exactly the working of the undertaking for the year. The directors are satisfied with the reception the electric light has obtained in Winchester. Ten thousand 8 c.p. lamps were connected by the end of last year. Further applications continue to be received. The accounts show a balance to net revenue account, after paying all expenses (including interest on debentures), amounting to £323. 12s. 2d., of which it is proposed to apply £202. 6s. 6d. in payment of a dividend at the rate of 2½ per cent. per annum for the year; and to write off £121. 5s. 8d., the balance, in reduction of £197. 17s. 4d., the preliminary expenses. During the year another large engine and dynamo set and a third boiler have been added at the works, and large extensions of the mains have been laid, to meet the public demand. The Company continue to do a fair share of the wiring work in the city, and introduced last autumn a system of free wiring, ½d. per unit used being charged as rental.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£287	12	1			
Oil, waste, water, etc.	17	7	5			
Proportion of salaries of engineers, etc..	87	8	4			
Wages and gratuities	114	18	6			
Repairs and maintenance	1	7	8			
				508	14	0
Distribution of Electricity.						
Proportion of salaries	10	0	0			
Wages and gratuities	9	15	0			
Repairs, maintenance, etc.	1	9	9			
				21	4	9
Rents, rates, and taxes				67	12	0
Management Expenses.						
Salaries	36	4	0			
Stationery and printing	8	2	11			
General establishment charges	4	10	2			
Auditor	8	0	0			
				56	17	1
Insurances, superannuation, etc.				5	0	0
Total expenditure				659	7	10
Balance carried to net revenue				558	16	1
				£1,218	3	11
Cr.				£	s.	d.
Sale of current per meter at 7d. per B.T.U.				1,156	4	11
Rental of meters and other apparatus				61	19	0
				£1,218	3	11

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	24,175	0	0
Sundry tradesmen and others	8,453	4	5
Sundry creditors on open accounts	327	4	11
Balance at credit of net revenue account	323	12	2
	£33,279	1	6
Cr. Assets.	£	s.	d.
Capital account—amount expended for works	30,474	6	0
Stores on hand: coal, £43. 11s. 3d.; oil, waste, etc., £16. 6s. 10d.; general, £6.	65	18	1
Unfinished work and wiring stock	984	13	8
Preliminary expenses	197	17	4
Sundry debtors for current supplied	658	12	7
Wiring accounts	816	4	11
Edmundsons' interest	74	19	9
Cash at bankers and in hand	6	9	2
	£33,279	1	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units	73,085
Quantity sold to private consumers by meter	56 707
Quantity used on works	6 979
Total quantity accounted for	63,786
Quantity not accounted for	9,298
Total maximum supply demanded (kilowatts)	89 2

NEW GENERAL TRACTION.

The report for the year ended March 23 shows gross profits of £76,299. The general expenses, salaries, etc., chargeable against revenue, amounted to £6,116. A dividend at the rate of 6 per cent. on the outstanding preference capital for the past year from the dates of payment will be paid. After writing off various amounts and placing £10,769 to a special and £20,000 to general reserve fund, £37,030 are carried forward to next year.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Burnley.—The Corporation invite tenders for cables. Tenders by May 14.

Dundee.—The Town Council invite tenders for the supply of copper bonds. Tenders by May 22. Details in our advertisement columns.

Wimbledon.—The Urban District Council invite tenders for the erection of additions to the electricity generating station, Durnsford-road, Wimbledon. Tenders by May 15.

Glasgow.—The Corporation invite tenders for creosoted poles, oak arms, insulators, and ironwork used in telephone construction. Tenders by May 16. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for indiarubber-covered and lead-covered branch cables and carbons for one year. Tenders by May 19. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each. Tenders by June 12. Details in our advertisement columns.

Wick and Lybster.—Tenders are now being asked for the work of constructing the Wick and Lybster Light Railway, which will extend from Wick station to the village of Lybster, 13½ miles.

Newcastle-upon-Tyne.—The Corporation invite tenders for switchboards, underground feeders, and pumping apparatus. Tenders by May 25 and June 1. Particulars in our advertisement columns.

Brussels.—Tenders will be received for nine lots of electric lighting materials for the Government on May 16. Specifications No. 617 are to be obtained from the Belgian Government Railways Department.

Southampton.—The Corporation invite tenders for the supply and erection of one water-tube boiler, with steam and other pipes, and sundry ironwork. Tenders by May 28. Particulars in our advertisement columns.

Devonport.—The Corporation invite tenders for the supply, delivery, and laying of electric light and traction feeders, distributors, boxes, etc. Tenders by May 25. Particulars in our advertisement columns.

Edinburgh.—The Corporation invite tenders for elevators and conveyors for coal and ashes in connection with McDonald-road electricity supply station. Tenders by May 21. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the construction and delivery of two steam-engines and two dynamos of 1,000 kw. capacity each for their electricity works, Valley-road. Tenders by May 24. Details in our advertisement columns.

Crewe.—The Town Council invite tenders for the wiring of the municipal offices, market hall, and corn exchange, and for supplying lamps and fittings for electrically lighting the same. Tenders by June 11. Details in our advertisement columns.

King's Lynn.—The Corporation invite tenders for the supply and erection of the following plant: steam dynamos, Lancashire boiler, economiser, condenser, pipes, etc., switchboard, and cables (supply only). Tenders by May 17. Particulars in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for two or three (at the option of the committee) 630 kw. two-phase generators; and one or two (at the option of the committee) sets of surface-condensing plant. Tenders by May 28. Details in our advertisement columns

London.—The Streets Committee of the Corporation of London invite proposals from firms or persons experienced in the manufacture and use of electric motorcars for the hire of an electrically-driven dustcart. Tenders by June 1. Full particulars in our advertisement columns.

Bradford.—The Corporation invite tenders for the supply and delivery of electric motors (enclosed type) of 4½ h.p., 7 h.p., and 10 h.p., for a period of 12 months commencing July 1, 1900, and terminating June 30, 1901. Tenders by May 24. Details in our advertisement columns.

Paddington.—The Vestry invite tenders for the execution of sundry works required to be done in certain alterations to the existing electric lighting arrangements at the public baths, Queen's-road, Bayswater, W. Tenders by May 14. Particulars in our advertisement columns.

Crewe.—The Town Council invite tenders for the supply and laying down of about 25,000 yards of three-core cable for street-lighting extensions, and the supply of upwards of 500 lampholders and reflectors for adapting the existing lamp-posts for electric light. Tenders by May 26. Details in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for two or three (at the option of the committee) 630 kw. two-phase generators, comprising triple-expansion engines and alternators, and one or two (at the option of the committee) sets of surface-condensing plant. Tenders by May 28. Details in our advertisement columns.

Bridgwater.—The Town Council are prepared to receive tenders for the supply and erection of boiler-house plant (boilers, fittings, steam and exhaust pipes, etc.), engine-house plant (steam dynamos, pumps), switchboards, etc., underground mains, lamp-posts, etc., accumulators, meters, and crane. Tenders by June 7. Details in our advertisement columns.

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Heywood.—The Corporation invite tenders for the supply and erection of Lancashire boilers, economiser, pipe work, feed pumps, two steam dynamos, balancer booster, travelling crane, storage batteries, switchboard connections and station lighting, underground mains and feeders, and meters. Tenders by May 14. Particulars in our advertisement columns.

Rhyl.—The Urban District Council invite tenders for the supply and erection of—boiler-house plant: water-tube boiler, fittings, steam and exhaust pipes, etc.; engine-house plant: steam dynamos, pumps, etc.; switchboard, etc.; underground mains lamp-posts, etc.; accumulators, meters, crane, etc. Tenders by May 14. Details in our advertisement columns.

Worksop.—The Urban District Council invite tenders for steam dynamos, balancers, boosters, and motors, Lancashire boilers, steam, exhaust, feed-water and condensing-water pipes, fuel economiser, condenser, and feed pumps, switchboard, accumulators, cables, joint boxes, arc lamps and posts, and overhead travelling crane. Tenders by May 23. Details in our advertisement columns.

London, W.—The Central Electric Supply Company, Limited, invite tenders for the supply, delivery, and erection of two 1,200-i.h.p. Willans engines, each direct coupled to a three-phase H.T. generator; six three-phase H.T. motors, each direct coupled to a L.T. continuous-current generator; and switchboards and connections for above plant. Tenders by May 22. Details in our advertisement columns.

Mariupol.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Consul at Taganrog stating that tenders are invited by the Municipality of Mariupol not later than May 16 (29) for the construction and exploitation of an electric tramway and the installation of electric light in that town. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

Port-y-waen and Llangynog.—The Cambrian Railways Company invite tenders for the construction of a light railway, about 15 miles long, 4ft. 8½in. gauge, commencing by a junction with the branch of the Cambrian Railways at Port-y-waen, in the county of Salop, and terminating at Llangynog, in the county of Montgomery. Plans can be seen, and copies of specification and quantities obtained, on payment of £1. 1s., at the office of Mr. A. J. Collin, engineer to the Tanat Valley Light Railway Company, Oswald-road, Oswestry. Tenders by June 5.

West Ham.—The Guardians of West Ham Union invite tenders for the execution of the following separate contracts: (1) supplying and laying cables and wiring the buildings and premises, and supplying and fixing the lamps, switches, and all other necessary fittings complete in accordance with a schedule of lights, which may be inspected at the Clerk's Office, Union Workhouse, Leytonstone; (2) supplying and erecting the plant complete, including storage battery, switchboard, instruments, and engines and dynamos in duplicate, of a specified power, particulars of which may be obtained upon personal application at the Clerk's Office aforementioned. Tenders by May 16.

RESULTS OF TENDERS.

Doncaster.—The tender of Messrs. Fisher and Allison for the electric lighting of the corn exchange has been accepted.

Rotherham.—The tender of Messrs. Thornton and Sons, of Rotherham, to build a generating station for the sum of £8,351 has been accepted.

Derby.—The tender of the British Electric Transformer Manufacturing Company for four transformers at £65 each, and three at £27 each, has been accepted.

Cheltenham.—The Lighting Committee have recommended for acceptance the following tenders: Messrs. Siemens, continuous-current dynamo, £489; and Messrs. Witting, traction dynamo, £420.

Warrington.—The Corporation have given a contract to the Klein Engineering Company, Limited, Manchester, to erect at the new electricity station one of their central barometric jet condensing plants for engines of 1,250 h.p.

Sheffield.—The City Council have accepted the tender of Messrs. J. Brown and Co., Limited, Atlas Works, at £8,550, to supply and erect three marine boilers of the type already supplied. The boilers are to be fitted with Messrs. Bennis's mechanical stokers at a further cost of £100 each boiler.

Whitechapel.—The Electrical Committee have accepted the tender of W. Griffiths for the construction of the first portion of the electrical power house, at £15,774, notwithstanding the fact that such tender is not the lowest tender, for the reason that Mr. Griffiths is already carrying out certain important contract works upon the same site, and as the site is limited and time of importance, considerable delay would arise in the event of another contractor being engaged upon the same site.

Birkenhead.—The following tenders have been accepted: Tetlow Bros., Hollinwood, to make, supply, and fix three Lancashire boilers, together with fuel economiser and mechanical stokers; Siemens Bros. and Co., Limited, London, for making, supplying, and fixing three steam dynamos, with their spare parts, as scheduled; Klein Engineering Company, Limited, Manchester, for making, supplying, and erecting an independent condensing plant, re-cooling tower, and two boiler feed pumps and spare parts, as scheduled; Electrical Power Storage Company, Limited, London, for making, supplying, and erecting a battery of accumulators and special booster for working in connection with the same; Marshall, Fleming, and Jack, Motherwell, for making, supplying, and erecting a 12-ton overhead travelling crane.

Maidstone.—The following tenders have been received by the Corporation for pipework:

Aiton and Co. (recommended for acceptance)	£1,432	0	0
Williams and Sons, Limited	1 680	0	0
J. Spencer, Limited	1,886	0	0
Davey, Paxman, and Co.	1 986	0	0
Alley and Maclellan	2 000	0	0
Babcock and Wilcox	2 022	0	0
R. Dann	2 030	17	6
R. Blackwell, Limited	2,041	0	0

BUSINESS NOTES.

TRACTION.

Darwen.—The profits of the tramways for the past year amounted to £1,054.

Bury.—The Council have now resolved to adopt the overhead system, and a 4ft. 8½in. gauge.

Great Harwood.—It is proposed to extend the tramways from Clayton-le-Moors to Great Harwood.

Stockport.—The Corporation Tramway Bill is coming before the House of Lords as an unopposed measure.

Dukinfield.—The Town Council have decided to oppose the Oldham, Ashton, and Hyde light railway scheme.

Brackenhill.—The Light Railway Commissioners have now granted the application of the promoters of the Brackenhill light railway.

Aberdeen.—The Tramways Committee have decided upon the experiment of electrically equipping two or three of the present horse cars.

Audenshaw.—The Council have agreed to the proposal of the tramway company to run omnibuses instead of tramcars during the reconstruction of the line.

Vale of Rheidol Light Railway Bill.—This Bill, which is an unopposed measure, has been ordered to be reported to the House of Commons for third reading.

Crewe.—The town clerk has been instructed to report upon the position of the Corporation with respect to obtaining powers to construct and work a tramway.

Mansfield Woodhouse.—The Council will receive, at their meeting in June, a deputation from the syndicate for the construction of the Mansfield and district light railway.

Jarrow.—In conjunction with the through service proposed to be opened along the south bank of the Tyne, it is intended to have a loop line along Ormonde-street and Western-road.

Paisley.—The Town Council last week agreed to accept the modified terms of Mr. Murphy, and have authorised the Tramways Committee to adjust the terms of the Bill and relative agreement and terms, and to close the arrangement.

Blackpool.—The electric light pillars to denote the stopping places of the tramcars are being partially painted vermillion, and conspicuous notice boards are being attached. It is expected that the residents will quickly become used to the system.

West Ham.—The Corporation have requested the Board of Trade to appoint a day for deciding as to the arrangement to be come to with the North Metropolitan Tramways Company in reference to the depôts and granary at West Ham, and the car works at Leyton.

Merthyr.—The Urban District Council are in litigation with the British Electric Traction Company, who are laying lines from Merthyr to Cefn and Dowlais, and the matter is to be the subject of arbitration. A committee has been appointed to watch the Council's interest.

Baker-street and Waterloo Railway.—The Bill for extending the authorised Baker-street and Waterloo Railway to Paddington at the one end and to the City and South London Railway near The Elephant and Castle at the other has passed the committee of the House of Commons.

Blackburn.—The Town Council have withdrawn their petition against the Lancashire Electric Power Bill in consequence of the undertaking which has been given by the promoters to the President of the Board of Trade, referred to in the debate on the second reading of the Bill.

Northwich.—At the meeting of the Rural District Council last week, the Clerk said he had met the promoters of the Warrington and Northwich light railway, and they willingly fell in with almost the whole of their suggestions. They, however, demurred at being called upon to light the route of the railway.

North Wales and District Light Railway and Electric Power Syndicate, Limited.—This Company has been registered with a capital of £1 200 in £100 shares, the object being to carry on the business of electricians, electrical and mechanical engineers, telegraph, telephone, and railway proprietors, etc.

Wigan.—The Electric Light and Tramways Committee are endeavouring to open the Martland Bridge section about October, and they are anxious to settle the contract for the cars. It appears that they do not intend to alter the gauge. The tramways will be under the control and management of the Corporation.

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Barrow.—The Town Council have decided to enter into an agreement with the British Electric Traction Company with reference to the working of the Barrow tramways by electric traction, subject to terms being mutually agreed upon.

Leeds.—The Tramways Committee have decided to proceed at once with the laying of a tramway along Aire-street and Whitehall-road as far as the cattle market. It is suggested that a number of cattle trams be provided to convey live stock from the cattle market to the public slaughter-house in Harper-street.

Camborne.—The Board of Trade have issued an order authorising the Urban Electric Supply Company, Limited, to construct a tramway in the parish and urban district of Camborne, in the parish and urban district of Redruth, and in the parish of Illogan, in the rural district of Redruth, all in the county of Cornwall.

Folkestone.—The Corporation have authorised counsel to give an undertaking to the committee of the House of Lords to whom the Folkestone, Sandgate, and Hythe Tramroads Bill will be referred, that the Corporation will proceed with their application for powers to construct and work tramways in Folkestone in the session of 1901.

Carlisle.—The Town Clerk has reported to the General Purposes Committee that he had had an interview with the Board of Trade with reference to obtaining the Board's sanction to the carrying out of the proposals agreed upon between the Corporation and the tramways company, and that the Board had promised to send their decision as soon as possible.

Swadlincote.—The electric railway question for the Swadlincote area is being actively discussed in the busy centres of Woodville, Newhall, Gresley, and Stanton. A well-known firm of electrical engineers have had plans prepared dealing with the proposed railway from Woodville to Burton, and at an early date steps will be taken to secure the necessary powers for constructing the line.

Southport.—The Town Council on Wednesday adopted the minutes of the Tramways Committee, which contained a resolution to borrow £40,000 for purposes of laying electric tramways. In addition to the work already in hand, it is proposed in a few weeks to commence to convert the lines in London-street, Chapel-street, Eastbank-street, and Scarisbrick New-road into electric tramways.

Automobile Manufacturing Co.—This Company has been registered with a capital of £100 in £1 shares, the object being to acquire the business carried on by W. C. Bersey at 4, Hythe-road, Willesden, N.W., and the business of the Southern Motorcar Company carried on at 59, Brixton-road, S.W., by Townsend and Bizzey, and to carry on the business of electrical and general engineers, motor carriage manufacturers, etc.

Glasgow Exhibition.—The Tramways Committee have had a meeting with the consulting engineer, who reported that he had gone over the work and the machinery that was being prepared for the purpose of having the electric tramways in working order for next year, and he assured them that, so far as he could judge, the work was so much forward that they would be able to have the electric tramways in the city ready for work by the time of the opening of the exhibition.

Llanelly.—The Council have entered into an agreement with the British Insulated Wire Company by which the Corporation carries out a scheme at a cost of about £80,000. It was reported last week, however, that the company had failed to come to terms with the owners of the existing tramway at Llanelly. The Council thereupon decided to acquire the property for subsequent transference to the company, and resolved to make the necessary application to the Board of Trade.

Bolton.—The Tramways Committee have adopted the following rate of wages for motormen and conductors: motormen, on appointment 5½d. per hour, at the end of six months after appointment 6d. per hour; conductors, on appointment 4½d. per hour, at the end of six months after appointment 5d. per hour; the hours of labour of such employés to be as near as possible 60 hours per week. When the minutes came up for consideration at the Council last week an amendment was submitted proposing that the 6d. per hour should be allowed to motormen and conductors at the end of four instead of six months. The question was referred back. It was pointed out that the minute to the effect that the Corporation do not find the bogie car suitable for their system only applied to the bogie car sent down, and not to the bogie system generally.

Sheffield.—The City Council have received the following report on the Kelham power station from Mr. A. L. C. Fell, electrical engineer: "On several occasions during the last few days the first large Cole, Marchent, and Morley engine has been driving the whole of the cars on the various routes. The engine still requires a little adjustment, but, on the whole, it is running very satisfactorily. The foundation for the second large engine is now nearly completed, but it will be impossible to erect very much of the engine until the crane girders are extended and the roof is completed over the foundation. The temporary end of the engine-room can then be moved forward. I estimate that the second large engine will take from six weeks to two months to erect after the above work is completed. All possible pressure should therefore be brought to bear on the building contractors so that there may be no further delay. The work on the boiler-house roof is proceeding very slowly, but this will not prevent the new boilers being put into operation."

Plymouth.—Mr. A. P. Trotter has held an enquiry into the application by the Corporation for sanction to borrow £20,000 for extension of plant at the electricity works required for supplying electric power to the Compton section of the tramways. The Town Clerk said the electric traction on the Ebrington-street section had been so satisfactory that the Corporation desired to extend it to the northern system of the tramways. The Local Government Board had already sanctioned a loan for the overhead equipment and cars for the Compton section, and the further loan of £20,000 now asked for was required for the provision of generating plant, boilers, and pipes, accumulators and switch gear, underground mains, sub-stations, fittings, and contingencies. Mr. Rider said the Corporation had already borrowed £18,000 for the overhead equipment and bonding of the lines. The track already existed, but certain sections of it would have to be renewed with heavier rails to carry the electric cars, the money for which was provided for in the previous loan.

London United Tramways Bill.—This Bill was before Sir Ughtred Kay-Shuttleworth's Committee of the House of Commons on May 5 and 7. It includes existing and proposed tramways serving, or to serve Hammersmith, Uxbridge, Acton, Ealing, Hanwell, Kew, and Richmond. Where the existing lines are worked by horses it is proposed to substitute electric overhead trolley traction. A circular route of 17½ miles of new line is to start from Isleworth and run through Teddington, Twickenham, and Hampton Wick. Mr. Balfour Browne, Q.C., contended on behalf of the company promoting the Bill that all, or nearly all, the local authorities on the route were favourable, and the opposition was limited to private interests on very small sections of the line. After hearing evidence, the Chairman said the committee were prepared to assent to the Richmond-road (Twickenham) line, subject to certain conditions. While assenting to the preamble generally, the committee would examine the deposited plans in regard to width of roads, single lines, curves, and so forth. The committee then adjourned.

Hull.—At a meeting of the Works Committee on May 5 the Tramways Special Sub-Committee reported on the recent breakdown of the electrical system of traction. They found that one of the employés had negligently allowed the bearings of the dynamo to get heated, and in consequence his services would no longer be retained. With respect to the accident which occurred to the armature of No 1 dynamo, they concluded that the cause emanated from some fault in the design of the dynamo, for which the contractors alone were responsible. They also had an interview with Messrs. Siemens and Co., Woolwich. The firm asked to be allowed to send down to Hull and erect the third engine and dynamo at their own risk, and to accept the responsibility of having to alter the dynamos so as to make them conform in all respects with the specifications attached to the contract. These minutes were approved. An official inspection of the Holderness-road section of the electric tramways has been made by Mr. Trotter, the inspector appointed by the Board of Trade to examine the electrical equipment. His object was mainly to see that the public safety is properly provided for, and we learn that he was satisfied with everything he saw.

Leicestershire.—At the quarterly meeting of the County Council the Highways Committee submitted a report containing the following minute: "An enquiry was held at Anstey on Feb. 16 by the Light Railway Commissioners in connection with an application for a light railway from Leicester to Anstey and Newtown Linford. The committee were represented at the enquiry, and supported the proposal, subject to the railway being properly constructed. The promoters were suggesting powers enabling them to run trucks 9ft. 3in. in width upon rails on the macadam part of the road without providing any groove, and leaving the flange of the wheel of the carriage to cut its own groove in the macadam of the road; and no provision was made for widening the macadam part of the road. The committee recommended that a representation be made to the Board of Trade, urging that the rails should be grooved or fitted with guard rails to form a groove, such groove not in any place to exceed 1½in. in width, and that the promoters should be required to widen the macadam part of the road to a width sufficient to permit of the free passage of the traffic upon the road when a train is passing; and wherever the railway was constructed by the side of, but not on the metalled part of the road, the uppermost surface of the rails should be on a level with the surface of the road." The report was adopted.

South-Eastern Metropolitan Tramways.—The preamble of the Bill of the South-Eastern Metropolitan Tramways Company was proved on Wednesday by Colonel Cotton Jodrell's Select Committee of the House of Commons. The object of the measure was the substitution of electric traction for horse traction on the tramway system between Greenwich and Catford. Mr. Little, Q.C., in opening for the Bill, said it had originally contained proposals for considerable extensions of the company's system in the direction of Sydenham and Norwood, but, unfortunately, those clauses had been struck out by the Standing Orders Committee. Sir William Preece, the engineer of the present scheme, said the road along which it was proposed to travel was an ideal one for the use of electric traction. The company favoured the surface-contact system, under which studs were placed along the road between the rails, jutting up about ¼in. above the roadway. Attached to the cars was a skate which slid on the top of these studs, and at every 15ft. or 20ft. the studs were placed in electrical contact with the mains, and it was only while the car covered two of these studs that they were alive with electricity. The system was absolutely safe and very workable, although there was no practical example in this country. The system would not be adopted if there was any doubt as to its success. In that case the conduit system would be substituted. There would be no danger to the company's mains from electrolysis, as the works would be carried out under the Board of Trade regulations.

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Dundee.—According to the *Dundee Advertiser*, operations are being pushed forward with all speed at the electrical station in Lochee-road with a view to the early starting of the new tramway system. The extensions which have taken place or are in progress are of the most comprehensive nature, and the whole works will embrace an area of about 50,000 square feet. All the space formerly occupied by the old cattle market, and in later years by the first People's Palace, has been included in the scheme of buildings, and now the city's electrical establishment and car station extends from the prison walls on the south to Dudhope-crescent road on the north, and to almost halfway along that thoroughfare on the east. In order to have the energy ready for supply at the earliest possible date, two new engines have been introduced into the present engine-room. One of these is completed, and the other is in course of construction. They will each be of 550 h.p., and this energy can be utilised either for tramways or lighting. Probably not more than 500 h.p. will be required for the tramways to begin with. The engines are by Messrs. Willans and Robinson Rugby; and the new dynamos, which are of the four-pole type, are by Messrs. Thomas Parker, Limited, Wolverhampton. To allow of the introduction of the extra machinery the existing engine-house has been lengthened about 25ft., but even then it is small compared with the magnificent engine-house which has been built immediately alongside. It is not intended to fully occupy this place just yet, but one large combined dynamo and engine set will be fitted up, and provision made for the extensions which are sure to be found necessary in the near future. The new building, as indeed all the erections within the ground, is constructed of brick, the interior, however, being made to look bright and artistic by the employment of enamelled tiles. A traction board for manipulating the electricity used by the tramways will be erected in the old house beside the lighting switches. At present there are four boilers working in the station, but Messrs. Cooper and Greig have laid down an additional four in a large house a short distance removed from the building now occupied by boilers. This house is 85ft. long by 60ft. broad. Adjoining it a new chimney shaft has been started, and when it is finished it will tower to a height of about 240ft. An economiser is situated beside the base of the shaft. Close to Lochee-road, and leading in from it by a large handsome gateway, is stationed the car-sheds. These are about 170ft. long by 70ft. broad, and they have six sidings, so that ample accommodation will be found for all the cars running on the streets. A house for car employés adjoins a workshop for repairs, and it may be added that lavatories and every possible convenience will be provided for the servants working on the cars. The offices in connection with the generating station have been enlarged by the addition of a drawing office, a meter-testing room, a staff room, and a store.

LIGHTING AND GENERAL.

Barnet.—The electric light columns are just being fixed in the streets.

Northallerton.—The contract with the electric lighting company has been approved of.

Audenshaw.—Councillor Davies has been elected chairman of the Electricity Committee.

Cardiff.—Mr. W. H Illingworth, of Halifax, has been appointed mains superintendent to the Council.

Dudley.—Preparations are now being made by the Corporation for the lighting of that town by electricity.

Tunbridge Wells.—Sir Wm. Preece is being consulted with regard to the smoke nuisance at the Council's works.

Rochdale.—In the new estimates for the town hall £2,000 is put down for "general repairs and electric lighting."

Sale of Plant.—A complete steam plant is for sale, for particulars of which we refer readers to our advertisement columns.

Cheltenham.—Application is to be made for a loan of £3,185 for extensions both of mains and of the Corporation's station.

Charing Cross and Strand Electricity Supply Bill.—This Bill has passed Mr. A. H. Brown's Committee of the House of Commons.

Luton.—An enquiry has been held into the long delayed electric lighting scheme of the Corporation; £26,000 is to be borrowed.

Brighton.—The appointment of Mr Christie, referred to in our last issue, was confirmed by the Town Council on Thursday evening last week.

Smethwick.—The question of establishing a telegraph office at Cape-hill and forming Smethwick into a postal district is still under consideration.

Sheffield.—Mr. S. E. Fedden, the newly-appointed engineer to the electric light department, will commence his duties about the middle of this month.

Nottingham.—The Electric Lighting Committee have granted £2,000 and the Tramway Committee £5,000 out of their profits for the relief of the rates.

Inverness.—The demand for electric lighting is steadily and rapidly increasing, and the company have now about 1,500 lamps connected to their mains.

Evesham.—The Town Council have agreed to authorise the Gas Committee to make enquiries and report on the question of electric lighting for the borough.

Deal.—The Council have decided not to consent to powers for the supply of electric light and traction in Deal and Walmer being obtained and exercised by the latter alone.

Bristol.—The Docks Committee have agreed to make certain concessions to the National Telephone Company in the conditions for laying a cable across the river at Hungroad.

Longton.—Application is to be made by the Town Council for sanction to a loan of £28,500 for the carrying out of the necessary works in connection with the electric lighting installation for the borough.

South Shields Electrical Engineering Co.—This Company has been registered with a capital of £2,000 in £1 shares, the objects being to carry on the business of electrical and general engineers, electroplaters, electricians, suppliers of electricity, etc.

London Gazette.—The last day for receiving proofs in the estate of H. L. Howard, trading as Thompson Howard and Co., Wyveston, Dragon-parade, Harrogate, is May 22. Mr. E. T. Wilkinson, official receiver, 28, Stoneygate, York, is trustee.

Malton.—The Urban Council on Monday had under consideration the proposed provisional order for electric lighting. It was resolved to offer no further opposition to the proposed order of the Board of Trade, provided the works are within the Council's district.

Marconi International Marine Communication Co.—This Company has been registered with a capital of £350,000 in £1 shares, the object being to acquire from Marconi's Wireless Telegraph Company, Limited, licenses and power to use certain patents, patent rights, etc.

Edinburgh.—The Electric Lighting Committee on Tuesday recommended that the charge for electric energy, as from May 15, be 3¾d. per unit, the charge for each public lamp £13 per annum, and that the charge for motor power be continued as at present—1½d. per unit. Exception was taken to the charge for public lamps, and the question was recommitted.

Aberdeen.—The Town Council on Wednesday agreed to apply for the consent of the Secretary for Scotland to the borrowing of the further sum of £22 000 in order to meet the additional expenditure on plant, machinery, etc., in connection with the electric lighting undertaking and the purchase price of the property at Dee Village recently acquired.

Throwing Stones at Telegraph Insulators.—Alexander Mutch, jun., millworker, 9, Blackhill-road, and James Laing Dressel, pudding maker, Glenburnie, were charged at Aberdeen Sheriff Court on Wednesday, before Sheriff Robertson, with having on April 9 thrown stones on the Great North of Scotland Railway Company's embankment at Chapel of Garioch, and broken 20 telegraph insulators. The Sheriff thought the practice was too common, and ought to be put a stop to. He fined Mutch 10s., with the option of three days' imprisonment, and Dressel 7s., with the option of two days' imprisonment.

Accident.—The *Newcastle Daily Chronicle* states that while a steamer was proceeding down the river to sea late on Tuesday evening she came into collision with the piles protecting the swing-bridge. One of the results of the impact, which was only slight, was that her anchor dropped overboard, and, being dragged along the bottom, tore from their coverings and completely severed the two cables belonging to the National Telephone Company. These were armoured cables carrying 300 double galvanised iron wires. The larger one is utterly ruined. The company have fitted new switchboards in the Gateshead exchange, to which all the subscribers cut off will be brought. It was intended to lay a new cable on Wednesday night, and the new Gateshead exchange will be worked independently of the old until such times as new cables have been manufactured.

Appointments Vacant.—The Johnson-Lundell Electric Traction Company, Limited, are inviting applications for the positions of engineer and general manager and of secretary.—The Corporation of Hastings require an assistant electrical engineer.—The Rathmines District Council require a canvasser.—An engineer is required at Leith to take charge of the Council's station.—A resident engineer is to be appointed shortly by the Aberystwyth and Chiswick Electricity Supply Company.—The Manchester Corporation have a vacancy for an installation inspector.—At Accrington, an electrical clerk of works is to be appointed, who, if satisfactory, may become resident engineer.—The Corporation of Glasgow invite applications for the post of outside superintendent for their telephone exchange system. Particulars of these appointments, and also of a vacancy for a young engineer to take charge of switchboard manufacture, a jointer, etc., will be found in our advertisement columns.

Parliament.—In the House of Lords the following Bills have been read a second time: Charing Cross, Euston, and Hampstead Railway, Wellingborough and District Tramroads, and Reading Corporation (Tramway). The following Bills have been read a third time and passed: City and South London Railway. In the House of Commons the following Bills have been read a third time: London County Tramways (No. 2) Exeter Corporation, and Hamilton, Motherwell, and Wishaw Tramways, Aberdeen Corporation Tramways. The Huddersfield Tramways Bill has been recommitted. The Examiners of Standing Orders in the House of Lords have certified that the Liverpool Overhead Railway Bill and the Salford Corporation Bill, both measures for introducing additional provisions, have failed to comply, notices having been given too late. The committee have granted an application of the Blackpool, St. Annes, and Lytham Company to dispense with compliance with Standing Orders of their Bill, under which they propose to extend their system of tramways by doubling their lines.

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Kidderminster and District Electric Lighting and Traction Co.—The transfer books and register of members of the 5 per cent. cumulative preference shares will be closed until the 15th inst., inclusive.

Cleethorpes.—The Electric Lighting Provisional Orders (No. 2) Bill, which has been passed as an unopposed measure, confirmed, *inter alia*, the electric lighting provisional order relating to Cleethorpes.

Barnsley.—A charge of 1½d. per unit is to be made for the supply of electrical energy for purposes other than lighting, and a new electric main will be laid in Pontefract-road at an estimated cost of £1,000.

Burton.—The Gas and Electric Light Committee's report for April states that the quantity of electricity sold in Board of Trade units was 8,833, showing an increase of 679 over the corresponding month of last year.

Stirling.—The County Council have adopted a report submitted by Colonel Wilson in connection with the electric wiring of the county buildings, and agreed to get the work done at an estimated cost of about £200.

St. Pancras.—The Vestry have sanctioned an expenditure of £3,000 for an additional feeder for the Seymour-street district, including distributing and arc lighting mains in Ampthill-square and Bedford street.

Glasgow.—It is proposed that an experimental installation of five or six of Prof. Becker's new electrically-controlled clocks, to be controlled from the observatory, should be fitted up in the western district of the city.

Ilford.—The Urban District Council are inviting tenders for the loan of £66,700, required for electric lighting purposes, repayable within two years, or within a period of 26 years by half-yearly repayments of principal with interest.

Mile End.—The Vestry have declined the proposals of the County of London and Brush Provincial Electric Lighting Company, Limited, as they will require the same ground for the purposes of their own electric lighting order.

Carlisle.—Enquiries are being made with a view of ascertaining whether there is a sufficient demand for the electric light in the neighbourhood to justify the Electric Light Committee in extending the cable to Charlotte-street Church.

Eccles.—The Works Sub Committee have been requested to select a design of a suitable lamp-pillar for the borough. It has been decided that the minimum charge for the supply of electricity at the sum of 13s. 4d. per quarter be now applied.

Nailsworth.—The Urban District Council are prepared to grant permission to the National Telephone Company to place their poles along the road from Nailsworth to Minchinhampton Common in order to extend the telephone service in that district.

Turkey.—Amongst a number of important measures of public utility which are announced as having been ordained by the Sultan last week, we note the construction of a railway from Damascus to the Hedjas and the construction of a telegraph line along the same route.

Morley.—The opposition to the Morley Corporation Bill has been withdrawn. The Bill has been promoted to extend the limit of the borrowing powers of the Corporation, and to make further provision in regard to the water, gas, and electrical undertakings of the Corporation, etc.

London County Council.—The Council on Tuesday agreed to lend the Poplar District Board £10,000 for electric lighting purposes, the Shoreditch Vestry £20,000 for electric lighting purposes, and the Shoreditch Guardians £7,500 for engineering works at the workhouse.

Hart Accumulator Co.—We have received from the Hart Accumulator Company one of their show cards. The card is highly glazed and well coloured, and illustrates one of their patent plate grids and a special non-corrosive terminal. A view of three accumulators is also shown.

Colne.—At last week's Town Council meeting the Town Clerk reported receipt of draft provisional agreement with Mr. Catlow's solicitors *re* purchase of site for generating station, which with certain alterations he had approved, and expected the matter would be very shortly completed.

Kingstown.—The unsatisfactory condition of the telephone system in the township was complained of at the last meeting of the Urban District Council. Notice was given for the next meeting to move that, unless the defects were remedied, the connection with the town hall be discontinued.

National Construction Co.—This Company has been registered with a capital of £10 000 in £1 shares, the object being to construct conduits, cables, wires, lines, accumulators, and works for electrical and other purposes, and to carry on the business of electrical engineers, suppliers of electricity, etc.

East Grinstead.—At the last meeting of the Urban District Council a resolution was discussed proposing that the Council take steps to obtain an order for the lighting of the district with electricity. The motion was ultimately withdrawn, and the matter was referred to the General Purposes Committee for consideration and report.

Eastbourne.—The Council have adopted the report from the Electric Light Committee referred to by us in our last issue, and which embodied a report from Mr. W. C. C. Hawtayne, recommending an outlay of £33,562 upon the erection of a new generating station at Roselands and the transference of the generating plant to this site.

Worcester.—The Town Council have decided to apply for sanction to a loan of £1,000 for defraying the cost of wiring private houses, etc., for electricity, the loan to be raised when and as the money is required. The Corporation do not propose to employ workmen to do the work, but will put it in the hands of local tradesmen.

Bacup.—The question of a refuse destructor being constructed in conjunction with an electric light station was considered by the Town Council last week, and it was resolved that the Health Committee be requested to proceed with the preparation of plans and estimates for a refuse destructor capable of raising steam for generating electricity.

Chesterfield.—The Electricity Committee have decided to charge 6d. per Board of Trade unit for public and private lighting, and 3½d. for power purposes. They have already applications for 4,713 lights and for 11 motors generating 50 h.p., and when to these are added the proposed 50 arc lamps, the whole of the power of their proposed plant will be required.

Crewe.—Sanction has been obtained to borrow, repayable within 25 years, a sum of £9,970 for the purposes of electric lighting. The Local Government Board have informed the Council that they have excluded from the sum applied for £30 required for the provision of 490 incandescent lamps, as they do not consider they were a suitable subject for a loan.

Newark.—At a recent meeting of the Electric Lighting Committee letters were read from the solicitors to the Great Northern Railway Company, objecting to powers being taken by the provisional order to lay mains across the railway in the road leading from Winthorpe-road to the Newark Navigation. The advisability of erecting a dust destructor was also suggested.

Alfreton.—The Urban District Council have decided upon the purchase of a piece of land for the proposed electric lighting station on Nottingham-road, containing one acre, at £225, upon the conditions that the land is suitable and approved by the Local Government Board and the Board of Trade, and that the Council be allowed to rent the same for one year at £4. 10s.

Wigan.—The Corporation have sealed an authority to the Public Works Loan Commissioners to pay to the bankers of the Corporation £15,000, being an instalment of the amount contracted to be borrowed in connection with the electric lighting undertaking. The boundaries with regard to the electric light are being extended in consequence of the requests received for a supply.

Accrington.—At the last meeting of the Town Council, the Town Clerk stated that the electricity station for the borough was now making good progress towards completion, and by the opening of the lighting season a supply of electricity would be available. He recommended shopkeepers and those who intended to take advantage of the electric lighting to put their houses in order so as to be ready for a supply.

Telephone Facilities.—In certain portions of Germany the telephone is introduced by tobacconists as an additional attraction to customers. Anyone who buys a cigar may, if he desires, speak over the tobacconist's instrument to a subscriber to the telephone service. Considering that you can get a cigar there for a farthing the concession is of great value, and is even economical for those who do not smoke at all.

Glasgow Telephones.—The Corporation Telephone Committee have accepted the tenders of the Ericsson-Bell Telephone Company to supply wall and table telephones, the same as those used in Norwegian State exchanges; and also the tender of the General Electric Company, London and Manchester, to supply wall telephones for the new municipal telephone service. The first lot of 1,550 telephones is to be delivered by October.

Bury.—The change in voltage on the mains has been completed, and the supply is now on the three-wire system, with a pressure of 440 volts across the outer mains and 220 volts between each middle and outer, instead of 220 volts across the outers, as had been the case since the works opened. The offer of the Electrical Power Storage Company to maintain the battery has been accepted. Two recording ammeters are to be obtained.

Barrow.—At the meeting of the Town Council on Monday a report was adopted on the working of the electric works for the last 12 months. The capital expended was £32,540, and the revenue amounted to £2,630. There was a gross profit of £758, of which £735 was absorbed in interest, leaving £22 towards redemption of loans. At the end of the year there were consumers representing 10,892 lamps, and since then the applications had brought the number up to 13,384.

Kilkenny.—The Urban District Council have been informed by the Board of Trade that the Kilkenny Electric Lighting Order, 1892, having been revoked, the Board have no power to revive it, and that if the Corporation desire to proceed with an electric lighting scheme it will be necessary for them to obtain fresh powers. The Board, having regard to the circumstances of the case, are prepared to consider any suggestions for saving the Corporation unnecessary expense in the promotion of an order.

Bradford.—The telephonic breakdown was discussed at the last meeting of the Corporation Finance Committee, and a proposal to establish a municipal exchange was made. The matter was referred to a sub committee. The National Telephone Company have promised the Postal Committee of the Chamber of Commerce to put the system in thorough working order in a fortnight, which means 13 weeks after the breakdown, and subscribers are anxious to know whether they will be allowed a quarter's rebate on the current year's subscriptions.

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Redditch.—Mr. E. A. Sandford Fawcett held an enquiry on May 3 into the application of the Urban District Council for permission to borrow £8,000 for work in connection with the electric lighting scheme. It was stated that the pressure on the plant was equal to 80 per cent. of its total capacity, and extensions were absolutely necessary. Plans of the proposed improvements and extensions were submitted by Mr. McMullen, the engineer, and at the conclusion of the examination the inspector said he did not think it necessary to call any further evidence.

Northern Submarine Cable.—The Copenhagen correspondent of the *Times* wires as follows: "I have every reason for believing that the projected cable from Denmark *vid* Scotland to Iceland will be laid by the Great Northern Telegraph Company with a subvention from Denmark and other foreign States. The Danish Aurora Borealis expedition, which has just returned from Iceland, highly favours the plan for meteorological purposes. The Great Northern Telegraph Company is said to be willing to make the sacrifice, though it does not expect that the project will pay."

Hanley.—Mr. J. M. Blair has been appointed junior assistant electrical engineer. The statement of the Electric Lighting Committee's accounts for the past year's working shows a profit of £1,177 on the receipts and working expenses and revenue account, which sum, however, is not sufficient to meet the charges for interest and sinking fund (£2,269.) In consequence of the increased demand for electrical energy and the uncertain price of fuel, the Council consider the present time inopportune to enter into negotiations with Fenton for a 10 years' supply of electrical energy.

Leyton.—The last report of the Electric Lighting Committee shows that the total number of consumers at the end of the month was 404, whilst the number of lamps connected totalled 20,741. The engineer's recommendation that additional feeders should be laid down as soon as possible at an estimated cost of £7,288, to reduce the present excessive loss in the transmission of the current, has been accepted, and application is to be made for a loan of £7,388. Arrangements are also to be made for lighting by incandescent lamps the streets leading from those in which the electric mains are laid.

Pacific Cable Question.—A Reuter's telegram states that the Postmaster-Generals of New South Wales and Victoria have come to an agreement on the disputed points in the proposed agreement with the Eastern Extension Telegraph Company. The arrangement is made subject to the approval of the company and the ratification by the Victorian and New South Wales Parliaments, which will not meet for two months. The tariff in the meantime will remain unaltered. The decisions of the Postmasters give the two Governments the option of purchasing the cable of the Eastern Extension. No other company is to be allowed to open offices in the Colonies before the Extension Company.

Leeds.—The *Leeds Mercury* says the Yorkshire House-to-House Electricity Company, when bought out by the Leeds Corporation some 18 months ago, were supplying about 75,000 electric lights in the city. The Corporation are now supplying 110,000 lights, an increase of something like 50 per cent. Of the 1,500 customers, the majority use the electricity for business premises. Between 300 and 400 houses in the Headingley and Chapeltown districts, however, have now an installation of electric light, and the demand in this respect is growing month by month. Mains have just been laid down in Clarendon-road, and already three or four new applications for electricity have been received from residents in that locality. The cost to the ordinary householder is 5d. per unit.

Beckenham.—The Postmaster-General has complained to the Urban District Council that they have allowed tubes for the use of the National Telephone Company to be laid in trenches constructed under the Beckenham electric lighting order. He points out that under Clause 6 of the Telegraph Act of 1892, work of this nature cannot be carried out by agreement between electric light undertakers and the Telephone Company, unless such agreement has been authorised by the Postmaster-General. It appears that the electric light cables were laid in the telephone trenches to save the breaking up of the streets twice, and the arrangement referred to was made, not by the Council, but between the National Telephone Company and the British Insulated Wire Company. The subject is now before the Electric Lighting Committee.

Hull.—An enquiry is to be held shortly into the application of the Corporation to borrow £42,000 for the purposes of electric light extension. The committee are already committed to the expenditure of the bulk of this sum, the contract for the dynamos having been let to Messrs. Earle; that for boilers to Messrs. Clayton, Turner, and Co., Hunslet; for engines to Messrs. W. H. Allen and Co., Bedford; and for mains to Messrs. Siemens. When the minutes of the Electric Lighting Committee came up for approval at the meeting of the City Council on May 3, it was stated with regard to Messrs. Earle's tender, which has been accepted against the recommendation of the committee some time ago, that the amount of the tender was £3,725, or £1,310 less than the one recommended by the committee. The fact that some forms with regard to the same contract had not been complied with was commented upon, and the matter was referred back to the committee.

Accrington.—Mr. Shoolbred, in his last report upon the progress of the various contracts, states that he has tested one set of engine and dynamos and a large portion of the cables, the latter of which had been delivered. The works would be in a position to commence supplying electricity by Michaelmas. He also pointed out the necessity of making an early appointment of a clerk of works who would act in the laying of the cables, and who would, if satisfactory, succeed to the position of electrical engineer. This recommendation has been agreed to. Tenders are to be invited for the wiring and lighting of the station and the destructor works, also for the overhead travelling crane, for the necessary quantities of house service cables, meters, terminal boxes, Board of Trade measuring instruments, and station meter, etc. The price at which to commence to supply electricity has been fixed at 5d. per unit for lighting and 3d. per unit for power purposes, with no charge for meters.

Southwark.—The value of a dynamo was discussed at last week's meeting of the St. Olave's Board of Works. The Works and Finance Committee recommended that the offer of Mr. Mackie of £12 for the dynamo offered for sale by the Board be accepted. It was submitted that the dynamo was worth more, and it was suggested that the Board should readvertise. It appeared, however, that £2 had already been spent in advertising this matter. Finally, it was resolved to refer the question back to committee. The St. Saviour's Board of Works will not raise any objection to the City's proposal to seek powers for the purchase of so much of the plant of the City of London Electric Lighting Company (at the expiration of the legal term) as is necessary to produce current for light required within the City boundaries. The Act provides for the purchase of wires, etc., and the City desire to purchase the plant, too, but this is situate at Bankside, within the area of the Board's administration.

Croydon.—Colonel W. R. Slacke, R.E., held an enquiry last week into a proposal to borrow £20,750 for electric lighting purposes. The application was for extension of mains and plants, £6,800 being for plant in the station, and the balance for cable and plant outside. The first part of the loan for feeders, etc., arose solely from the great increase in the demand in the area already supplied. Up to March 31, 1900, the supply was equal to 45,122 8-c.p. lamps for private lighting and 3,500 for public lighting. When the Corporation took the undertaking over it was 18,000 lamps for private lighting, and for public lighting about 2,000. The existing plant will only be just sufficient to meet the demand next winter—assuming a normal increase—without any reserve. The new engine will supply about 15,000 8-c.p. lamps alight at one time, or about 20,000 connected. In all probability the new plant will not be available until the winter after next. The borough electrical engineer has been instructed that until otherwise resolved, current, whether for lighting purposes or motive power, be supplied to new consumers upon the maximum demand principle only.

Inquest.—On Monday at Helsby, near Chester, Mr. J. C. Bate, coroner, held an inquest on the body of William Martin Littler, aged 22 years, of Bredbury, Stockport, who was killed at the works of the Telegraph Manufacturing Company, Helsby, on Friday last. Deceased, who was employed in the department for the purification of gutta-percha, was found lying at the bottom of a tank. Dr. Bryant deposed that when he arrived at the works the deceased was dead. In his opinion, the deceased had first been intoxicated by the fumes, and had fallen into the tank and gradually been suffocated. Mr. Eraut, of Liverpool, inspector of factories, suggested that in future two men should always be in the room while a tank was being emptied, and that a long time should be allowed to elapse after the lid of a tank was removed before a man went into it to discharge the contents. The jury returned a verdict to the effect that the deceased was accidentally suffocated, and expressed approval of the factory inspector's suggestions, and further recommended that the tanks should be made more shallow, so that men would not need to enter them in order to empty them.

Manchester.—In reply to a question at last week's meeting of the City Council it was explained that the lighting of Cheetham Hill would shortly be dealt with. It had been pointed out that there would probably be a very large demand for current from that district, but hitherto the engineer could not with the existing plant have given the voltage which the people would have had to pay for. The customers there would have been in the same position as the consumers in Hyde-road, where they paid for 200 volts and got 140. Until they had the plans completed the committee thought it advisable to keep to districts where they could supply the full pressure of 200 volts. The committee had paid very handsome dividends to relieve the rates of the city in the past, and were being criticised because they had already given £63,000 in such relief, and they had built up a reserve fund of £40,000. The committee were not this year contributing £10,000 or £12,000 to the rates, but this was only a temporary postponement. The rise in the price of coal had made a difference in the year's revenue of over £6,000, while some of the lines laid down in the city and outside areas had not yet returned a dividend sufficient to meet the expenditure on interest and sinking fund.

Stock Exchange.—The Stock Exchange Committee has appointed May 23 special settling day for Crompton and Co.'s further issue of 7,582 ordinary shares of £3 each, fully paid, Nos. 46,419 to 54,000; and the National Telephone Company's 81,092 ordinary shares of £5 each, £3. 10s. paid, 18,908 ordinary shares of £5 each, fully paid (within Nos. 490,001 to 590,000), and fully and partly paid provisional certificates for £500,000 4 per cent. debenture stock. The committee has ordered the undermentioned securities to be quoted in the official list: the British Aluminium Company's £300,000 5 per cent. first mortgage debenture stock, and the Buenos Ayres Grand National Tramways Company's further issue of £26,400 5½ per cent. preference debentures, Nos. 1,237 to 1,500. The committee has also been asked to appoint a special settling day in the British Motor Company's 800,000 ordinary shares of £1 each, fully paid, Nos. 1 to 800,000, and the Nernst Electric Light, Limited, 250,000 vendors' 7 per cent. cumulative preference shares of £1 each, fully paid, Nos. 115,001 to 140,000; and to allow the British Insulated Wire

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Company's further issue of 12,500 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 27,501 to 40,000 to be quoted in the official list.

Hammersmith.—At the meeting of the Vestry on Wednesday evening, Mr. G. G. Bell, engineer and manager of the electric lighting department, submitted a report on the result of the past year's working of his department. In the report it was stated that the number of consumers had increased during the year from 275 with 19,390 8-c.p. lamps, to 464 taking a supply of 26,365 8-c.p. lamps. The average number of lamps per consumer had decreased from 70 to 56. This was mostly due to the number of small flats in the parish which were wired for electric lighting. The department had received £3,375 for lighting and maintaining 150 arc lamps in the public streets. This was a reduction from 3¼d. per unit last year to 2·9d. per unit this year, and was accounted for by the increase in the candle-power of the incandescent lamps, which are used after 12.30 a.m., from 32 c.p. to 50 c.p. Sixty-three additional arc lamps had been added since he submitted his last report. With regard to private lighting, the Vestry had sold 620,078 units, producing a revenue of £10,274. 5s. 7d., which worked out at an average price of barely 4d. per unit. The average lighting hours of the lamps had been increased from 840 to 900 per annum, but owing to the reduction in the Vestry's charges of practically ½d. per unit on the price obtained last year, the annual revenue per lamp had gone down from 10s. 10d. to 9s., a most satisfactory state of affairs for the consumers, the price paid by them for electricity being the lowest but one in the London district. The total cost for the year of generation, distribution, etc., was £7,764. 14s. 11d., or 2·05 per unit, a decrease of nearly ½d. per unit on last year, being 56·5 per cent. of the revenue, leaving a gross profit of £5,974. 0s. 10d., or 43·5 per cent., towards paying interest and sinking fund charges. The whole of the buildings, generating machinery, and distributing mains have been maintained in efficient working condition out of the revenue. The result of the year's working showed a net profit of £1,615. 4s. 8d. after the deduction of interest and repayment of capital. Although the cost of production had decreased, he was afraid that these results might not be improved upon in the present year owing to the greatly-increased prices of fuel and other materials. With regard to the capacity of the generating station, the machinery now installed and in working condition would be able to supply a further 10,000 8-c.p. lamps after allowing an ample margin for reserve.

PROVISIONAL PATENTS, 1900.

APRIL 30.

7979. Improvements in portable electric lights. Alfred Julius Boult 111 Hatton-garden, London. (Edwin Ruthven Gill, United States.)

7983. Improvements in electrical signalling. John Nevil Maskelyne, jun., 6, Bream's-buildings, Chancery-lane, London.

7989. Improvements in electric switches. Walter Frederick Jones, 4, South-street, Finsbury, London.

7997. A new and improved electric gear for cranes. Otto Kammerer, 37, Chancery-lane, London.

MAY 1.

8013. Improvements in and connected with electric switches. Henry Oliver Farrell, 16, Kensington-road, Chorlton-cum-Hardy, Manchester.

8015. A new or improved method and apparatus for electric railways and traction purposes. Arthur Ballance and Samuel Ambrose Jefferson, 3, Brunswick-grove, Brunswick-avenue, Hull.

8016. A new or improved means and apparatus for collecting current from surface contacts for tramcars, etc. Arthur Ballance and Samuel Ambrose Jefferson, 3, Brunswick-grove, Brunswick-avenue, Hull.

8019. Improvements in and relating to winches for raising and lowering arc lamps. James Dewar, 96, Buchanan-street, Glasgow.

8022. Improvements in dynamos and electromotors. Albert Henry Midgley, 2, Market-street, Bradford.

8028. Improvements in and relating to electric bells or instruments requiring vibrating motions. George Whittaker Holt and Archibald James Hallam, 63, Lionel-street, Birmingham.

8061. Overhead electric protector for conductors. Joseph Arthur Poché, 36, Chancery-lane, London.

8067. A new or improved method of tuning electric currents and producing musical sounds by electrical agency. Arthur Thomas Metcalf Johnson and George Guyott, 109, Calabria-road, Highbury, London.

MAY 2.

8103. Improvements in electric igniters for internal-combustion engines and the like. Anthony George New, The Voltage, Woking.

8107. Improvements in or connected with telephone instruments. The British Electric Works Company, Limited, and Bertil Brander, 24, Temple-row, Birmingham.

8111. Improvements in parts of telephone instruments. The British Electric Works Company, Limited, and Bertil Brander, 24, Temple-row, Birmingham.

8116. Improvements in the construction of casing and capping and in the means of attaching same together for use in connection with electrical installations. Ferrand Agnew Williams, 86, Clifton-street, Old Trafford, Manchester.

8122. The improved electrical fusible cut-out. Bruce Charles Bouquet, Oak Cottage, Ealing-road, Wembley, London.

8123. Improvements in and connected with electric light wall plugs. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actien-Gesellschaft Mix und Genest, Germany.

8142. An apparatus for receiving Hertzian waves and translating them into perceptible signs. Johann Christian Schäfer, Paul Lippold, and Eduard Renz, 7, Quality-court, Chancery-lane, London. (Complete specification.)

8152. Improvements in transformers. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (The Actien Gesellschaft Elektricitätswerke, vorm. O. L. Kummer und Co., Germany. (Complete specification.)

8160 Improvements in electric switches. William Ely, 6, Lord-street, Liverpool. (Complete specification.)

MAY 3.

8179. Improvements in electric switch apparatus. Walter Frederick Jones, Albert Works, Beavor-lane, Hammersmith, London.

8181. Improvements in junction boxes for the conduits or casings of electric wires. Charles John Wightman and Arthur Hudson, 2, Market-street, Bradford.

8201. Globe or shade holder for gas, oil, or electric light fittings. George Henry Barnes, 267, Gooch-street, Birmingham.

8207. Improvements in insulated electric conductors and process of and apparatus for making the same. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Wallace S. Clark and George H. Rupley, United States.) (Complete specification.)

8208. Improvements in high-potential electric switches or circuit-breakers. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Edward M. Hewlett, United States.) (Complete specification.)

8225. A new or improved article of manufacture for use in connection with telephone or telegraph instruments. Stephen Gelder, 6, Lord-street, Liverpool.

8226. Improvements in plates for secondary batteries. Paul Schmitt, 46, Lincoln's-inn-fields, London. (Complete specification.)

8227. Improvements in or connected with windings for dynamo-electric generators, motors, and converters. Valère Alfred Fynn, 55, Chancery-lane, London. (Complete specification.)

8234. Improvements in electric rail bonds. The British Westinghouse Electric and Manufacturing Company, Limited, Westinghouse-building, Norfolk-street, Strand, London. (Constant F. De Redon, United States.)

8239. An improvement in electricity meters constructed on the Ferraris principle. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske, Actien-Gesellschaft, Germany. (Complete specification.)

8241. Improvements in electricity meters. Martin Kallmann, 18, Southampton-buildings, Chancery-lane, London.

MAY 4.

8257. Improvements in electric ignition devices for gas and oil engines. Thomas Harry Gardner and Lawrence Gardner, 55, Market-street, Manchester.

8271 A new or improved electrical switch. Peter Charles Middleton and William Samuel Hadgraft Smith, 7, Staple-inn, London.

8274. Improvements in the manufacture of electrical fuse heads and electrical fuses. Herbert John Haddan, 18, Buckingham-street, Strand, London. (Fabrik Electrischer Zünder, G.M.B.H., Germany.)

8289. Improvements in or in connection with insulated electric cables or conductors and the manufacture thereof. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

8290. Improvements in or relating to insulated electric cables or conductors, and the manufacture thereof. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

8293. Improvements relating to electrical installation and distribution. Joseph Frank Smith, 11, Burlington-chambers, New-street, Birmingham.

8299. Improvements relating to two-liquid primary batteries and regenerating the same. James Yate Johnson, 47, Lincoln's-inn fields, London. (Herman Jacques Dercum, United States.) (Complete specification.)

8300. Improvements relating to two-liquid primary batteries and regenerating the same. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Herman Jacques Dercum, United States.) (Complete specification.)

MAY 5.

8315. Improvements in electric switches. Walter Frederick Jones, Albert Works, Beavor-lane, Hammersmith.

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8344. Improved double pin plug for electrical connections. Felix Hudson Minn and the Sun Electrical Company, Limited, 61, Carey-street, Lincoln's-inn, London. (Complete specification.)

8347. Improvements in or relating to the "trolley-head" employed in connection with electrically-propelled cars or vehicles. Joseph Taylor and Arthur Hudson, 8, Quality-court, Chancery-lane, London.

8357. Improvements in electricity meters. George Hookham, 18, Southampton-buildings, Chancery-lane, London.

8361. Improvements in apparatus for switching electric currents on and off, especially suitable for lighting telephone switchboards. Frank Gill, Robert Gilmour, and Percy Heywood Claxton, 24, Southampton-buildings, Chancery-lane, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on May 26.

1899.

9134. Electric accumulators. Mouterde.

9245. Electric maximum demand indicators. British Thomson-Houston Company, Limited. (Cox.)

9981. Means for driving sewing and other machines by electricity. Joseph and Ehrenreich.

11693. Apparatus for connecting branch circuits to electric mains. Callender's Cable and Construction Company, Limited, and Callender.

11843. Devices for starting electric induction motors. British Thomson-Houston Company, Limited. (Union Elektricitäts-Gesellschaft und Zani.)

11934. Poles for supporting overhead wires in electric tramways. Smith.

12788. Method and means for increasing the conductivity of carbon to be used in electric cells and dynamo-electric generators and motors. Hertel.

13233. Apparatus for periodically producing electric current by wind power. Gebre.

13270. Telephone exchange systems. Sinclair and Aitken.

13276. Enclosed motors or dynamos. Roeling and Appleby.

13593. Secondary batteries. Tommasi. (Date applied for under International Convention, Jan. 23, 1899.)

13656. Brakes for electric motor vehicles. Leitner.

25072. Electrolytic interrupter. De Mare.

1900.

240. Magnetic brakes and magnets suitable therefor. Von Zweigbergk.

2621. Safety and indicating device for electric circuits. Ruhstrat and Ruhstrat.

2862. Electric traction motors. Richter and Eschler.

3441. Systems of telephonic communication and signalling. Byng and Bell.

4457. Electrically-controlled door locks. Schadf.

5136. Intercommunication telephone systems. Byng and Bell.

5321. Plates for storage batteries. Haddan. (Lindstrom, Hewitt, and Hewitt.)

5693. Telephonic systems. Mengis and Christensen.

5848. Conduits and conduction supports for electric tramways. Smith.

6023. Electric bells. British Electric Works Company, Limited, and Brander.

6152. Electrically-propelled motor vehicles. Justice. (Columbia and Electric Vehicle Company.)

6296. Electric furnaces. Borchers.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	May 5	4 297	4,094	+ 203	73,262	69,408
Blackburn Corp'rat'n	,, 4	422	422	—	7,047	6,042
Blackpool Corporatn.	,, 3	279	247	+ 32	1 905	1.435
Blackpool-Fleetwood	,, 5	333	419	- 86	4,252	4,360
Bradford City Trams	,, 6	413	334	+ 79	2,269*a*	1 757
Bristol Tramways Co.	,, 4	2 881	2 815	+ 66	—	—
City & South London	,, 6	1,283	995	+ 288	22,245	19.317
Dover Tramways	,, 5	189	151	+ 38	2,842	2,731
Dublin U.T., elec. cars	,, 4	3,421	1,086	+2,325	—	—
Dublin S.D. Electric	,, 4	804	772	+ 32	—	—
Halifax Corporation	,, 5	632	461	+ 171	3 297	2,226
Hull Corporat'n E.S.	,, 5	1,085	—	—	5 258*a*	—
Liverpool Corporat'n	Apl. 28*b*	7,270	6,302	+ 986	116 961	101.409
Liverpool Overhead	May 6	1,433	1,426	+ 7	25,336	24,289
Sheffield Corporation	,, 6	2,148	—	—	—	—
South Staffordshire	,, 4	703	628	+ 75	11 597	11,095

a Since April 1. *b* Partly electrical.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.	Price last Monday.
Commercial and Industrial.—		
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	13/16-15/16
British Insulated Wire, Ord., 1-40,000	5	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	6 6½
—— 5 per cent. Mortgage Debentures	100	98-103
British Electric Works, Ordinary, 50,001-95,000	1	¾-1
—— 6 per cent. Cum. Pref, 1-50,000	1	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	4½-4¾
Brush Electrical Engineering, Ordinary	2	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	2-2¼
—— 4½ per cent. Debenture Stock	100	103-113
—— 4½ per cent. 2nd Debenture Stock	100	103-105
Callender's Cable, Debentures.	100	112-116
—— Ordinary	5	14½-15½
—— 5 per cent. Pref.	5	5½-6
Crompton and Co.	2	3¾ 4
—— 5 per cent. Debentures	—	99-102
Edison and Swan United, Ordinary	2	2-2¼
—— 5 per cent. Debentures	5	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	93-95
Electric Construction	2	2¼-2¾
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	103-106
W. T. Henley's Telegraph Works, Ordinary	5	13½-14½
—— 4½ per cent. Preference	5	5½-5¾
—— 4½ per cent. Debentures	100	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	21-22
—— 4 per cent. Debentures	100	100-103
Telegraph Construction and Maintenance	12	35-39
—— 5 per cent. Bonds	100	102 105
Telegraph Manufacturing, Ordinary	5	10-11
—— 5 per cent. Cum. Pref.	5	5½-6
Willans and Robinson, Ordinary 1-30,000	5	11½-12½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	7½-7¾
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	104-106
Electric Lighting and Supply.—		
Blackheath & Greenwich District Ordinary 1,201-101,200	1	⅝-¾
Bournemouth and Poole, Ordinary	10	11½-12½
—— 4½ per cent. Cum. Pref.	10	10-11
Brompton and Kensington, Ordinary	5	7-8
—— 7 per cent. Preference	5	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	7-7½
Charing Cross and Strand	5	8½-9¼
—— 4½ per cent. Cum. Pref.	5	5½-5¾
Chelsea Electricity Supply	5	6¾-7¼
—— 4½ per cent. Debentures	100	108-111
City of London, Ordinary	10	10-11
—— 6 per cent. Cumulative Pref.	10	12-13
—— 5 per cent. Debenture Stock	100	122-127
County of London and Brush Provincial, Ordinary	10	9½-10¼
—— 6 per cent. Cum. Pref.	10	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	109-112
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	4¼-5
—— 4½ per cent. First Mort. Deb.	100	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	9½-10¼
London Electric, Ordinary	2	1¾-2
—— 6 per cent. Pref.	5	4¼-4
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	100-102
Metropolitan, Ordinary	10	13¾-14¼
—— 4½ per cent. First Mortgage Debenture Stock	100	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	96-98
Notting Hill Electric Lighting	10	15½-16¼
Oriental, 1879	1	1⅝-1¾
—— £5 Shares	5	7-7¼
—— £4½ Shares, New	4½	6¼-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	6¾-7
River Plate Electric Light and Traction, Deb.	100	75-85
Royal Electrical Company of Montreal	$ 00	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$100	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	2-2¼
—— 4 per cent. Debenture Stock	100	85-95
South London, Ordinary	3	4-4¼
St. James's and Pall Mall, Ordinary, 101-20,080	5	14½-15½
—— 7 per cent. Pref.	5	8¾-9¼
Westminster, Ordinary	5	15 16
Electric Railways.—		
Central London, Ordinary	10	10-10⅛
—— Pref. Half-Shares	5	4¾-5¼
—— " " deferred	5	5-5⅛
City and South London, Consolidated Ordinary	100	61-64
—— Ordinary	10	5¼-6¼ xd
—— 4 per cent. Debenture Stock	100	125 130
—— 5 per cent. Pref. Stock '91	100	140-145
—— " " '96	100	132-137
Liverpool Overhead, 5 per cent. Pref.	—	13¼-13½
Waterloo and City, Ordinary	100	101-103
Electric Tramways.—		
Blackpool and Fleetwood Tramroad	10	17-18
Brisbane Tramway	100	102-104
British Columbia Electric Railway Co., 5 per cent. Pref.	10	9¾-10¼ xd
British Electric Traction, Ordinary, 1-30,000	10	15½-16¼
—— 60,001-75,000	10	15-16¼
—— 6 per cent. Cm. Pf. 30,001-60,000	10	12¼-13
—— 5 per cent. Perpetual Debenture Stock	100	124-127
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	5-5¼ xd
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	4-4¼
—— 5 per cent. Deb. Stock, Red.	100	104 107
Isle of Man Electric Power, 1-95,000	1	7/16-½
—— 6 per cent. Preference, 100,001-170,000	1	⅜-9/16
Kidderminster and District Lighting and Traction, Pref.	10	9½-10¼
New General Traction, Ordinary	5	3¾-4
—— 6 per cent. Cum. Pref.	5	5-5¼
North Staffordshire Trams	6	—
Oldham, Ashton, and Hyde Tramway, Ordinary	10	16-18
—— Preference	10	10¾-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	11½-12¼
—— 5 per cent. Cum. Pref., 1-20,000	10	9½-10¼
Telephones.—		
Consolidated Telephone Construction and Maintenance	½	⅜-½
National Telephone, Ordinary	5	4¾-5¼
—— 6 per cent. Cum. First Pref.	10	13-15
—— 6 per cent. Cum. Second Pref.	10	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	5¼-5¾
—— 3½ per cent. Deb. Stock, Red.	100	97-100
Oriental Telephone and Electric Company	1	15/16-1 1/16 xd

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NOTES.

A Telegraphic Money Service.—We are informed by Reuter's Paris correspondent that the British Chamber of Commerce in that city have been advised by her Majesty's Postmaster-General that the request for the establishment of a telegraphic money order service between England and France has been granted, and that the arrangement will enter into force after the completion of the necessary diplomatic procedure.

Electric Distribution in Paris.—Our contemporary *L'Industrie Electrique*, in its issue for the 10th inst., gives most full information as to the distribution of electrical energy in Paris up to Jan. 1 this year. The numerous tables which have been compiled by our contemporary give very full details of the equipment of the stations and of the types of machines which are used in distribution. A glance over these tables will be of great value to the engineer when visiting the Paris Exhibition, to enable him to decide which of the central stations of Paris will best repay him for a visit.

Medical Electricity.—With respect to the paper which Dr. Lewis Jones read some time ago before the Institution of Electrical Engineers on "Medical Electricity," it is curious to find an application of this force in an American zoological gardens. Thus we learn that an ostrich in the gardens at Cincinatti has had a severe attack of paralysis, and in order to save the bird recourse was taken to electrical treatment. According to *Electricity* of New York, the bird was hung up by the neck, and electric shocks were administered. It is stated that after three applications the bird is appreciably better, and that it will probably recover.

Electrical Power in Calcutta.—We learn from our contemporary *Indian Engineering* that the Port Commissioners of Calcutta have resolved to procure Messrs. Brown, Hoisting, and Co.'s electrical coal-trimming plant at a cost of £3,000 for trimming coal on vessels at the Kidderpore Docks. The plant, it is estimated, will be capable of trimming 320,000 tons of coal a year, and thus effect a saving of over £1,300 per annum, or 45 per cent. on its capital cost. In addition to this application of electricity, we are also pleased to notice that in Colombo, Ceylon, the railway yard is about to have electricity installed for lighting purposes.

The Electrical Engineer Institute. — We are informed that the Electrical Engineer Institute of Correspondence Instruction has removed from 120-122, Liberty-street, New York, to new quarters at 240-242, West Twenty-third-street, New York, U.S.A., the growth of the institute having been so rapid that the old buildings have become inadequate to meet the demands for space. The institute has a very large number of students located all over Great Britain and the Colonies, as well as in the States, and the students study under the personal supervision of competent electrical engineers, the text-books supplied to them being prepared by practical experts.

Leeds Tramways.—We notice that in Leeds, with the introduction of electric traction on the tramways, the question of ½d. fares has come into consideration. This price has been charged on the old horse vehicles, but the service is stated to have been so bad that if 1d. fares had been charged the inhabitants would not have cared to ride. It has been decided that on a certain portion of the line the ½d. fares are to be continued, and that on one other portion the ½d. fares shall be discontinued. We should think that, in a large town like Leeds there ought to be no question as to the providing of cheap fares for the working classes, as with the increased economy in working with electric traction these smaller charges could easily be made.

Water Power in Finland.—In view of the number of waterfalls which are to be found in Finland, it is not remarkable to find that the authorities have recognised that they have at their doors a source of cheap power, which, if utilised, would greatly benefit the country. Besides Finland itself, however, we learn that a scheme is about to be put into operation to supply St. Petersburg with power from these falls. It is estimated that about 70,000 horse-power will be transmitted to Russia's capital, where it is proposed to substitute arc lamps for the gas lamps at present in use for public lighting. The number of arc lamps which it is stated will be required is about 4,000.

Water Power in Canada.—The *Electrical World* for April 28 describes a large water-power plant which is now being carried out on the Saguenay River in Quebec province. The Saguenay power at tide level is capable of developing over 2,000 h.p. with a head of 69ft. At the chosen point the Ship Shaw River falls into the Saguenay, and gives a minimum horse-power of 15,000ft. Here it is proposed to obtain 10,000 e.h.p. on the Ship Shaw and 100,000 h.p. on the Saguenay. In this way, besides working his own calcium carbide works, the proprietor intends to distribute power to other neighbouring industries, of which wood-pulping and papermaking form a large part.

An Adjustable Hanging Telephone.—We notice in the *Electrical Review* of New York an illustration and description of an ingenious telephone apparatus. This consists of a hanging combination receiver and transmitter, which is attached by cords and a counterweight to the box containing the telephonic apparatus. The box may be attached to either the wall or ceiling, and in the wall type carries the battery. In the ceiling type this, however, has been thought too cumbersome, and it is separately installed. On pulling down the combination transmitter and receiver, the bell is rung. The whole apparatus seems to us to be very convenient, and would take up no space in awkward positions such as the usual telephones do.

Obituary.—We regret to have to record the death, which took place last week, of Mr. E. Pritchard, a well-known engineer. He was intimately connected with many large tramway undertakings, more particularly the Birmingham tramways. In conjunction with Mr. Kincaid, he was retained as engineer to these tramways after the decision to adopt accumulator traction on the Bristol-road section. His views on electric traction were in favour of the overhead trolley system, and not accumulators. The firm of Pritchard and Co. are also connected intimately with the construction of a number of other lines in the country. Mr. Pritchard had also large experience as a sanitary and mining engineer, and was a member of numerous engineering and scientific societies.

X-Rays.—A new application has, we learn, been found for X-rays. According to *Public Policy* of Chicago, Prof. Brignitti has studied carefully the inks used in writing on ancient manuscripts. It was also a custom of the ancients that when they wanted parchment for writing on they erased the writing on old documents. In the usual way the erasure was not perfect, and the letters would again appear when certain acids were applied. This, however, spoilt the manuscript, and Prof. Brignitti, in order to avoid this, tried the effect of using the Rontgen rays. Remarkably good results are said to have been obtained, and the use of acids rendered quite unnecessary. In this way the destruction, as in former times, of very

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interesting and valuable manuscripts will not need to take place.

The Paris Exhibition.—We notice that on Tuesday last the Paris Exhibition was alarmed by a fire which broke out in the underground portion of the Château d'Eau. The damage done was not extensive, but the electrical apparatus was put completely out of order, and the work of organising the luminous fountains has to be begun again. The alarm was given a little before noon, when the bulk of the workmen had left the basement for their mid-day meal. No injury was done to any of the buildings, but it is stated that the whole electrical apparatus of the château has been destroyed, or at least damaged beyond immediate use for illuminating purposes. The exhibition seems doomed to be unfortunate in the matter of accidents, and it is curious to note that the fire should break out in the Water Palace.

Glasgow International Exhibition. — At the Glasgow International Exhibition to be held next year electricity is to play a great part. Thus, about 1,000 Brockie-Pell arc lamps are to be used in lighting the grounds and main buildings, and in addition, electric cranes will be fitted up to handle the exhibits. There is, of course, also to be an electrical display in one of the principal sections. Applications for entries in this class must, we are informed, be made to the general manager, Mr. H. A. Hedley, 36, St. Vincent-place, Glasgow, before June 1. Most of the electric machinery is to be lent by the large firms, the indicated horse-power of the sets ranging from 70 to 1,200. The progress of the works in the exhibition is stated to be very satisfying, and it is to be hoped that Glasgow will not, as in Paris, have half of the exhibition to complete on the opening day.

Underground Electric Traction.—We are glad to note that the Select Committee of the House of Commons presided over by Colonel Cotton-Joddrel on Monday last decided to pass the preamble of the Bill of the Metropolitan District Railway Company, which, *inter alia*, empowers the construction of a generating station at Lot's-road, Chelsea, for the supply of electric power for the working of the Metropolitan District and Metropolitan Railways, and the laying of two mains, the one running along the West London Extension Railway to West Brompton, and the other through the public streets to Warwick-road. The line at present equipped for electric traction will, of course, be somewhat of an experiment, and should give the Metropolitan Railway Company the experience which they will require in order to fit the whole of their line electrically. The progress, therefore, of the pioneer electric section between Earl's Court and Kensington High-street will be watched with interest by the general public as well as those connected with the lines.

A Typewriting Telegraph.—We understand that a company, called the Typewriting Telegraph Corporation, Limited, has been formed to acquire certain rights for improvements in telegraph recording instruments. This new telegraph typewriter is the invention of Mr. Steljés, and is said to be much superior to the instruments now in work. One of the advantages of this telegraph will be that it will print a copy of any message sent at the receiving end. The apparatus will also be applicable to the telephone, and there also print the message. In this way one would not need to spend a long time at a telephone in order to obtain a message, this waiting at the telephone for the person addressed. Of course, the telephone would not give automatically any answer the sender of the message required, but still it may be a great aid when waiting for a message. By this system the inventor claims to have done away with the reading of confidential messages by tapping the lines, and this is a very important matter. We hope that there is something in the patent, and are sure that if it can do all that is claimed for it, it will not be long before the makers have sufficient orders to occupy their shops.

Nikola Tesla Power Transmission. — Another patent by Mr. Nikola Tesla for the electric transmission of power by means of the upper strata of the atmosphere has now been published in America. The inventor proposes to use balloons to lift his sending and receiving conductors, and to employ such high electric pressures as millions of volts with a frequency of several thousand per second. The earth is to be used as a return, but we are not quite clear how the inventor will be able to prevent earth troubles with his return. In the patent the experimental apparatus is described for generating E.M.F.'s of from two to four million volts, and it is stated that current from such a machine can be sent through a glass tube 50ft. long with a barometric pressure of from one-third to one-fifth of an atmosphere. The estimated height of the captive balloons is put at from four to seven miles above sea-level, and Mr. Nikola Tesla proceeds to claim broadly the propagation of electrical energy by conduction through earth and air. The theoretical difficulties, let alone the practical difficulties, are so great in connection with this proposed scheme, that we do not propose to criticise it further until some actual results of experiments are published.

Electrolysis.—Mr. H. E. Herrick read before the New York Electrical Society at the end of last month a paper on the effects of electrolysis from the earthed return currents of street railways. The paper contains a good deal of useful information as to the specific resistance of various soils and as to the resistance at the contact between the soils and cast iron, wrought iron, and lead pipes respectively. The author also gives diagrams of the effects which are produced, and of the grade of the potential on the return circuits of electric tramways. He concludes by saying that "if the water and gas companies will only work in harmony with the electric tramways, there is no need for trouble whatever." He suggests that in laying down new pipes for water and gas service they should be coated with some insulating solution, and that the joints should be made with a compound of iron filings and sulphur. This breaks up the conductivity of the line of pipes. The author adds that wood blocks have been used successfully in the jointing in one town in the States. He also refers to the false predictions of early disaster to all water-pipes, and remarks that the Brooklyn Bridge and the iron buildings in Chicago have not yet succumbed to the supposed inevitable destruction by electrolytic action. The reason for this is that the tests made were all carried out by means of voltmeters, while the actual current flowing to produce electrolysis was very small.

Electroplated Ships.—Some five years ago we made mention in our columns of an experiment to be made on a steam-tug with a view to protecting the iron hulls of ships, the protection being secured by electroplating the iron or steel with copper. The ship on which the experiment was made was in the water for about four years, and no attempt was made to clean her. On being hauled out of the water she was found to be remarkably clear from marine growth, the other tugs on the same service requiring constant cleaning. We gather from the *Western Electrician* that the report to the United States Navy Department states that the electroplating process can be carried out before fitting the plates on the frame of the ship, the time required to treat a plate being about 48 hours. The cost of electroplating is said to be about 12s. 6d. per square foot, as against £1 for the sheathing ordinarily used.

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The attendant increased weight and other disadvantages of sheathing would by this process be avoided, 20 tons of copper being needed as against 100 tons of sheathing in a vessel 250ft. long. There is no doubt, if the report is a correct one, that there are advantages to be gained from the use of this process, but to use it on a large liner, such as the "Oceanic," for instance, would be rather an expensive matter. However, if the extra friction due to fouling were overcome by this means, there would no doubt be some compensation in decreased docking expenses.

Coherer Resistance.—Mr. E. Branly recently read a paper before the Academie des Sciences on the resistance in what he calls "radio-conducteurs." As an example of the author's experiments, he took a tube filled with gold dust, the ends of which were closed with electrodes of pure gold. The diameter of the tube was 1·3mm. When newly filled the resistance before any electric action had taken place was 400 ohms. The voltage was then put on to the tube through an external resistance of three megohms. After 30 seconds with a battery of eight volts the resistance of the tube had fallen to 160 ohms. With 16 volts it fell to 81 ohms, and with 160 volts to 25 ohms. A discharge from a Wimshurst machine in the neighbourhood caused a still further reduction in the resistance, which finally fell to 6·5 ohms. When, however, the ends of the tube were touched with the two poles of the machine, the resistance augmented till it became higher than 10,000 ohms. The fall in resistance with voltage of the battery used in the first experiment was found to be more marked with a second tube filled with gold dust which had been obtained by precipitation. When, however, a tube containing peroxide of lead was used, exactly the opposite took place. For instance, the initial resistance was 630 ohms. Eight volts across the tube with a very high resistance in series increased this to 650 ohms, while an E.M.F. of 160 volts caused the resistance to rise to 2,070 ohms. In the same way a spark from a static machine further increased the resistance to 6,000 ohms. The author draws comparisons between the behaviour of the finely-divided particles in the above experiments with results he obtained with platinised glass in 1891.

Electric Lamp Renewals.—We have before us a paper read by Mr. H. L. Monroe in America on "Poor Electric Light, its Chief Cause and Remedy." The great point made by the author is that all the time electric light consumers purchase their own incandescent lamps they will burn them until the filaments give out. The result is that they have to pay a heavy price for current which only provides them with an indifferent light. This naturally tends to depreciate the value of electric lighting as compared with gas, and the author strongly recommends that lamp renewals should be done by the central-station authorities. In this case he advises that all lamps should be removed from the circuit from one to four times per annum, and replaced by new ones. The lamps removed should be examined with a photometer, and any 16-c.p. lamps not giving 13 c.p. should be destroyed. An alternative proposal is to give one new lamp in return for a definite quantity of electrical energy supplied, and the author here suggests that 12s. worth of electrical energy should entitle a consumer to one new lamp. As he does not state what price per unit he has in mind, the equivalent in electrical energy cannot be given. This plan, while offering a compensation for the use of the current, regulates the renewals on the basis of the number of lamp-hours. He claims that this supply of incandescent lamps has done more than anything else to build up the successful electric lighting business of the United States, while the opposite policy is stated to be responsible for the miserable electric lighting services to be found on the continent of Europe. In conclusion, the author reiterates his approval of electric lighting undertakers giving free lamp renewals, which should make electric lighting so good that no one could afford to do without it.

Motor Control Governors.—With all shaft governors of large size the question of regulating the governing while the engine is running becomes a somewhat complicated process. We notice in the columns of the *American Electrician* a description of an electrically-controlled governor which has been installed on the 1,350-h.p. McIntosh-Seymour engines of the Boston Electric Lighting Company. It was found, when these engines were installed, that it would be advantageous to be able to adjust their speeds slightly by means of the governor when synchronising, as this was preferable to regulating on the throttle valve. The arrangement tried at first was a loose collar on the shaft, which, in combination with a friction brake, would turn a screw and alter the tension of one of the governor springs. This device proved to be too quick in operation for sensitive adjustment. The plan now adopted is that of mounting a small motor on the hub of the flywheel and gearing it by means of a worm and wheel reduction to a screw, which tightens or loosens a governing spring. Four collector rings on the main shaft supply the motor with current, and enable it to be stopped and started in either direction. This small motor is worked from the switchboard, so that the electrical engineer in charge of the synchronising process has the step of his engines practically under control. The adjustment required is only some 2 per cent., but this can be obtained exactly by a slight adjustment of the governing spring.

The Paris Congress.—The organisation committee for the international electrical congress to be held in Paris from Aug. 18 to 25, has issued a programme giving a list of the questions which are proposed for discussion at the congress. This list covers about three columns of our contemporary *L'Industrie Electrique*, and suggests that those who attend the congress will be expected to work considerably more than the recognised eight hours per day. As will be remembered, the congress is divided up into five sections, the first of which is devoted to scientific considerations and to the discussion of apparatus for electrical measurements. In this section alone 19 subjects are put down for discussion, but this number is insignificant compared with that listed in some of the other sections in the congress. In fact, the list of subjects covers practically the whole range of electrical engineering, and all the applications of electricity to the arts. We think that the committee would have done much better to select a few problems of national interest and confine the papers and discussions to these problems. Under the present arrangement such a large diversity of common subjects are open for discussion, that no useful conclusion is likely to be reached in the majority of cases. For instance, at this date what advantage will arise from an international discussion on the comparison between alternators with moving iron and other types? Points like these are settled by the manufacturers, who alone possess the expert knowledge required for the useful discussion of such subjects, and who, as a rule, prefer to keep this information for their own use. The same thing applies to a discussion on the coupling of alternators in parallel, which subject has by now practically been worn threadbare. As we are told that a number of visits will be arranged to large works in Paris during the congress, we trust that the above suggestion of reducing the number of subjects for discussion at the meetings will be accepted by the committee. All communications respecting the congress

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and applications for membership should be addressed to Mr. Paul Janet, 14, Rue de Stael, Paris.

A Large Private Power-House.—The new power-house of Messrs. Armour and Co., of Chicago, was opened on April 20. In this power-house the steam necessary for the engines is supplied by 12 boilers of the vertical water-tube type, and having a capacity of 375 h.p., with a working pressure of 150lb. Automatic stokers are used, and coal is brought by a conveyor from a siding, and up to a crusher, whence it is taken by another conveyor into coal-bins over the boiler-room. The furnaces are fed from pendulum chutes from these bins. The ashes from the boilers are taken on small cars to the railway trucks outside the building. The outside coal conveyor is driven by a 50-h.p. motor, and the inside conveyor by a 30-h.p. motor. There are two smoke-stacks, each 225ft. high, with a 12ft. flue. The generating plant consists of three engines coupled direct to a direct-current generator, and driving an alternator by means of a rope drive from the engine flywheel. The largest engine is of the Bass-Corliss type, and is rated at 2,000 h.p. with a speed of 85 revolutions per minute. Coupled to this engine is a 12-pole 850-kw. direct-current Walker generator, which is designed to carry 1,600 amperes at 500 volts. The rope-driven alternator is a 60-cycle 1,000-volt machine with a capacity of 350 kw. The next two units are duplicates, and each consists of a 1,200 h.p. Corliss engine connected to a 500-kw. 10-pole direct-current generator. From each flywheel is driven a 180-kw. 1,100-volt 60-cycle alternator running at 600 revolutions per minute. The switchboard in the installation is 42ft. long and 8ft. high, and has 18 marble panels. The left side of the board is used for alternating current, and the right for direct current. All the voltmeters and ammeters are illuminated-dial dead-beat instruments, and they are all of the same design. The alternating-current lighting circuits supply 300 enclosed arc lamps and, at present, 7,000 incandescent lamps, although provision is made for 10,000. The incandescent lamps are of the 16-c.p. 110-volt type; and the current is therefore transformed down from 1,100 volts by 40 transformers of various sizes. The direct-current circuit furnishes current at 500 volts for some 120 motors, used on a narrow-gauge electric trolley railway used for transporting materials from one building to another. The motors total over 4,000 h.p. As would be expected from their special trade, Messrs. Armour and Co. have a large refrigerating system for meat storage, and the ammonia expansion system is used. The various generators, etc., used in the installation are well illustrated in the *Western Electrician* of Chicago.

The Power Bills.—The side issue raised before the committee of the House of Commons this week is a good example of the objections raised by municipal authorities to free trade. We refer to the remarks of the learned counsel representing the Corporation of Newcastle-on-Tyne when representing the Tyneside Bill. He explained that the streets of Newcastle were already sufficiently crowded with wires and pipes of all kinds, and that the present supply companies were supplying electric light throughout the borough. He assumed, therefore, that the new company would not offer any benefit to the ratepayers of the district, and that they only required to have the Newcastle district mentioned in the Bill in order that they might lay mains through the district to get from Wallsend, where it is proposed to place the stations for those districts west of Newcastle. He suggested, therefore, that the site of the station should be removed and that Newcastle should be struck out of the Bill. The chief argument used was that the trunk mains running through the town would do damage to the streets without any corresponding advantage being derived by the ratepayers. He quite admitted that the company were prepared to pay for damage done to the streets, but thought that additional clauses should be inserted to make the company responsible for the cost of removing the mains should any necessity arise in the future. As the committee has already decided to allow trunk mains to be carried through any district when required, the only point at issue is whether such clauses are to be introduced. The question then arises as to whether the power given by such clauses would not be used by the Corporation in order to tax the undertaking. In other words, they might result in a tariff being imposed on electricity passed through the district. The counsel compared the right to lay these trunk lines in the streets with the similar rights obtained by private routes for providing current. In that case he argued an annual rent for wayleaves was made. We trust that the committee will look at this matter in the broad-minded way which seems likely, and not allow the large power companies to be harassed by every small local authority through whose streets the trunk mains are required to pass. Otherwise if such trunk lines are to be moved at the whim of the local surveyor, or, rather, of the councils in question, a heavy tax will be imposed on those consumers who are supplied through these trunk mains. This tax would be a direct infringement of the general principles already laid down and accepted.

Variable-Speed Motors.—The number of purposes for which widely varying ranges of speed are required in commercial work is not great. The question arises as to whether, when using electric driving, these ranges of speed are best obtained by a gearing or by electrical means. In every workshop employing machine tools it is now the custom to have these tools equipped with gearing to give definite speeds according to the work being done by the tool, and, as a rule, the machines are also driven by means of belts on coned pulleys. In this case arrangements are made to suit a uniform speed of countershaft, and it must be remembered that, while a wide range of speeds is provided, there is no need to pass gradually from the maximum to the minimum speed. In the case of printing machines, on the other hand, there is that need, as, while exceedingly slow speeds are required in making good, it is necessary when all is ready to slowly accelerate the machine up to its maximum speed. For this purpose the Chatworth-Holmes system of combining a small motor for the low speeds with a large motor for the high speeds gives every satisfaction. Referring to the ordinary workshop conditions in which definite speeds are required, we notice in the *American Electrician* a proposal by Mr. L. M. Mather to provide these by varying the voltage of supply. The author proposes to run a number of wires to each motor, and to arrange the voltage between them in gradual steps. The system illustrated by Mr. Mather is not unlike the five-wire system used at Manchester, except that the voltages between the adjacent pairs of wires are not equal. In fact, the author shows these wires running to each motor. He suggests a 250 volt pressure between the two outside wires, while the voltages between adjacent pairs, commencing at one end, would be 50 volts, 25 volts, 100 volts, 50 volts, and 25 volts. By means of a suitable controller he can then obtain for each armature of the motor any voltage of supply from 25 up to 250 volts with increases in each step of only 25 volts. The field magnets, of course, would be excited always on the full voltage of the outside wires. The intermediate wires would be supplied by means of equalising motors in the same way as the middle wire in three-wire systems. The problem is one which might well be looked into from a

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commercial point of view when a large new factory is being equipped. The question for consideration is whether the extra cost of wiring and of the commutators, together with the proportional cost of the equalising motors, would cost more than the usual mechanical reduction gear. The disadvantage of the electric system compared with the mechanical is that the power of the motor would be reduced with its speed, as while the voltage at the brushes is reduced, the current capacity of the armature is not increased. It would seem, therefore, that the system, while interesting from an electrical point of view, is not likely to find favour commercially.

Magnetic Salts.—Messrs. C. Liebknecht and A. P. Wills publish in the April number of the *Physical Review* the results of some extensive experiments they have carried out to determine the magnetic susceptibility of salts of the iron group. They refer in the commencement of the article to the previous experiments of Prof. G. Wiedemann and other experimenters in Germany. The authors have carried out determinations on 36 salts of the five metals of the iron group and of copper. They laid great stress upon the procuring of the purest material possible, and all salts in which there was a danger of rapid decomposition were discarded. They have studied the solubility of salts such as fluorides, chlorides, bromides, iodides, sulphates, and nitrates, but with the method used it was not possible to carry out experiments on certain of the iron and chromium compounds. The accuracy of the results is said to vary between ·2 and ·5 per cent. The method of experimenting adopted was the zero method of Prof. du Bois, which allows very small quantities of a substance to be studied. The level of the capillary tube in the magnetic field can be so adjusted that the unmagnetic solution can be prepared with great precision, so as to be well within the limits of error in the subsequent chemical analysis. Briefly, the procedure is as follows: A conveniently strong paramagnetic solution is prepared, and then diluted with the diamagnetic solvent until the solution is unmagnetic. The practicability of the method is only limited by the susceptibility and solubility of the salt. Sometimes the method is inadmissible on this account, as, for example, in the case of potassium chromate and bichromate and of potassium and calcium permanganate. The peculiarly-constituted salts are well known to be but weakly paramagnetic; the similarly-constituted dry K_2FeO_4 proved to be much more paramagnetic; the alkali solution decomposed so quickly that the authors were prevented from making a quantitative determination. The apparatus used is described fully, the electromagnet being so devised that a field of 40,000 C.G.S. units was obtainable. The authors found that the capillary constants of non-magnetic solutions are quite unaltered in the magnetic field. This independence of surface tension under magnetic influences seems, therefore, to hold generally. On the other hand, the influence of a field of varying strength on drops of liquid susceptible to magnetism is appreciable. With the apparatus devised for determining this a number of experiments were carried out, from which the authors derive the following conclusions: Paramagnetic solutions show in a uniform field an increased rate of dropping when the magnetic force upon the liquid column acts downwards; through diminution of the pressure, the (original) rate being again approximately established, the weight of the drop suffers no change. On the other hand, the authors observed an enlargement of the drop in a non-uniform field; the form of the drop is then changed and depends upon the particular distribution of the field as regards the sense and manner in which it happens. The experiments confirm Quincke's results and conclusions. The actual values obtained for the magnetic susceptibility of the various salts experimented with are given in tabular form, and are too extensive for individual mention here.

Experimental Trains.—After the ridicule which was thrown on the trials made by the Metropolitan District Railway Company between Kensington High-street and Earl's Court, on the ground that any further trials with electric traction were quite uncalled for, it is interesting to note that in the United States they are still experimenting on this subject. Thus, during the past month competitive tests have been made by the Boston Elevated Railroad Company in order to decide which kind of apparatus is most suitable for working the new lines. There are three systems competing—viz., the Sprague multiple-unit, the Westinghouse electro-pneumatic, and the General Electric master-controller system. A portion of the line was fitted with a third rail, and the tests were begun on April 3. In addition to the tests of controlling systems, three kinds of air brakes were tried, and also five types of electric heaters. Each train consisted of four cars, one car on each train being a standard type of passenger coach. The Sprague and General Electric Companies used flat cars for the other three, the Westinghouse Company using one flat car, and two other passenger cars, in addition to the Boston Elevated car. All the trains were loaded with ballast to the weight of 30 tons. Each car in the trains was fitted with two motors mounted on a special truck made to the specification of the railroad company. In this truck the two motors are supported outside the axles, in a frame hung on the axles. The springs supporting the car are kept quite free from the motor spring support. All the motors were geared for a speed of about 40 miles per hour. The instruments were mounted in the passenger car, and consisted of a voltmeter, ammeter, and a revolution counter. This last was worked electrically, and was connected to a contact on a drum on one of the axles of the motorless truck. In addition, there was a bell which was worked by a clock every two seconds. All instruments were read at each stroke of the bell. At every 100ft. were red flags, and the train was timed by an operator on passing these. The route was about 6,000ft. long, and there were five stations. Runs were made with one car alone, and with two, three, and four cars in order to obtain comparative results of current and acceleration over the same part of the route with one car and with several, and thus determine any inequality in the division of the work between the cars. The steepest grade the cars were made to climb was 8 per cent., there also being a curve at the bottom of the grade. The master-controller system of the General Electric Company is a new one. In it the main controller of each car consists of a series of solenoids, each operating a contact with a magnetic blow-out, or accomplishing the same purpose as the contacts on ordinary hand-operated controllers. There is one of these controllers under each car body. On each platform is a master controller of the usual form, but of small size, which simply closes and opens the circuits of the main controller. The General Electric magnetic controllers open on any cessation of current, differing from the Westinghouse Company's apparatus in this respect. The General Electric controllers, however, come back into position directly the current is again flowing. The Westinghouse controlling apparatus has been also considerably improved. The trains in the tests ran at 800 to 1,000 amperes per car, or from 3,200 to 4,000 amperes per train when going on parallel. The load will probably be a very fluctuating one, and to meet this it is proposed to instal two 1,500 kilowatt-hour storage batteries in substations near each end of the route.

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MESSRS. FERRANTI'S HOLLINWOOD WORKS.

The object of the following article is not so much to describe the organisation and equipment of Messrs. Ferranti's Hollinwood works as to detail some of the principal products of the same. To the electrical fraternity the name Ferranti is so well known as to render any further introduction here quite superfluous. Nor is the important part played by Mr. Ferranti in the modern development of the electrical industry in this country known to a lesser degree. It was he who during the earlier days of electric lighting so strenuously insisted upon the economy of transmitting electric currents over long distances at high pressures, and the Deptford station may be instanced as the practical outcome of this theory, a theory, by-the-bye, much criticised at the time, but which experience has since proved to have been substantially correct. Its soundness might, indeed, have waited much longer for verification had it not been combined with inventive genius of no mean order. To the happy combination of these two gifts in one master mind the industry owes many efficient

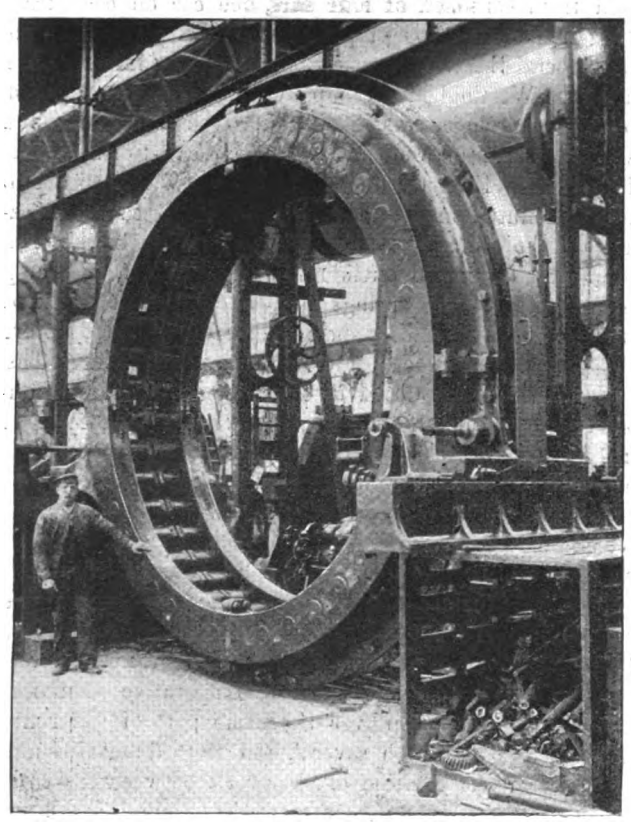

FIG. 1.

designs of machinery and other apparatus used in connection with central-station work. But, great as may have been the development in the practical application of electricity for lighting and power purposes during recent years, the evolution in the designs of the generating and other apparatus involved has certainly been none the less so. Take the Ferranti rectifier as a random example. This piece of apparatus is frequently described as being of the "well-known Ferranti type," but the impression conveyed by these words to the mind of the individual reader may be very misleading. To one they might recall the constructional details of the rectifiers originally installed at Portsmouth, while the type supplied later to the Blackpool Corporation might be mentally conceived by another mind, and so on. The point is, however, that neither of these conceptions would yield an up-to-date picture of a Ferranti rectifier. Since the original plant at Portsmouth was put down the evolution of the rectifier has been rapid, until at the present date, as the outcome of practical experience, a type differing very considerably in form and attaining to a far higher degree of perfection has been evolved. What may be said in this respect with regard to the rectifier also applies to the various other machines and apparatus of the Ferranti design, for although as perfect originally as the limited experience of the day could make them, that perfection was far inferior to what has since been rendered possible by modification of the original designs suggested by intelligent deductions from extended experience. This continual endeavour towards perfection in detail has resulted in what may be termed "standard designs," differing more or less from the original models. As a matter of fact, these designs are not only "standards" in Messrs. Ferranti's works, but may be found as such all over the country, a stage in the perfecting of details having been reached by the firm at which consulting engineers are content to take the designs offered them without attempting to introduce modifications of their own. This perfecting of detail has been applied alike to generators, engines, switch gear, rectifiers, transformers, meters, etc., by Messrs. Ferranti. Hence our excuse, if one be needed, for dealing at some length with the principal and latest productions of the Hollinwood works. It may be mentioned incidentally that the firm has grown from comparatively small beginnings. For some years the works of the company were situated in

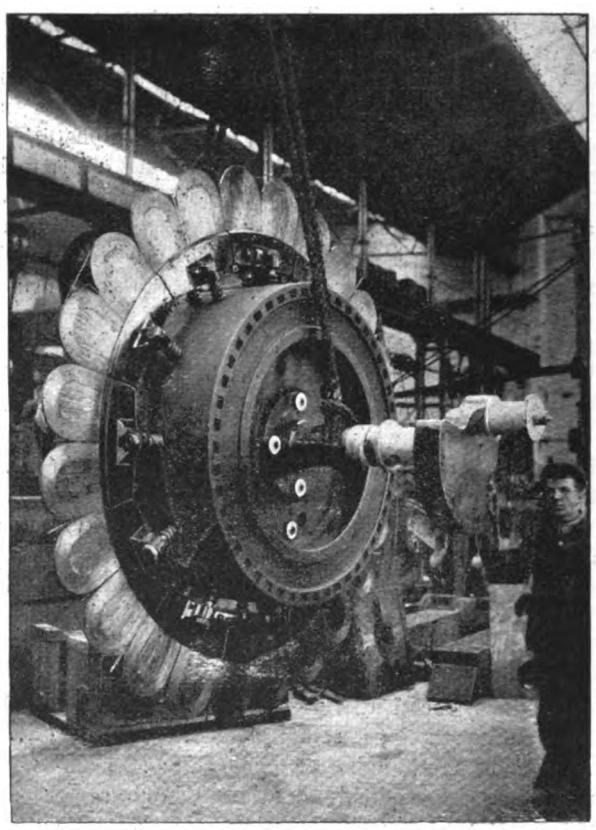

FIG. 2.

Charterhouse-square, London. Finding, however, the growth of their business rapidly overtaking the capacity and conveniences of this site, the company were compelled to look further afield. The urgency of the situation precluded any possibility of erecting new works, but premises were discovered at Hollinwood, near Manchester, which were eminently adapted to the requirements of the undertaking. These are the premises at present occupied by the company, and comprise some splendid, roomy, well-lighted shops, as will be seen later on. There is also ample room for future extensions. An old proverb says "Nothing succeeds like success," and we find its truth verified here, for as compared with a maximum of from 300 to 400 workpeople formerly employed at Charterhouse-square, the Hollinwood works can boast upwards of 1,000 hands.

Entering the works, we may first of all take a brief survey of what may be termed the feeders of the establishments. These comprise a pattern shop, where pattern-making is in full swing, a foundry, which provides all the brass castings required by the switchboard and meter departments, etc., and a smithy, which executes light forgings and the bending, punching, or fashioning of plates used for constructional work. Proceeding we come

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to a large well-lighted shop which presents a picture of activity. Numerous machine tools and lathes of the lighter order are engaged here in fashioning special tools for the works' needs. In this respect it is interesting to remark that the works are self-contained, all the special tools required being manufactured on the premises. Turning to the machine tools and lathes contained in this shop, it is seen that they comprise the very latest designs for their respective purposes. The machines of similar type are grouped in parallel rows across the shop, a line of countershafting driven by an electric motor at one end supplying the requisite driving power to each group. This systematic arrangement of lathes, machine and automatic tools is observed throughout, scattering being carefully avoided. Higher up in the same shop are arranged the automatic tools engaged in turning out standard screws and meter parts. These, like some of the lighter tools previously mentioned, are of American design, and represent the latest development of this class of tool, a few remarks with regard to the manner in which its various parts are made and assembled may prove interesting. It is also appropriate that we should deal first of all with the meter department, since in it is conducted the most delicate work of which it is possible to conceive in a great engineering establishment such as the one under notice, the delicate clockwork constituting one of the meter's essential parts being in striking contrast with some of the huge components of the Ferranti engines and alternators which are seen in another department.

The outside cases, inside sockets, pole-pieces, train carriers, terminals, washers, and mercury rings of the meter are machined and fitted in the first place, and when completed put away in separate compartments of a store adjoining the department, the aim being to have a stock of parts in hand for never less than 2,000 meters. The coils are wound on small lathes, and stored in a similar manner to the other parts, ready to be drawn from at a moment's notice. As the average output of meters from the works

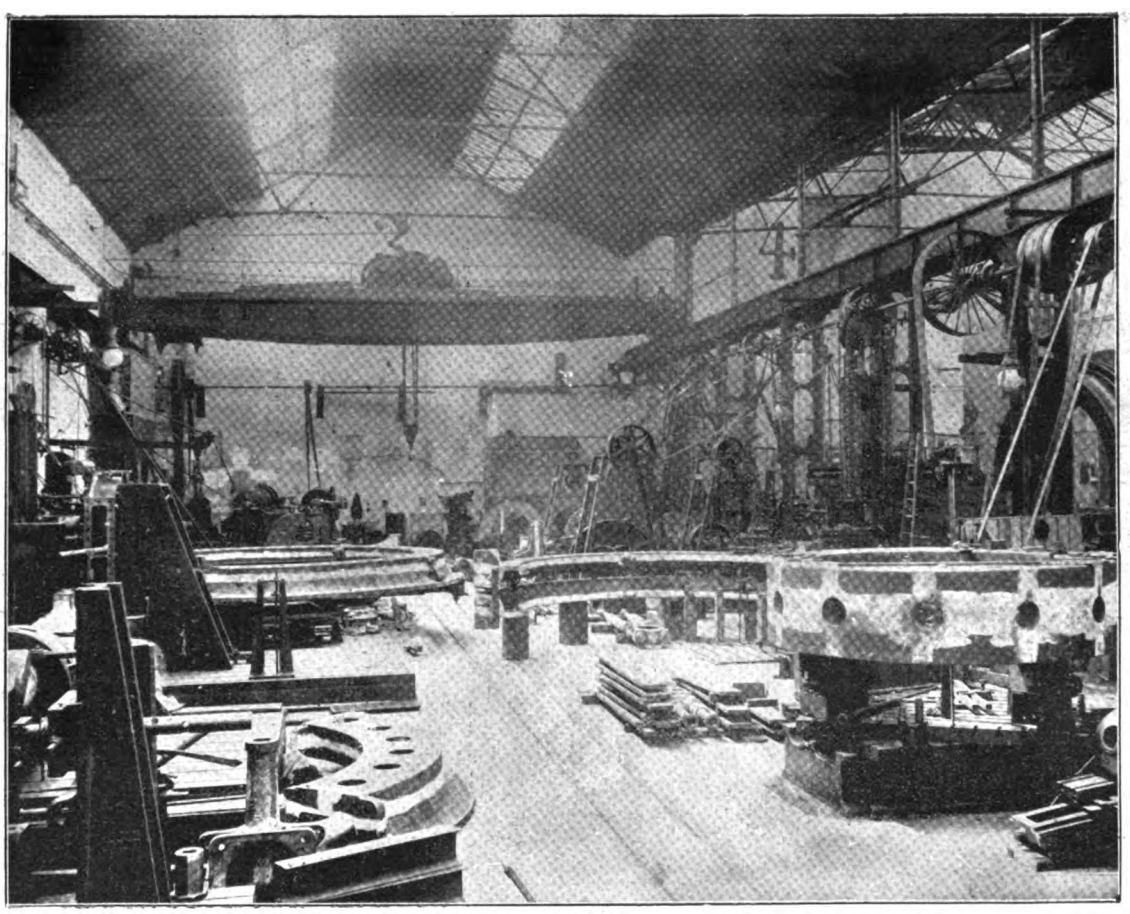

FIG. 3.

being entirely automatic in action and safe to leave unattended after a supply of solid bar or hollow brass tubing, as the case may be, has been fed to them. We obtain a practical illustration here as to the only means of successfully meeting American and German competition. It is to be regretted that British toolmakers have been left so far behind in the race to provide automatic tools for light work of this nature, though some consolation may be found in the fact that home manufacturers still maintain their supremacy where machine tools of a heavier type are concerned. Messrs. Ferranti, Limited, are certainly to be commended on their policy of adopting the very latest and best tools in each class irrespective of cost or origin. Proceeding further, we arrive at one of the most interesting and important departments of the works—namely, the department in which the well-known Ferranti meter is manufactured. It will be unnecessary to enlarge upon the completed meter considering the many descriptions of the same which have already appeared in these columns and elsewhere, and considering further that the instrument was long since standardised, and has consequently undergone no essential modification in design. However, is 250 per week, this stock must be continually replenished, and the machines are therefore constantly employed. We now pass to the fitting up of the smaller and more delicate parts of the meter—*i.e.*, the trains, fans, mercury baths, dials, hands—etc., the whole of which are fitted by skilled watchmakers, the gear wheels, spindles, pivots, and jewel holes being made and machined on high-class watchmaking machinery, electrically driven, capable of turning out 2,000 complete trains per week. All these machines are worked by girls, supervised by a skilled mechanic. The whole of the screws, dial distance pieces, etc., are made on the premises by the automatic machinery previously mentioned, which is also electrically driven. The spindle of the meter has a specially selected hard sapphire-jewelled bearing at the bottom and a ruby bearing at the top. The pole-pieces are pressed into the bottom washers by means of hydraulic presses capable of exerting a pressure of 25 tons. From the watchmakers, some of whom fix all the parts together, thus making the complete instrument without the outside case, the meters are handed over to the testers, who test a daily average of 400.

An interesting feature in connection with the testing of

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these meters is the stamping of distinguishing numbers on the back wheels of the train, which so simplifies the testing that two testers are capable of dealing, if necessary, with 1,000 meters of all sizes varying from 5 to 600 amperes per day. In order to ensure steadiness the requisite current is obtained from a battery of accumulators, and is measured by means of standard ampere-balances. From the testing tables the meters when adjusted are passed on and put into their outside cases, after which operation they are again checked before being handed over to the packers to be sent out. It is also interesting to note that all the mercury necessary for the working of these meters is purified on the premises, 800lb. to 1,000lb. of mercury being dealt with per week. In connection with the department there is an experimental laboratory, in which two electricians are constantly employed. The ammeters which are supplied with Messrs. S. Z. de Ferranti's panel switchboards are also fitted up and calibrated in this department, the alternating current, both for experimental purposes and for calibrating, being obtained from two Ferranti copper-type alternators (arranged to give any periodicity from 40 to 120), driven by a direct-current motor, the before-mentioned accumulators also supplying the power for this. A record is kept of the history of each individual meter, and its whole life can be ascertained at a glance. The office where these records are kept, and the forwarding department, are quite close to the machinery, thus making this particular department entirely self-contained, and quite independent from any other portion of the factory, except its supply of energy for driving the machine motors and for charging the accumulators. At the time of our visit to the works there were about 700 meters banked up for testing in the room set apart for that purpose, a large number of all sizes being kept in hand to avoid delay in executing orders. We were greatly impressed both by the thoroughness of the work executed in this department and the admirable organisation which prevailed.

In the order of progression from the most delicate to the most imposing productions of the Hollinwood works, it would be most appropriate to deal now with the switch and rectifier departments, but lest the reader should obtain a misleading impression as to the extent of the works, and by way of better contrast, we will proceed to the main erecting shops, in which much of interest is to be noted. Here there are huge Ferranti alternators of two distinctive types in various stages of completion, together with the engines destined to drive them. But before describing the machines under construction a glance may be given to the shops containing respectively the light planing machines and heavy machines, lathes, etc., which deal with the rough forgings as they are taken from stock to build up machines on order. These various shops and departments are interconnected by a complete system of light railways, besides being served by electrically-driven overhead travelling cranes. Thus an alternative means of transport from one position to another is provided. The system adopted by Messrs. Ferranti, Limited, is to anticipate orders, hence

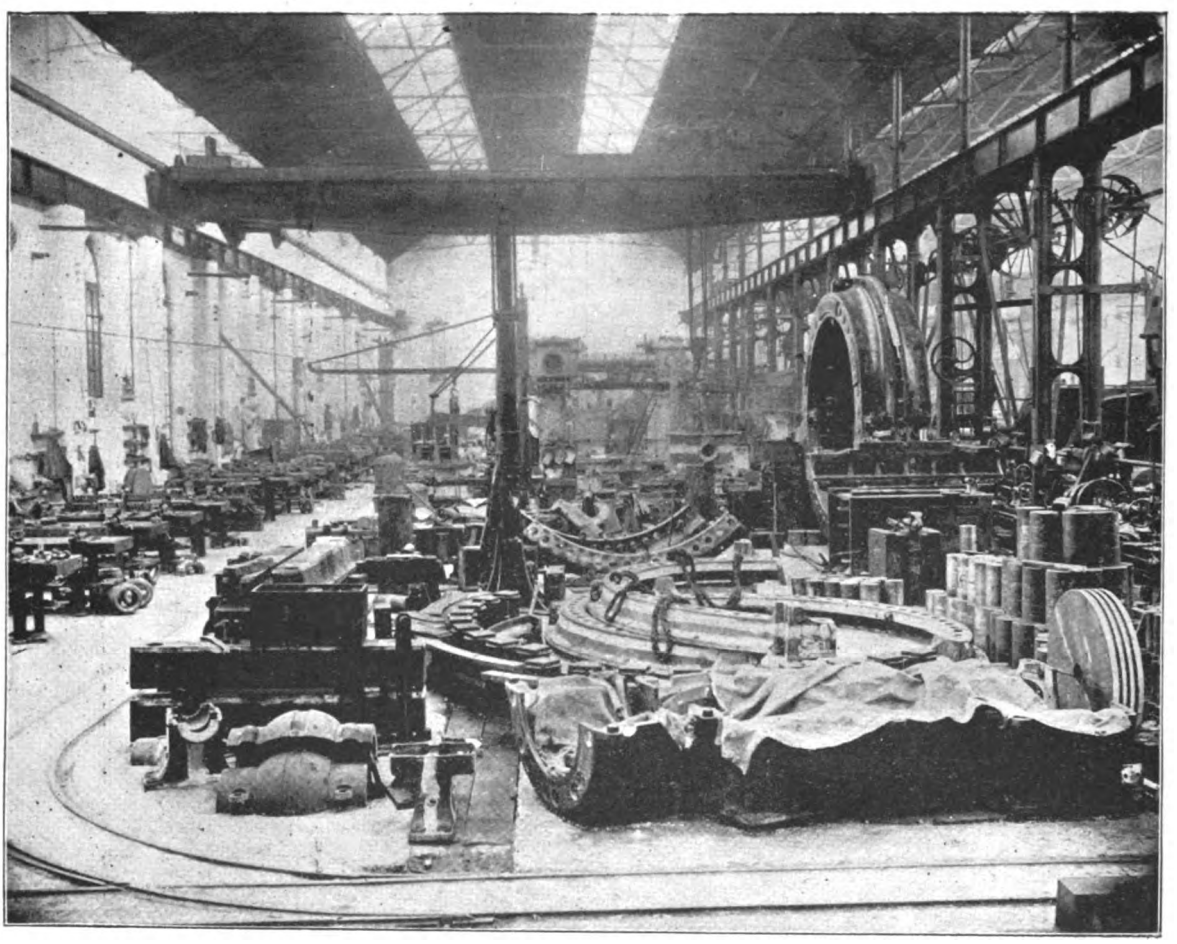

Fig. 4.

stocks of the component parts which go to make up the several standard sizes of engines and alternators manufactured by the firm are kept on hand. Thus it is that there is in one place a stock of base-plates, in another a row of various sized crankshafts, spindles, etc., and in yet another a group of cylinders, all being in the rough, ready for planing, turning, or boring, as the case may be, and subsequent erection into the whole of which they are merely parts. Amongst the machines under construction may be mentioned two 1,200-kw. steam sets destined for West Ham, three 1,000-kw. sets for Islington, and others for Manchester, etc. One of the 1,200-kw. sets was being tested under steam at the time of our visit, the alternator working on a water resistance. On such occasions a hitch generally occurs, especially if a Press representative happens to be present, but in justice to the Hollinwood staff it must be recorded that no such hitch occurred in this case, the machine running steadily throughout and without appreciable vibration.

The earlier forms of the now well-known Ferranti alternator were so totally different from the machine as it is now, that in giving a short description of these alternators

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it would be of little interest to mention any other than those of up-to-date manufacture. The modern form of Ferranti alternator can be distinctly divided into two classes—those with stationary armatures, and those with revolving armatures. Amongst the advantages of the former class may be mentioned the ease and safety with which the revolving portion can be constructed, the facility in winding the armature for single, two, or three phase, and the completeness with which it can be insulated from the core; whilst the latter claims advantages from its revolving armature being able to run at a higher peripheral speed than the corresponding field magnet, and also from the ease and quickness with which a coil can be replaced by a new one in case of failure. The construction of the revolving-armature type has been especially successful in the hands of Mr. Ferranti, and alternators from 100 kw. to 1,500 kw. capacity, of varying voltage up to 11,000, made on this principle have been running satisfactorily for the past 10 years, and for single-phase distribution can be compared most favourably with the revolving-field type. Of the revolving-armature type, the most noteworthy examples are, of course, the well-known Deptford machines, representing a total of 7,500 kw. One of these has an output of 1,500 kw. at 11,000 volts, its armature being connected up in two parallel halves. A later machine of 650 kw. and 11,000 volts has its armature connected up in series, but so arranged that the greatest difference of potential between any two adjacent coils does not exceed 5,000 volts, and these two coils are themselves separated by a space which is filled up by blank coils so as to prevent any risk of failure. The field-magnet frame of this machine is very clearly shown in Fig. 1. In Fig. 2 is shown the armature of a 200-kw. plant, being one of the smallest size that is now turned out. The accompanying illustration (Fig. 3) of No. 3 shop in the Hollinwood works shows on the left a frame having its pole holes bored out ready to receive the magnets, and on the right in the foreground a flywheel for a 1,200-kw. alternator, and further back another view of a field frame. Fig. 4 shows frames in various stages of progress, and in the distance a 1,600-h.p. engine in course of erection, for driving a 1,000-kw. 3,000-volt alternator. A very fine example of the stationary armature is illustrated in Fig. 5, which shows the armature of one of four 600-kw. single-phase machines, of which one has just been erected at Paisley, while the remaining three are in course of erection at Islington. It represents a machine having a diameter on the armature face of 18ft. with 64 poles and running at 94 revolutions per minute, being thus probably of a larger diameter than any other machine yet built. A point worth mentioning is that the armature as shown has been so constructed that it can be wound for two or three phase distribution without any alteration other than the number of groups of winding. One of the first slow-speed alternators of this class that was made in England has been running at Portsmouth without any trouble since 1894, giving an output of 212 kw. at 96 revolutions.

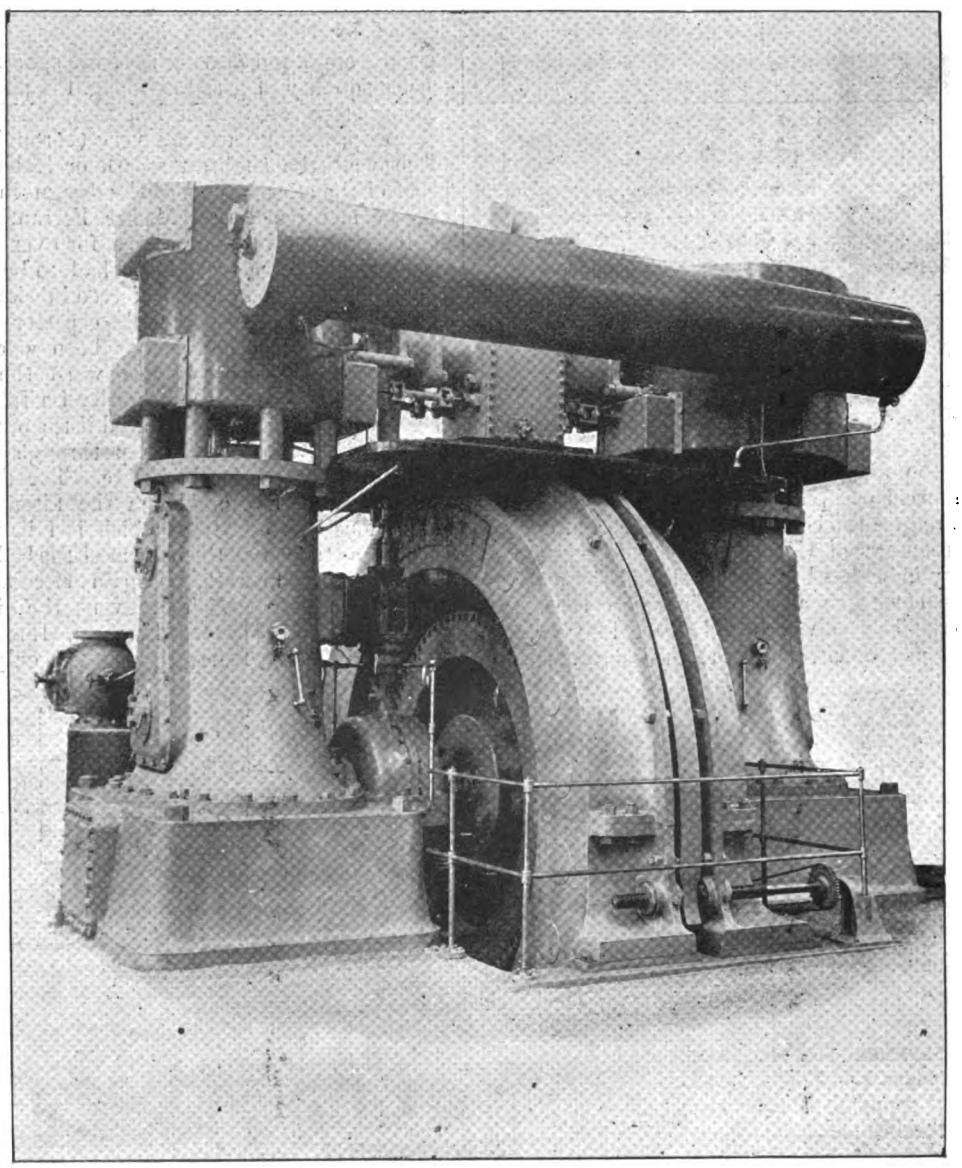

FIG. 6.

The engines now supplied by Messrs. Ferranti, Limited, to drive these alternators are almost exclusively of the vertical compound type, of which that undergoing tests in one of the erecting shops at Hollinwood, to which we have previously referred, is a typical example. Fig. 6

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gives a good idea of the general appearance of this set, while Fig. 7 shows the details of the same. The engines of this type run at medium speeds, and have several special features, as will be seen from the accompanying drawing, particularly as regards valve gear. The object of the design is to attain the economy of Corliss engines combined with the possibility of much

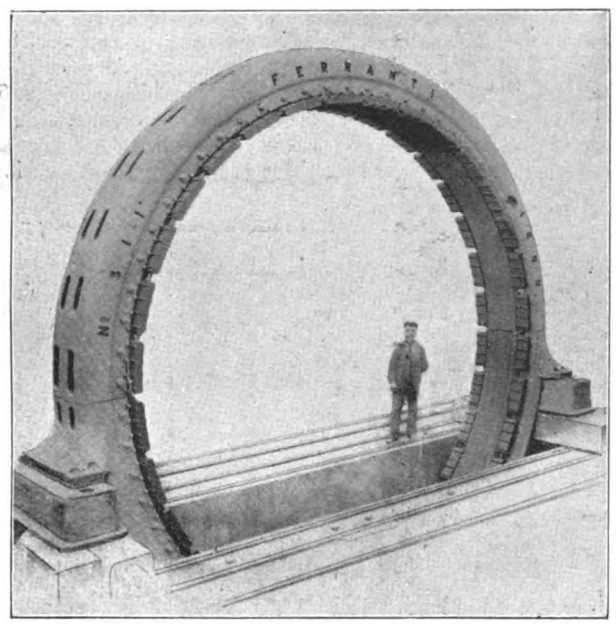

FIG. 5.

higher speeds, the advantage of high speed being to reduce the floor space occupied, to give more even turning moment, and to reduce the cost of the dynamo and engine. To obtain the economy of Corliss engines the system of four valves per cylinder has been adopted, and these valves are placed in the covers so as to minimise clearance surfaces and spaces. The valves are of the grid type, and have a very short movement, and as the valve gear is only worked at half the speed of the engine, the surface speed of the valve faces is very low indeed, consequently the wear and tear is low. The valves are actuated direct from cams, the latter being so designed as to give a constant distance between the cam rollers, thus making it possible to work with fixed rollers, and making the motion quite independent of springs, and therefore quite positive. The cams are arranged on vertical shafts working in a completely enclosed box, which will be seen from the accompanying illustrations to stand midway between the cylinders. This box is filled with oil, consequently the whole of the valve gear works absolutely immersed in oil. This feature has a very important bearing on the satisfactory working of cam gears, and, further, it leaves no part of the valve gear to be oiled by the engine attendant. The connection between the cam and valve is a direct one, thus there need be no joints to wear, and, as will be seen from Fig. 6, the external valve gear is extremely simple. The cam shafts are driven by means of cut gearing from the crankshaft, and each wheel is arranged to run in an enclosed casing containing oil, thus eliminating any question of their lubrication. As regards governing, the governor can be either arranged to vary the "cut-off" automatically or to act on a throttle valve, in which latter case the cut-off can be made either adjustable by hand or fixed. Turning to the main parts of the engine, we may say that these are on the whole of ordinary construction similar to those usually adopted in marine practice, except that the crank-pin bearing is of the spherical type so as to ensure equality of pressure along the pins; also the main bearing steps rest in spherical seats with the same object. The reciprocating parts are very thoroughly enclosed so as to prevent the slightest splash or leakage of oil, and in proof of the effectiveness of the design in this direction, it may be mentioned that Messrs. Ferranti, Limited, had an engine running in their shops for over six weeks, during which period not a pint of oil had to be added except for the cylinders. A system of forced lubrication is employed, the oil-pumps being of ample capacity to give sufficient pressure after the engine has been a considerable time running, and in consequence worn the bearings rather slack. This removes the necessity for frequent adjustment of bearings which is experienced if the pump is small. The oil is forced from the pump through a filter which is arranged in the engine bed-plate. The door of this filter will be seen in Fig. 6. From the filter the oil passes to the various bearings, from which it falls into the bed-plate through a strainer at the bottom of the bed-plate into a tank below, from which it is again circulated through the filter to the bearings. To prevent the oil creeping along the crankshaft, Messrs. Ferranti, Limited, arrange oil throwers in series, believing that the only effective way to prevent creeping of the oil is to see that the last thrower has only to deal with such small quantities of oil as may have escaped past the preceding thrower. In connection with electrical work the matter of keeping oil away from the dynamo is of the utmost importance, quite apart from the point of view of cleanliness and avoidance of waste, while it is further to be remembered that oil damages concrete foundations.

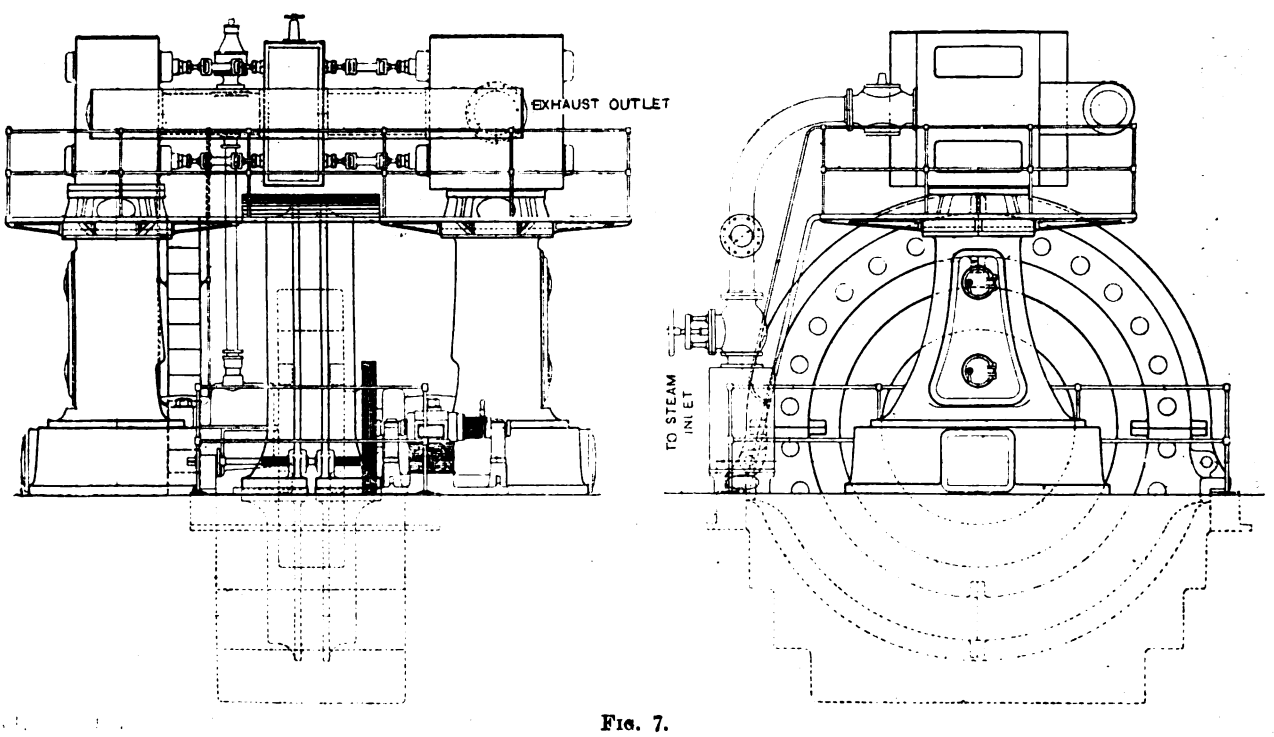

FIG. 7.

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Before leaving the main erecting shops we must again comment upon the admirable organisation which seems to pervade the whole establishment. Here, as elsewhere in the factory, a place is allotted for everything, hence there is no apparent confusion, and there is not seen machines of various sizes and types indiscriminately mixed up. The rough material enters at one end of a shop, and after working round, leaves in the shape of a finished article at the other end.

(To be continued.)

ELECTRICITY APPLIED TO MINING *

BY HAROLD BENTHAM.

(Concluded from page 672.)

Motors, etc.—Motors and apparatus for starting, stopping, and reversing same. The usual practice is to keep all the big motors near the pit bottom, using the smaller ones further out in the workings. They are sometimes geared down by spur gearing similar to Figs. 4 and 5, or by belt gearing from the motor to the intermediate shaft, the next reduction in gear being by spur gearing, as in the first case.

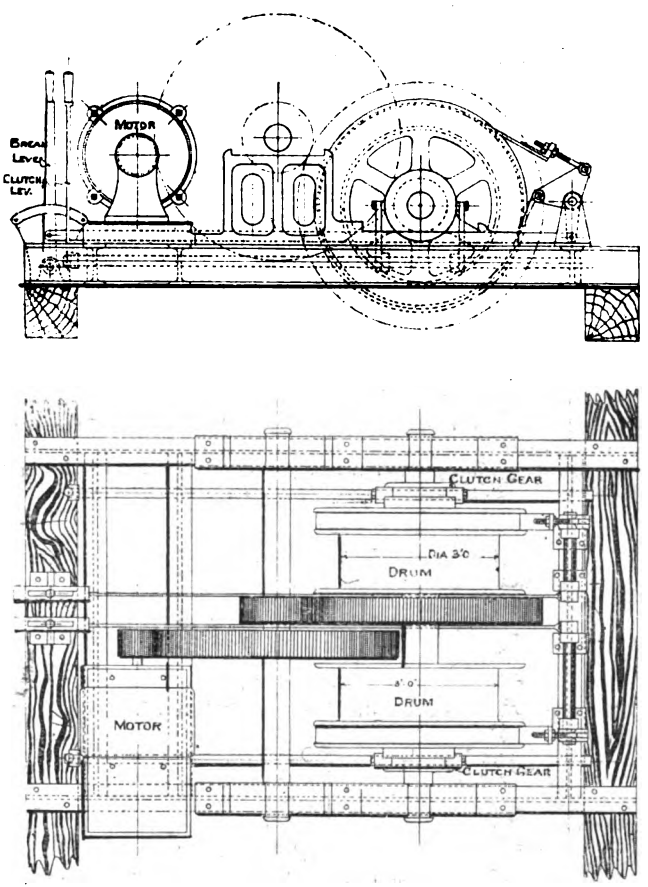

FIG. 4.—Electrically-Driven 25-h.p. Hauling Gear.

My opinion is that, whenever possible, a belt should be used from the motor to the intermediate shaft, for the following reason. Supposing, for instance, there is a fall of roof in the mine, the next train of tubs jump the rails owing to the *débris* on the rails, and usually overturn. This very often stops the motor if it is not well above its work; the result is that if the fuse does not blow, some of the armature coils burn out. If belt driving is adopted, on the first motion the belt would come off immediately the rope drum stopped rotating. This would cause delay, but not so long a stoppage as would be occasioned by the changing of a burnt-out armature for a duplicate. The above mishap is of very frequent occurrence at mines where the electrician is of the jack-of-all-trades' description, or it may happen that the driver of the motor, seeing the fuse blow, will insert fuses of larger current capacity until he burns out the armature by trying to start on an overload. All motors on the surface (with the exception of the fan motor) must be of the enclosed type, similar to those used in the pit bottom. It is only necessary to have the motors used in the workings of the mine of the enclosed airtight description. The motors must be supplied with the necessary equipment for starting, stopping, reversing, etc. These are usually mounted on a slate slab close to the motor, and consist of an ammeter, reversing switch or switches, regulating switch

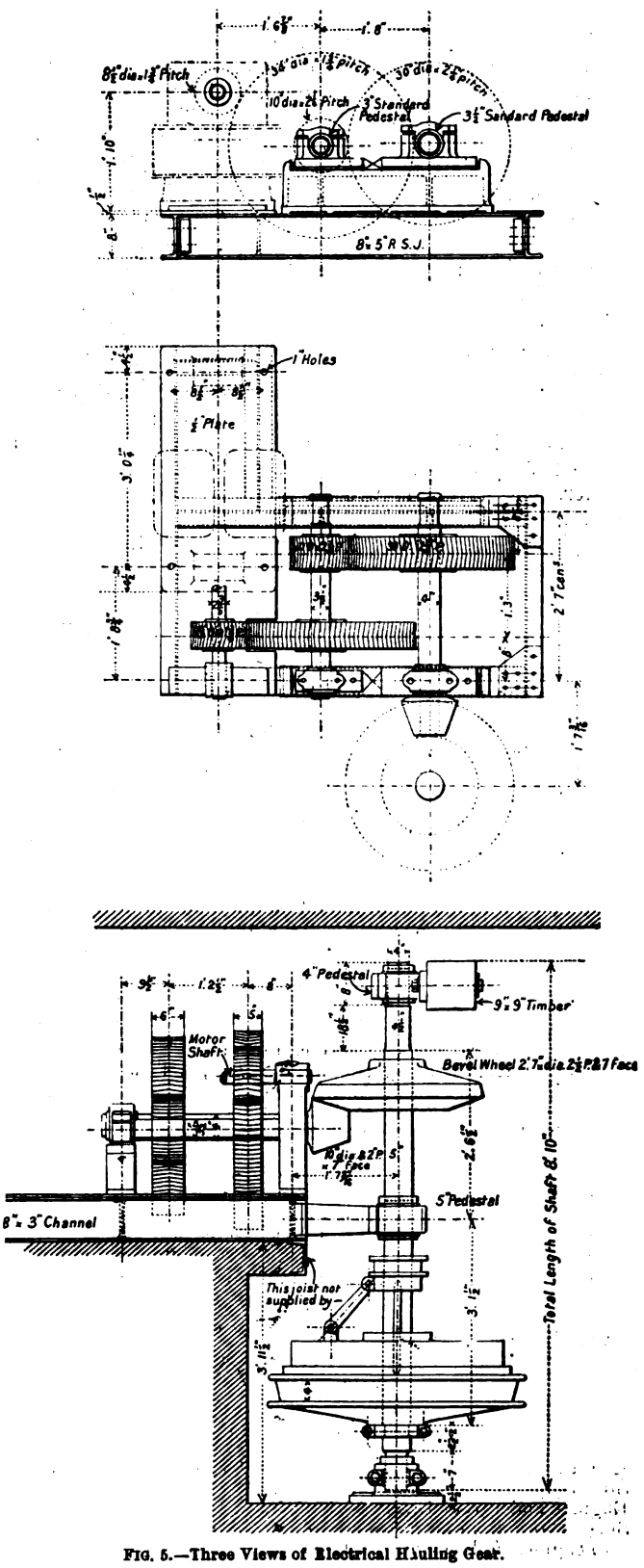

FIG. 5.—Three Views of Electrical Hauling Gear.

and resistance, also the necessary fuses. When the motors are not in the workings, the main switch and fuses are enclosed in the same airtight case as the motor, in order to prevent any chance of explosion. The fuses, when mounted on slate, ought to be enclosed in an airtight cast-iron case, or the cast-iron case should be fitted with a gauze cover similar to what are used in the ordinary safety lamps.

* Paper read before the Manchester Society of Junior Electrical Engineers.

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The fuse will then work on the same principle as the safety lamp, thereby excluding all danger.

Electric Coal-Cutters.—Electric coal-cutters are mounted on a trolley, and consist of motor with the necessary gear running in oil, starting switch, etc., in one airtight case, otherwise it would be dangerous, owing to the occasional presence of gas in the mine. The cutter itself is usually of the rotary type.

Section 1(c).—Comparison of First Costs and Efficiencies, together with Comparison of Working Costs.

In the following tables I have compared the relative first costs and also the working costs of electric power *versus* steam power, where steam is taken down the mine, the engines being fixed in the pit bottom. The reason for my taking the latter is because I think that is the only method of power driving which is at all likely to rival electricity in economy or first cost. Taking a mine where the engines are on the surface, the percentage loss due to condensation is not nearly so great as when the hauling engines are in the pit bottom; but this is more than compensated for by the additional load on the engines, due to the extra weight of rope, increased friction, and the extra periodical cost of new rope. Again, supposing the compressed-air system is employed. The first cost in this case would equal or greatly exceed the first cost of the electric power plant, depending on the distance the power is transmitted; secondly, the efficiency of compressed air power transmission rarely exceeds 30 per cent. of the total power developed in the boiler. Therefore it will be seen that next to electric power comes steam, when the steam-engines are placed in the pit bottom. I have not allowed in Table I. for the cost of coal-cutting machinery, as it would be impossible to use coal-cutters where steam plant is employed, and it would hardly be fair to saddle one system with costs which have no equivalent on the other side. It must also be borne in mind that these tables are comparative:

TABLE I.—Comparison of First Costs.

Steam Plant.

Assume buildings, foundations, etc., same in both cases.	Same.
Steam-engines and accessories for screens	£500
,, ,, ,, ,, coal washing	1,000
,, ,, ,, ,, fan	500
,, ,, ,, ,, joiners' shop	120
,, ,, ,, ,, fitting shop	120
,, ,, ,, ,, feed pumps	300
,, ,, ,, ,, draining mine	300
,, ,, ,, ,, hauling	1 600
Cost of piping, also the erection and covering of same, on the surface and down the mine	1 500
Additional boiler, as shewn by Table II.	500
	£6,440

Electric Plant.

Assume buildings, foundations, etc., same in both cases.	Same.
Central station, including engines, dynamos, and switchboard	£7,000
Cost of cable and laying of same	1,500
Motors with starting apparatus for screens	400
,, ,, ,, ,, ,, coal washing	800
,, ,, ,, ,, ,, fan	400
,, ,, ,, ,, ,, joiners' shop	100
,, ,, ,, ,, ,, fitting shop	100
,, ,, ,, ,, ,, feed pumps	200
,, ,, ,, ,, ,, draining mine	200
,, ,, ,, ,, ,, hauling	1,200
	£11,900

TABLE II.—Comparison of Efficiencies, also Total Boiler Capacity required in Horse-Power.

Steam Plant.

	Efficiency. Per cent.	B.H.P. required.	Total H.P. to be generated in boilers to allow for losses.
Engines on surface	85	550	924
Steam-pipes on surface	70	—	—
Engines underground	85	450	1,058
Steam-pipes from surface to engines in the mine	50	—	—
Total horse-power		1,000	1,982

Electric Plant

Motors	90	—	—
Average loss on line	95	1,000	1,528
Generators	90	—	—
Engines	85	—	—
Total horse-power		1,000	1,528

This shows a difference of 454 h.p. required in boiler capacity.

TABLE III.—Weekly Coal Consumption.

Steam Plant.

Total H.P. generated in boilers.	Lbs. of coal per H.P. per hour.	No. of working hours per week.	Tons of coal consumed per week.
1,982	5	80	353

Electric Plant.

1,528	5	80	272

Showing a difference of 81 tons per week in the coal consumption, which would require an additional stoker per shift.

TABLE IV.—Daily Wages Sheet.

Steam Plant.

Where working.	How employed.	No. of shifts per day	No. of men per shift.	Rate per shift.	Total.
Engineer	Engineer	1	1	10s.	£0 10 0
Engine repairs	Fitter	1	3	6s. 6d.	0 19 6
Screening plant	Engine attendant	2	2	4s. 6d.	0 10 0
Coal washing	,, ,,	1	2	4s. 6d.	0 9 0
Fan	,, ,,	2	1	5s.	0 10 0
Fitting shop and joiners' shop	,, ,,	1	1 boy	3s.	0 3 0
Draining mine	,, ,,	1	1 ,,	5s.	0 5 0
Hauling engines	,, ,,	3	3 ,,	6s.	2 14 0
Labourers	Fitters' labourers	1	3 ,,	3s. 6d.	0 10 6
Additional stoker	Stoking	3	1 ,,	4s.	0 12 0
					£7 11 0

Electric Plant.

Electrician	Electrician	1	1	10s.	£0 10 0
Constant electrician	,,	1	1	7s.	0 7 0
Central station	Engine attendant	3	1 boy	5s.	0 15 0
Central station	Switchboard	3	1	3s.	0 9 0
Screening plant	Motor attendant	2	1	4s. 6d.	0 9 0
Coal washing	,, ,	1	1	4s. 6d.	0 4 6
Fan and draining mine	,, ,,	2	1	5s.	0 10 6
Fitting shop and joiners' shop	,, ,,	1	1 boy	3s.	0 3 0
Hauling plant	,, ,,	3	3 youths	4s.	1 16 0
Labourers	Elec. labourer	1	1	3s. 6d.	0 3 6
					£5 7 0

The difference in cost for steam raising only is shown here, and not the total cost.

TABLE V.—Difference in Weekly Costs.

Steam Plant.

	Per week.	Per year of 50 weeks.
Stores, oil, waste, etc., assume same in both cases	Same.	
Coal, 353 tons at 5s. per ton	£88 5 0	£4 412 10 0
Wages (Table IV.)	7 11 0	377 10 0
	£95 16 0	£4,790 0 0

Electric Plant.

Stores, oil, waste, etc, assume same in both cases	Same.	
Coal, 272 tons at 5s. per ton	68 0 0	3,400 0 0
Wages (Table IV.)	5 7 0	267 10 0
	£73 7 0	£3,667 10 0

Showing a total yearly reduction of £1,122. 10s. in the working expenses.

TABLE VI.—Result of One Year's Working.

Steam Plant.		*Electric Plant.*	
Interest on capital of £6,440 at 5 per cent.	£322 0	Interest on capital of £11,900 at 5 per cent.	£595 0
Depreciation at 10 per cent. per annum	644 0	Depreciation at 10 per cent. per annum	1,190 0
Working expenses	4,790 0	Working expenses	3,667 10
	£5,756 0		£5,452 10

The above result shows that after paying off the interest at 5 per cent. and depreciation at 10 per cent. on the increased capital, there remains a balance of £303 per annum in favour of electric working.

Section 2.—Lighting.

It is preferable to keep the colliery lighting quite independent of the power plant for the following reasons: (1) It would necessitate running the incandescent lamps in series if they were tapped on to the proper mains, and if one clamp failed all the batch would immediately go out, which is a great disadvantage, as each batch of lamps placed in series would usually be placed near together. (2) The lamps would give a very perceptible flicker every time a motor was switched on; this might cause great inconvenience and even danger. The only remedy for this is to keep the circuits quite distinct and run the lighting plant at, say, 200 volts. This may be done by employing a separate engine and dynamo, or by a motor-generator driven from the power plant.

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Cables.—All colliery surface cables or wires of my acquaintance used for lighting are run on the overhead system, chiefly on account of cheapness in first cost. In a great many cases these cables are of bare copper strand suspended from porcelain insulators of the double-shed or oil pattern; the leakage is very small, even in foggy or wet weather. Arc lamps are employed for lighting up the yard and railway sidings and in buildings wherever height will permit.

Wiring.—The method of wiring the buildings and the various structures vary at nearly every colliery. Sometimes the cables are run in wood casing, at others in iron tubing, and very often the wires are suspended in porcelain cleats. These cleats may be obtained in varying sizes. The cleats suspend the wires clear of all framework, and increase the insulation resistance enormously. They also possess the advantage of being easy to get at for repairs and cheap in first cost. Objections may be raised that these insulators are not pretty, but as effect at a colliery is of secondary importance this may be dismissed.

Lamps.—All lamps on the surface, with the exception of the engine-room lights, should be protected from the weather by waterproof fittings.

Cables in Shaft.—The lighting cables in the shaft are usually insulated by vulcanised rubber possessing an insulation resistance of 2,000 megohms per mile, and are suspended from the top by the oil insulator (Fig. 3). The cables are taken direct to the office in the pit bottom, and distributed from there by means of a distribution board. All roads within a radius of 300 or 400 yards from the pit bottom should be lighted, but extra precautions must be taken when lighting up the return air roads. Electric lighting possesses great advantages over any other methods of lighting down a mine; it also greatly facilitates the traffic, and reduces the number of accidents. The cables are sometimes broken in two, owing to the roof giving way. I found that the insulator cleat previously mentioned was a quick and neat method of suspension, as well as possessing the advantage of cheapness. A well-lighted colliery will require on an average about 400 incandescent and 10 or 12 arc lamps, and, when worked in conjunction with a power plant, cost very little compared with other means of illumination.

I am much indebted to Mr. Rosslyn Holliday for the use of sketches (Figs. 3 and 4) taken from his paper on "The Uses of Electricity at Acton Hall Colliery."

SHEFFIELD.

The Board of Trade makes some stringent rules for the proper working of all electric tramways, and it is, perhaps, only right they should. One of these is that the motorman should have full control of the car as regards the brakes, power, etc., and there does not appear to be anything wrong about this, seeing he is at the front end and can see whatever dangers may be awaiting him and his charge. But an official at Sheffield has been, ever since the electric cars started running, so busy causing strife and dissension that it is now quite a task for the electrical engineer's staff to keep the men from open rebellion. The tantalising acts of this party are too numerous to detail to the readers of the *Electrical Engineer*, but the files of the local Press will show them at any time. All this, perhaps, is more of a matter for the men themselves to decide, but when the safety of the public at large is at stake, is it not time that someone else knew of it beside the big and little wig wearers of Sheffield?

The electrical engineer seems powerless in the matter; the interference has become so acute and dangerous even to the extent of the conductors being instructed to use, or rather misuse, the brakes at the tail end of the car. Three times this week has the control of cars been taken out of the hands of the motorman in this way. In one case a car was descending a grade of 1 in 15, when the motorman, finding the car travelling too fast, tried to check the speed and could not do so. He was within a short distance of running on to a single line, on which was another car approaching from the opposite direction, and but for the promptness of the man on the front of it, who exerted all his own and the car's power, the one would have dashed into the other. As it was, the two just escaped by about a yard what would have been a very serious accident, and, when the down grade car did stop, the motorman found the conductor had applied the handbrake from the rear platform, and had locked the wheels, rendering everything he tried inoperative. It may be remembered something of the kind happened at Bradford. Such a thing is contrary to the Board of Trade regulations. Who should control the working of the cars—the electrical engineer, who designed, arranged, and opened the line, or some other official, whom, it appears, is disappointed because he has not more power than the minutes of the City Council has given him?

INSTITUTION OF ELECTRICAL ENGINEERS.

The Calculation of Distributing Systems of Electric Traction under British Conditions.

BY H. M. SAYERS, ASSOCIATE MEMBER.

The design of electrical distributing systems in this kingdom has been practised hitherto almost exclusively for electric lighting purposes. The short daily duration of the heavy load and small annual load factor obtained in most cases induce economy in capital expenditure, and the current density at times of full load is restricted by considerations of pressure variation rather than by losses in the conductors. The conditions of working electric tramway systems are so different that calculations of another order come in, and very materially affect the design of the conductors when highest total economy has to be studied. The principal special conditions are as follows: (1) The high load factor—due to the fact that a large output is called for throughout the whole of the working hours, which are usually from 15 to 18 per day in the United Kingdom. There are daily "peaks" and seasonal peaks, but the hills and valleys are of much less extreme character than those observed on a lighting system. (2) The permissible variation of pressure is much greater. So far as the working of the line is concerned, the only limitation is that sufficient pressure be given at every point to enable the cars to keep schedule time. At the speeds allowed in this country, and with the motors usually fitted, a variation of 10 per cent. of the normal pressure causes no inconvenience. (3) The unsymmetrical arrangement of the two conductors, as between the outgoing or insulated positive conductor, and the return earthed negative conductor. In the great majority of cases the rails forming the negative or return conductors are of such large section that no other conductors are needed on that side of the system whether for economical or pressure-regulating purposes—so far as the working of the line is concerned. But for the protection of other property, the extreme potential difference allowed to exist between different points on the rails is limited by the Board of Trade to seven volts, and the proportion of current allowed to return through the general mass of the earth to an earth-plate at the generating station must not exceed 5 per cent. of the average load, or two amperes per mile of line. Hence, on a tramway or railway using the rails as return conductor, while the positive conductor should be designed with regard to ordinary considerations of economy and efficiency (including the fact that practically the whole of the pressure drop will occur on that side of the system), the negative conductor designed primarily to satisfy mechanical conditions in most cases accidentally happens to afford much better conductivity than the positive conductor, and yet its conductivity has in many cases to be supplemented in order to satisfy the regulations imposed by a benevolent Board of Trade. It will be seen below that the determination of these auxiliary return conductors can be arrived at by calculations similar to those controlling the choice of the positive conductors, but that some of the factors have different values, and their load has to be estimated in a different way.

One effect of these special conditions is that the use of conductors designed for lowest total working cost is practicable in many electric traction systems. The well-known consideration that the total working cost of a conductor during any given time is the sum of two items, one being the value of the power wasted in it, and the other a percentage of its original cost at some annual rate, indicates at once that for a higher load factor a conductor should be worked at a lower rate of loss, or, in other words, at a lower current density. To determine the most economical current density in a given case, values are required for the following factors: (1) The money cost of the cable to be employed expressed in terms of the amount of copper in the cable, say the price in pounds of a ton of copper, insulated, sheathed, and laid $=p$. (2) The percentage of the cost of the cable which must be annually set aside to provide for interest,

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maintenance, and depreciation = R. (3) The average number of hours per day taken throughout the year that the cable will be under load = h. (4) The load factor of the cable during the time it will be under load. If the load will be steady, the value of this will be unity. If the load will vary in a known way, the load factor will be the mean square value of such variable load referred to a steady load of its maximum value as unity, and can be calculated from a prophetic load diagram, and in the case of such variable load the most economical current density given by the calculations will correspond to the square root of the mean square value of the current. In what follows, this load factor will be taken as unity. (5) The cost of a Board of Trade unit generated and delivered to the conductor in pence = n.

From 3, 4, and 5 the cost per annum of a watt wasted in the conductor can be calculated, or, inversely, what number, w, of watts wasted in the cable will cost, say £1 per annum, and the two quantities representing the total cost per annum reduced to a common measure. In Perry's "Calculus for Engineers," p. 55, the question of economy in electric conductors is used as an example in maxima and minima, and I have found the method there indicated convenient for practical use. Prof. Perry there shows that the waste in watts or ohmic loss, and the constant loss or interest loss, can both be simply expressed as functions of the resistance of a conductor, assuming a certain current and certain length, and that their value may be written: $y = C^2 r + \frac{t^2}{r} + b$. Where $C^2 r$ is ohmic loss, $\frac{t^2}{r}$ is the interest item—expressed in watts, and b is a constant which depends upon factors not affected by the size of the cable laid. In Appendix No. 1 Prof. Perry's expression is worked out at length, and the result shown that the most economical current density $\frac{C}{A} = \sqrt{\frac{R\ w\ p\ m\ \cdot 045}{100}}$, where C = amperes, a = cross-section of cable in square inches (so that $\frac{C}{a}$ = amperes per square inch), and m = tons of copper in a mile length of one square inch section, R = annual rate per cent. for interest, etc., w = the number of watts wasted continuously during working hours, which will cost £1 in a year's working, and p = the price in pounds of a ton of copper in the form of cable; ·045 is resistance in ohms of a mile of copper of one square inch cross-section, the weight, m, of which is 9·1 tons. In Appendix No. 2 an example is worked out numerically and tables are shown giving values obtained by taking figures within probable practical limits. The method of calculation here used is, of course, perfectly general, and applies equally to low-tension, high-tension, continuous and alternating currents, however fed to the conductors. The cost per ton of copper in cabled form will, of course, vary widely with the way the cable is to be used, the working pressure, and other conditions; for example, a triple-twisted cable for three-phase currents will be much more costly per ton of copper than a concentric cable for continuous currents, working pressure and material being equal. It has also to be carefully noted that the value of the Board of Trade unit to be used is that of the unit delivered to the conductor system under consideration, and if the energy has to be transmitted or transformed before such delivery, the cost of generating the unit has to be "loaded," with the cost of such transmission or transformation, including the interest, maintenance, and depreciation cost of transmitting or transforming system. For example, the most economical density in a low-tension system fed from transformers is lower than in a low-tension system fed direct, assuming that the generating stations in the two cases supply energy at equal costs. It must also be recognised that power wasted (or used) in distribution costs as much as power used in the motors. For cables of a given construction and for use under given conditions, it will generally be found that the average price per ton of copper taken from makers' prices through such narrow ranges of size as are usually employed on a given system is sufficiently accurate. Where a very wide range of size is called for, it may be worth while to calculate separately for the larger and the smaller cables.

The question of systems of laying cables and the cost thereof is not considered here, as the choice of the methods to be used depends much upon various local conditions, and the cost per mile is very little affected by the size of the conductor laid. It may be worth while to suggest, however, that the cost per ton of copper of a cable armoured for laying direct in the ground is higher than that of a similar cable sheathed for drawing into pipes or conduits, and as the allowance for depreciation and maintenance of pipes and conduits is a good deal lower than that for cable, economy may frequently be best studied by the use of a "drawing-in" system. The facilities for renewal and repairs and for replacing cables by others of larger size, if required, are advantages not to be lightly ignored, and the conditions on electric traction systems enable these advantages to be utilised to a degree that does not obtain in some other services. The calculation of best sizes for track feeders is exactly that above described, but in most cases a higher value has to be taken for the wasted energy—*i.e.*, w in the equations is smaller. This leads to the use of a lower density in such cables or to a larger provision of copper for the current to be carried. The reason is that in most cases a "negative booster" has to be employed in connection with such a feeder, and the energy wasted has to be loaded with the loss in transforming and the capital charges on the apparatus. The booster may be considered a part of the feeder, and as its size and the losses in it are proportional to its output, they are properly brought into the calculation by charging a higher price per unit delivered to the cable. Appendix No. 3 gives some examples of such calculations, and is also applicable to trolley feeders in which "boosters" are employed to keep up the voltage at the distant end.

Considering the figures given in the tables, it will be seen that the limiting distance due to loss of pressure in feeders designed on economical principles is reached at from two to three miles from the generating station. The density of the traffic does not affect this limit. The cost of energy does affect it, and in such a way that the lower this cost, the shorter is the range of economical distribution, because the economical density being higher, the limiting drop of voltage is the sooner reached. But it may be worth while in any particular case to use heavier conductors and so extend the working radius of a station, because the cheaper generation of power at that particular place more than compensates for the increased distribution costs. It may happen, also, that the use of heavier mains for the more distant parts of the system may prove to be cheaper than any other means of keeping the pressure up on those parts. It is a useful feature of the methods of calculation herein described that they indicate in a facile way the results of any departure from the theoretically best conductor sections, and so provide at least part of the data for determining the best system to adopt. When the distribution radius much exceeds the distances above named, it will be obvious that the single station supplying direct to the feeder system becomes impracticable, and it is under these circumstances that an engineer is called upon to thoroughly investigate the alternatives, and estimate the total annual cost of working the lines by means of each of such alternatives. Only certain systems in practical use in the United Kingdom can be mentioned. They are: (1) The multiplication of generating stations retaining the direct-current low-tension system of generation; (2) the use of battery sub-stations charged from a single generating station; (3) the use of a single generating station, generating polyphase currents at high pressure, and transforming sub-stations placed at suitable points on the line, supplying low-tension direct current to the line feeders. The direct current for the lines near the station may or may not be generated by special direct-current sets; when it is, separate consideration has to be given to such contiguous area in calculating conductors and costs.

The second system above mentioned has but few examples, and reliable data are somewhat difficult to obtain. Its application would seem to be limited to cases where an infrequent service is given on distant lines; hence the feeders having to carry but a small average current, their size may be kept down, and the battery provides for the larger current needed by the cars. It will be obvious that the arrangements require to be carefully thought out in order to ensure the battery being properly charged, and always available during service hours. A very good example is that designed by the late Dr. John Hopkinson for the Leeds tramway, and described in Prof. Ernest Wilson's "Electrical Traction." It will be found that some complication is involved. Considering the present limited application, and the many questions of detail involved in calculating the working cost of such arrangement, the system cannot be discussed now, and is mentioned as a practical means of meeting the demand which may be sometimes made for working a long branch, the traffic on which only calls for a sparse service, or on which the traffic is relatively heavy for only a small portion of the working hours. The discussion will be narrowed down then to a comparison of the first and third alternative systems, involving a statement of the data which affect the choice and the calculations by which the working cost of each may be estimated with an exactness dependent upon the accuracy of the figures adopted. As some of these figures must themselves be estimated, the judgment and experience of the engineer are here very important factors.

It is quite clear that there are two broad questions to be decided—firstly, What will be the total cost of producing a unit at the station or stations? and, secondly, What will be the total cost of getting a unit to the car? in each case. The first question involves the charges on the capital cost of the station plant in addition to the working expenses; and the second question involves the efficiency of the distributing system as well as the capital charges upon it, as the cost of delivering a unit includes the energy wasted in its distribution. "Used in distribution" seems a more rational expression than "Wasted in distribution," but the latter phrase is so widely

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adopted that confusion might result from an attempt to reform. It is obvious that by the multiplication of directly feeding generating stations *ad lib.*, the loss in distribution as above defined may be reduced to any desired extent. On the other hand, with a system involving transformation there is some minimum loss which cannot be reduced, and which corresponds to the attainable efficiency of the transforming devices. Clearly, then, this minimum loss constitutes a handicap upon the multiphase high-tension system which must be overbalanced by other advantages in order to justify its adoption. The reduction in the cost of generation of energy due to the employment of large units in one large station as against smaller units in a number of stations can only be estimated in advance by a complete study of local conditions guided by experience and judgment. Cases arise, of course, where it is clear that a station at a particular place enjoys such a great advantage as regards cost of fuel, abundant available condensing water, and freedom from neighbours who may object to noise and vibration, that direct and indirect costs must be much lower than in any other available site. The greater economy in staff and in total value of plant and buildings to be obtained by generating at one station instead of several can be estimated very fairly. A more difficult item to estimate is the relative value of the land.

Whilst every case requires special study to determine what advantage in generating costs is attainable by the adoption of the single large station, a study of the distribution costs can be made on general principles, which will indicate what that saving must be in order to give the single station a balance of advantage. The limit of direct-current supply has been assumed to be the distance at which the drop in the trolley wire is 50 volts—*i.e.*, 10 per cent. of the energy given to the cars. Assuming a uniform distribution of the cars, this means an average drop of 5 per cent. over the whole system. (Notice that if the system is one radiating from a large town, so that the cars are more dense near its centre, the average drop will be less. It can be calculated as closely as the service can be predicted.) The loss in track feeders will be less; probably 2½ per cent. will cover it in most cases. This total loss of power in distribution, amounting to 7½ per cent. of that delivered to the cars, can be attained with generating stations spaced from four to six miles apart—*i.e.*, delivering power—each for a radius of from two to three miles. As the interest item of distributing cost equals in value that of the loss of power item, it follows that distribution costs in such a system = 15 per cent. of the value of the power delivered to the car, and the total cost of 100 B.T.U. at the cars = that of generating 115 B.T.U. The plant has to be proportioned to produce 107½ per cent. of the energy delivered to the cars as its normal full load. In a multiphase transforming system, the overall efficiency cannot at present be taken at more than 80 per cent. Mr. Parshall has given figures from Dublin experience showing somewhat lower rates, but 80 per cent. seems attainable. Then the generating stations will have to supply 125 units per 100 units delivered to the cars. The interest and operating costs of the distributing system cannot be calculated so simply in this case as in the former, as moving transforming devices calling for human attention are involved: but if the prices of those devices are known, and a proper rate of interest calculated to cover depreciation, the cost of attendance and sites can be got at pretty closely, and a price worked out per unit delivered to the mains which can be expressed as a percentage rate of loss of the energy delivered. If this is called N, we have the following expression showing at what proportionate cost the high-tension station must generate energy to counterbalance the larger distribution losses. $\frac{b}{a} = \frac{115}{125 + N}$, where b equals cost of production at the single high-tension and a = cost of production at the multiple low-tension stations. Unless $\frac{b}{a} < \frac{115}{125 + N}$, the low tension multiple-station system will give the lower working cost. For this calculation to be of any practical value, it is evident that the cost of production must be properly debited with all charges in each case. To make such an estimate for prospective stations with a near approach to accuracy, is a task much more difficult than calculating conductors, but an incorrect decision as to the system to be preferred in a given case is not probable if experience and judgment are brought to bear on a careful investigation of the local conditions.

The value N above taken includes the interest item on both the high and low tension conductors. This value can be found as in the other case, and will, as in that case, be equal to the ohmic loss in each: but it must be noted that the cost of a watt is greater in the low-tension conductors owing to the transforming loss. The best density in the high-tension conductors is found exactly as in the case of direct supply, but the cost per ton of copper will be considerably higher in the case of the three-core high-tension cable, and hence the best density will be higher. The interest and operating costs of the transformers must be carefully considered, proper allowance being made for the necessary spare plant and margin of power necessary. If these costs come to d pence per unit, the condition of advantage for the high-tension system is

$$\frac{b+d}{a} < \frac{115}{125+p},$$

where p is the percentage value of the losses in the high-tension conductors. This will usually be small, not over 5 per cent., and taking this value we get

$$\frac{b+d}{a} < \frac{115}{130};$$

so that for equal costs under the two systems

$$b = \cdot 885\, a - d;$$

or in words, the cost of generation at the single high-tension station must be less than 88½ per cent. of the cost at the low-tension stations by the cost per unit of interest, attention, and stores due to the transformers. If $b < \cdot 885\, a - d$, the difference is the saving per unit to be made by the high-tension system; if $b > \cdot 885\, a - d$, the difference is the advantage for the low-tension system. Using correct data to suit the case, a very good judgment can be arrived at as to the most economical system to be adopted, and it is suggested with much confidence that such calculation is a safer guide than a general statement that for a traction station of over so many thousand horse-power this or that system is the only commercial one. It seems to be overlooked sometimes that the cost per unit at the car, and not at the switchboard, is the commercial criterion, and that to attain a lower figure at the car the cost of the unit at the switchboard must be very considerably lower in the case of any system using moving transformers than in alternative arrangements.

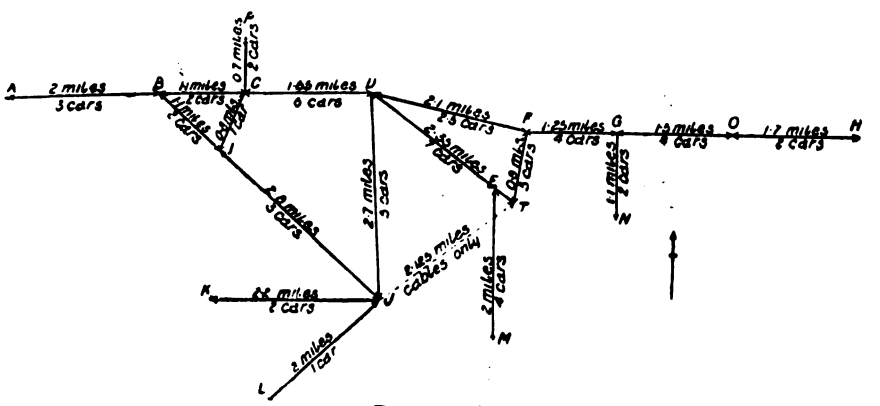

DIAGRAM A.

The choice of a site for a generating station may greatly affect the generation costs, and as these materially influence the design of the distributing system, the importance of careful choice of site or sites is very great, and in any contemplated electric traction system this should be one of the earliest matters submitted to and decided by the engineer. Wherever possible, eligible sites for compulsory purchase should be scheduled in the order authorising the line. The points affecting the choice are foreign to the subject now discussed, and a certain cost per unit at the switchboard will be herein assumed, the sole subject considered being the delivery of the power to the cars at minimum cost under the conditions imposed. The economical use of the power on the cars is also foreign to this discussion, but it cannot be seriously contended that waste on the car excuses avoidable waste in the distributing plant. The consideration of a particular case will best illustrate the application of the foregoing principles. Diagram A is a scale plan of a tramway system, all single lines with turnouts.

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The proposed service results in a distribution of cars as marked in figures along each section of the line. The total number of cars is 57. The average current taken by each car is reckoned at 15 amperes. Hence the average power demanded at the cars will be

$$\frac{57 \times 15 \times 500}{1{,}000} = 427{\cdot}5 \text{ kw.}$$

At T is a site available for a power-house. The extremes as regards distance from T are A 7·1 miles west, H 5·2 miles east, and L 7 miles south-west of T. There is, however, a shorter route from T to J than by the tramway, and this route being available for a feeder cable reduces the distance, T L, to about 4·35 miles, and facilitates feeding at J, which it will be seen is an important centre. In natural order one should first consider the use of T as sole generating station for the whole system, find the most economical current density, and see whether the drop permits of low-tension generation and direct feeding (Diagram B).

For the purpose of this example the following figures are used: annual charges on cost of cable for interest and depreciation, 7 per cent. or R=7; annual hours of use, say 15×365 =5,475; cost of energy per Board of Trade unit at switchboard, n=·75d.; tons of copper per mile run of one square inch cross-section=m=9·1; cost of insulated cable per ton of copper, p=£151; watts continuously lost worth £1 per annum $= w = \frac{240}{5{,}475} \times {\cdot}75 = 58{\cdot}45$.

Then by formula given in Appendix No. 1 we have

$$t^2 = \frac{R\,w\,p\,m\,{\cdot}045}{100} = \frac{7 \times 58{\cdot}45 \times {\cdot}045 \times 9{\cdot}1}{100}$$

$$= 251 \text{ or } t = 15{\cdot}8;$$

say $\frac{t}{{\cdot}045}$ = 352 amperes per square inch is thus the most economical density in this case. The voltage drop per mile is 15·8. Hence the drop from T to A would be 15·8×7·1=112 volts, and from T to H 15·8 × 5·2 = 82 volts. These are too great for good working, and, taking 50 volts as the limit, the distance limit is $\frac{50}{15{\cdot}8}$ = 3·16 miles. Beyond this limit there are 15 cars west and three cars east of T, so that two-thirds of the load comes inside the permissible drop and should be supplied by directly-fed cables. The remainder should be fed by "boosted" cables. No allowance is made for the conductivity of the trolley wires excepting where they suffice without cables in parallel, and there two No. 0 wires of ·162 square inch combined section are reckoned on. It is found in practice that in a tramway system calling for several feeders it is better to work the trolley wire in separate sections, each being fed by a distinct feeder. This results in the rapid localisation of short-circuits of all kinds, and minimises disturbance to traffic. It also facilitates the proper loading of the individual feeders, and gives valuable information to the power-house staff as to the distribution of the load.

The losses in the feeders to the directly-fed portions of the sample system will be approximately as follows: The cable, T J, has to carry 98 amperes 2·125 miles; the average length on the branches beyond J over which the power will be distributed is, say, one mile total from T, 3·125 miles. The branches J D and J I will only be fed *vid* J to points equidistant from T by the other routes, and on all these branches the trolley wires suffice without cable. The remainder of the current from T within the area is supplied by cables accompanying the line, and for the purposes of this approximate calculation it may be taken that the load is symmetrical along them, so that the average load may be taken as half the total, and the loss as that due to half the current carried the extreme distance. (Obviously, the loss may be calculated much more minutely than this for any given distribution of cars, gradients, etc.) The current being 532 amperes, half of it is 266 amperes. Then we get total loss in watts—

For current supplied to J 98×3·125×15·8= 4,820
And the balance..... 266×3·16 ×15·8=13,300

18·12 kw.

As 58·45 watts cost £1 in a year's working, the money cost of this loss will be $\frac{18\,120}{58{\cdot}45}$ = £310 in round figures, and as the interest cost of the cables should equal the total cost of distribution (strictly speaking, that portion of the cost affected by system adopted) to the trolley wire, the total cost under these heads for the lines considered would amount to £620 per annum. But the use of the trolley wire where practicable will reduce the cable cost and interest item below this theoretical amount, and a table follows giving the actual feeder cost. Inspecting the plan, it is clear that the junction I is about the centre of gravity of the load beyond the 3·16 miles on the western sections. This is five miles from T, and the load to be delivered is that for 15 cars=45 amperes. The energy lost in these boosted feeders is more costly, having been transformed by the boosters, whose efficiency is rarely over 75 per cent. The value of the boosted unit must therefore be taken at ·75×1·33=1d., the value of w becomes 44 instead of 58·45, and $t^2 = \frac{251 \times 44}{58{\cdot}45}$ = 189 nearly, or t=13·75 and $\frac{13{\cdot}75}{{\cdot}045}$ =306 amperes per square inch as best density. Drop per mile is 13·75 volts.

The boosters would only be necessary to make up the drop in the lengths beyond the 50-volt drop limit, so that this lower density should, strictly speaking, apply only to the excess of cable length beyond 3·16 miles. It will be better, obviously, to use a conductor of uniform section to give the same drop. In the case of the western section, then, the drop will be 50+ (13·75×1·84) =75·3 or 15·06 volts per mile, showing that the refinement makes little difference in this case. On the eastern section the drop will be 50+ (13·75×1·16)=65·95, say 66 volts, or 15·3 per mile. The losses will thus be:

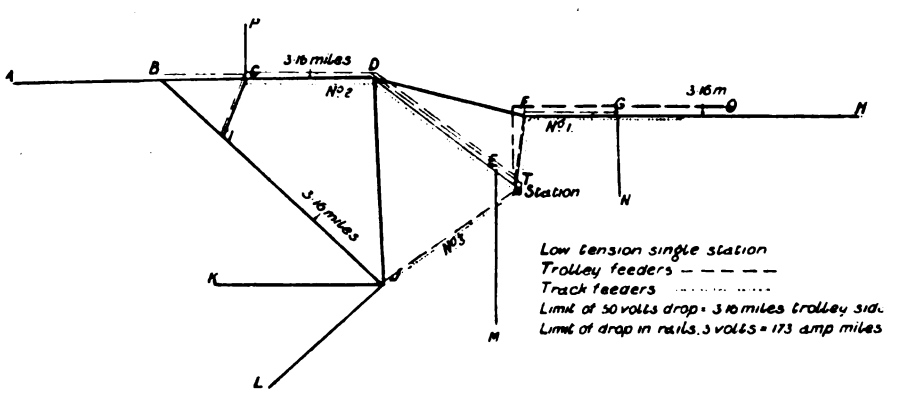

DIAGRAM B.

Western 75·3×225=16,942 watts.
Eastern 66 × 45= 2,970 ,,

19,912 (say 20 kw.)

Of this 20 kw., 270×50=13,500, the unboosted cost £1 per 58·45 and 6,500 cost £1 per 44, so that the total annual cost of the loss in these feeders will be:

$$\frac{13{\cdot}500}{58{\cdot}45} = £231 \text{ nearly.}$$

$$\frac{6{\cdot}500}{44} = 148 \quad ,,$$

£379 ,,

The interest on the mains will be somewhat less, owing to the use of trolley wire on the more lightly-loaded branches. To this has to be added an annual charge representing interest, maintenance, and running cost of "boosters" to give an output of 6·5 kw. With spare plant 10 kw. might be provided, and would probably cost £20 per kilowatt, say £200. Fifteen per cent. per annum is a proper charge for interest and running expenses on such plant, so that this item would be £30 per annum. The following is a schedule of feeders on the trolley side, wherever needed to supplement the trolley wires:

Direct Feeders.

Line.	Length, miles.	Amperes.	Section Cu. sq. in.	Tons Cu.	Value.
T J	2 125	98	·277	5 37	£817
T E	·35	247	·700	2 23	337
E D	2 00	165 mean	·470	8 55	1,290
T F	·9	187 ,,	·531	4·35	655
F G	1·25	120 ,,	·342	3 56	538
	6·625			24 06	£3,637

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Boosted Feeders.

T C	4·1	225	·672	25·0	£3,775
C I	·9	60	·179	·15	23
C B	1·1	75	·224	·22	33
T O	3·8	45	·134	4·63	699
	9·9			30·00	£4,530

Total, £8,167.

The cost of distribution on the trolley side is thus :

Loss in direct feeders, 18·12 kw., worth annually.....	£310
Interest on cables in ditto, 7 per cent., £3,637	255
Loss in boosted feeders .....{13·5 kw., worth £231 / 6·5 kw., worth £148}	379
Interest on cables in ditto, 7 per cent., £4,530	317
Annual charges on boosters	30
	£1,291

This works out per unit delivered to the cars :

$$\frac{1,291 \times 240}{427{\cdot}5 \times 5,475} = \frac{309{\cdot}840}{2,340,000} = {\cdot}133\text{d.},$$

making total cost ·883d., disregarding losses in the return conductors. But the regulation as to potential difference in rails forbids such disregard, and their effect must now be considered.

Assume that the track is single and laid with 90lb. rails, or 180lb. rail per yard of track. Assuming the resistance of the rail to be 11 times that of copper of equal section, and that joints add 5 per cent. to that resistance, a mile of bonded track will have a resistance of ·0289 ω. The interesting paper read by Mr. Parshall before the Institution on April 28, 1898, will be familiar to all interested in this question, as it shows by examples how the chemical composition of rails, kind of bonding, and number of joints per mile, has to be taken into account. Naturally, the mechanical use of the rails takes precedence of their electrical functions, and hence the electrical engineer has to be thankful for what he can get. The resistance of the return as laid is usually lower than that of the rails alone, some conduction being afforded by the earth. The amount of this varies very much. Mr. Parshall has found an instance in which only two-thirds of the current returned by the rails. Weather affects it. In one case within the writer's knowledge wet weather reduces the voltage drop, and also the stray current, evidently increasing the conductivity of the non-metallic parts of the track. But as this earth shunting of the rails cannot be foretold, the safe course is to take the resistance of the uninsulated return as that of the rails alone. To allow for possible increase of service, abnormally busy days, and bunching of cars, the limit calculated on should be, say, five volts, not the whole seven volts allowed in the Board of Trade regulations. The integrated product of amperes into miles to give this drop will thus be $\frac{5}{{\cdot}0289} = 173$ ampere-miles.

Mr. Trotter's paper of April, 1898, gives a neat and simple graphic method of showing the drop under given conditions. It can be easily applied along any section of line with a uniform service. For such a case as that under consideration, with varying services along different sections and junctions, an arithmetical process seems a little simpler. The arithmetical process is as follows : starting from the station, sum the product of amperes into miles until this product equals the constant corresponding to the limiting drop—*e.g.*, 173 for the case here assumed. It is at once clear that all current from cars beyond this point has to return by track feeders.

From this point start the integration afresh, and go on until the constant is again reached. At this second point the rails should be at earth potential. Recommence the summation from this second point and go on again to the constant. Then all the current due to cars between the first and third points should return to the station by a track feeder connected at the second point, and so on in succession, the even points marking feeder connections kept at earth potential, the odd points marking points of maximum D.P. above earth in the rail. This calculation applies equally to feeding points in transforming systems, so far as such points depend upon the drop in the return. It will be clear that the direction of the current must be from odd points to even points. When the terminus of a route does not correspond with an odd-numbered point, integrate the ampere-miles from the last odd point forwards, and from the terminus backwards, and the point on the line where these sums are equal is the last feeding point, the potential of which may be above that of the earth by the amount corresponding to the defect in the ampere-miles from the constant. This means, of course, a little lighter feeder, but the difference is usually insignificant as regards economy.

Obviously, the calculations above described will only give correct results for the distribution of traffic and current assumed. Such assumptions can only approximate to average working conditions, and it is only prudent to allow a considerable margin on the upper side in assuming the traffic for growth and other obvious possibilities. Again, the feeding points so found may not be the best practically. It would be better, for example, to feed the track at a junction, connecting the feeder to all the diverging roads than at a near point indicated by calculation, which should result in excessive current density in the rails of one road. Such excessive density may damage rails and possibly cause local damage to pipes near by. The best density of current for track feeders is determined exactly as for trolley feeders, giving the wasted watts their proper rate as "boosted watts." Unboosted track feeders are of no commercial value, as Mr. Parshall distinctly showed in the paper before referred to. In our example the density for boosted feeders has already been shown to be 306 per square inch, giving a drop of 13·75 volts per mile run. From these figures the feeder sections and losses and sizes of boosters can be readily applied to suit the feeding points found in the manner above explained. The detailed calculation for track feeders is given in Appendix No. 4, and all track feeders needed on this system are shown in Diagram B. The list of them is as follows :

No.	Route.	Length.	Current.	Sections sq. in.	Tons Cu.	Value	Drop	Loss in watts.
1	T E'wards	2·97	120	·39	10·5	£1 585	41·6	5,000
2	T W'wards	4·00	273	·89	32·3	4,877	60·24	17,000
3	T to J	2·15	127·5	·415	8·1	1,223	32·4	4,200
		9·12			50 9	£7,685		26,200

Boosters to a total capacity of, say, 36 kw., would be needed, costing, say, £15 per kilowatt, or £540. Annual charges at 15 per cent. on these amount to £81. As before, the interest on the mains is rather less than the cost of power, the assistance of the rails coming in to reduce it. We then get on the track side :

Loss in feeders, 26·2 kw., worth annually	£600
Interest on cables, 7 per cent. on £7,685.....	538
Charges on boosters	81
Total	£1,219

Adding this to the cost on trolley side, £1,291, we get a total of £2,510. This equals ·266d. per unit delivered to the cars, making its cost there 1·016d.; and the total annual generating and distribution costs, as far as here considered, £9,936. There will be 25·645 miles of cable laid in 12·025 miles of trenching, weighing 104·15 tons, to the value of £15,853, in addition to the cost of laying them. Boosters will cost £740.

The electrical efficiency of the whole system will be about $\frac{427{\cdot}5}{499} = 86$ per cent., or a trifle higher. These figures show very strongly that a single low-tension station for this system is very expensive in first cost of distribution plant, cables alone costing £32 per kilowatt capacity. The regulation as to potential drop in rails puts direct supply out of court as soon as the distances and traffic exceed certain moderate figures. It seems, however, that a modification in track construction, using continuous girder supports under the rails and dispensing with concrete and setts between them, should be a logical consequence of electrical traction, and that the conductivity of the track might thus be largely increased and bonding made much more permanent without much increase in construction costs. The difficulty now experienced at the joints of tramrails should disappear, and the life of the road be greatly increased. For electric traction purposes the granite between the rails is entirely unnecessary. Municipal tramway engineers might give this a trial ; companies cannot do so in the present state of the law.

(To be continued.)

The following is a list of the candidates balloted for at the meeting on the 10th inst. :

Associate Members.—E. W. Dickinson, Jère, 57, Beckwith-road, Herne Hill, S.E. ; E. A. Ellicott, 25A, Cockspur-street, S.W. ; J. J. Mann, Belsize Works, Clayton, Manchester ; G. Prescott, 9, Merrion-row, Dublin.

Associates.—J. Y. Fletcher, Grosvenor Lodge, Rathgar, Dublin ; J. R. Gibson, 3, Church-lane, Dublin ; E. Green, R.I.E. College, Cooper's Hill ; H. L. Joly, 20, Alfred-place, W.C. ; E. R. Matthews, C.E., F.G.S., borough engineer, Bridlington ; A. E. Preston, assistant engineer, Kidderpore Docks, Calcutta ; S. R A. Wood, R.I.E. College, Cooper's Hill.

Students.—G. B. Dyke, 1, Wyndham-place, Bryanston-square, W. ; F. H. Fitt, 5, Peckham Rye, S.E. ; E. L. Hocking, 10, Avenue-road, Highgate, N. ; F. J. Holmes, 2, St. Thomas's-road, South Hackney, N.E. ; R. A. Kennedy, 10A, Saunders-road, Notting Hill, W. ; H. F. Northcote, 39, Fitzroy-road, Primrose Hill, N.W.

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MUNICIPAL QUESTIONS.

During the past few days two questions of interest have come prominently into the field of practice. The Joint Committee of Lords and Commons on Municipal Trading has been nominated "to consider and report as to the principles which should govern powers by Bills and provisional orders to municipal and other local authorities for industrial enterprise within or without the area of their jurisdiction." Such are the terms of reference, and the Joint Committee consists of Earl Crewe, Viscounts Hampden and Peel, Lord Windsor, and Lord Rothschild, Sir T. Foster, Mr. Lewis Fry, Mr. Hobhouse, Mr. Grant Lawson, and Sir Leonard Lyall. These gentlemen have an arduous task to fulfil an important duty. Singularly, almost simultaneously with the nomination of this committee comes the inaugural address of the President of the Royal Statistical Society, the Right Hon. Sir Henry Hartley Fowler, G.C.S.I., M.P., who chose as the subject of his address, "Municipal Finance and Municipal Enterprise." A good many figures are given by Sir Henry Fowler, and some very pertinent remarks. The receipts by local authorities for 1898, the last year for which we have returns, is given as, roundly, 69 millions, and the expenditure 67¾ millions. The expenditure on public lighting is given as 1¼ millions, on gas and waterworks and tramways as 5½ millions, while interest on various loans and repayments accounts for 14¼ millions. An important item on the revenue side is from waterworks, gasworks, and other undertakings producing revenue, bringing in 11¾ millions. Of course, all this belongs to what may be termed the ordinary business of the year, but irrespective of this large sums are being borrowed and expended, thus increasing the accumulating debt, for the borrowing is at a greater rate than the repayment. The outstanding local debt of the country is given at, in 1898, £262,017,000. We have at various times pointed out that the Imperial debt has decreased less rapidly than the local debt has increased, and thus the total indebtedness of the country is increasing. When the money borrowed for works producing revenue is considered, 18¼ millions have been obtained for gasworks, 3¾ millions for electric light, and 3¼ millions for tramways. We are not going to burden ourselves with many comments now, but merely wish to give figures for contemplation and future criticisms, with perhaps one or two critical quotations from Sir Henry Fowler's address. Our commercial interest is in tramways and electric light works. "There are twenty-eight corporations who own their tramways," with a capital provided of £3,213,654, of which £2,689,384 is borrowed, £499,377 paid off, there being an annual net profit of £34,079. There are fifty-five corporations who own electric light works. The capital provided was £3,416,711, borrowed £3,108,533, with an annual net profit of £5,338. This net profit is merely what remains after payment of working expenses, interest, instalments of principal, depreciation, etc., have been made. It is estimated that out of the 262 millions outstanding debt, no less an amount than 87½

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millions has been used for trading and similar purposes. Just so; 87½ millions used by public authorities in business, and this raises the question, "What is the true boundary line which must be maintained between public enterprise carried on at the public cost and at the public risk, and private enterprise carried on by individual traders in partnership or in companies?" This is the question that the Joint Committee will attempt to solve. "There are," says Sir Henry Fowler, "beyond question certain public needs which ought to be supplied under the control of the local authorities." The conclusion of the President of the Statistical Society may be gathered when he says: "I apprehend that there will be a general agreement that any extension of municipal enterprise should be confined to such undertakings as are clearly for the common good and the general use of the whole community, and that they should comprise undertakings which it is for the public advantage that they should be placed under public control." This view, of course, leaves the difficulty just where it did before: it neither defines nor indicates such undertakings; but for the moment let us merely refer to one phase of the discussion and ask, what will be the probability of progress of manufactures, the results of which may be, in a sense, for the common good, if they are controlled by local authorities? So far as we can see, most of the incentives towards change will be wanting in these concerns. It will benefit no particular individual to improve the process or the article manufactured. The one great incentive towards improvement—viz., success in free competition for personal benefit—will be altogether wanting, so that it is most important to consider how public control will act in this direction. If this view is generally approved, it will go a long way in assisting to determine the limits of municipal trading. Unfortunately, it must be argued in the abstract, for there exists little in the concrete to assist towards a right conclusion, and what little in the concrete does exist is of a very misleading character.

FORTHCOMING EVENTS.

FRIDAY, MAY 18.

Royal Institution.—At 9 p.m., discourse on "The Structure of Metals" by Prof. J. A. Ewing, M.A.

Institution of Junior Engineers.—At 8 p.m. Paper on "A Short Review of the Motorcar Industry," by Messrs. Basil H. Joy and C. H. Rush.

North East Coast Institution of Engineers and Shipbuilders.—At Newcastle, closing meeting.

SATURDAY, MAY 19.

Manchester Society of Junior Electrical Engineers.—At Manchester. Paper on "The Application of Accumulators to Telegraphy and Telephony," by Mr. T. E. Herbert.

MONDAY, MAY 21.

Society of Arts.—At 8 p.m., Cantor lecture on "The Incandescent Gas Mantle and its Use," by Prof. Vivian B. Lewes. Lecture III.

THURSDAY, MAY 24.

Institution of Electrical Engineers.—At 8 p.m., at Society of Arts. Annual general meeting to receive report of Council for 1899.

FRIDAY, MAY 25.

Physical Society.—At 5 p.m., ordinary meeting. "Experiments illustrating the Aberration called Coma," by Prof. S. P. Thompson, F.R.S.; "Notes on the Measurement of some Standard Resistances, by Mr. R. T. Glazebrook, F.R.S.; and also "On the Strength of Ductile Materials under Combined Stresses," by Mr. J. J. Guest.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

TRAMWAY ACCIDENTS.

SIR,—Referring to your note in the *Electrical Engineer* of the 20th ult. *re* "Tramway Accidents and the Non-Technical Press," it is not only in the headlines that exaggerations are made, but frequently in the body of a report, as the following will show: "A man named Samuel S. Horsfield, aged 51, of 171, Walkley-lane, Sheffield, died in the Sheffield Infirmary yesterday from a fractured spine—an injury he received in alighting from a Sheffield tramcar."

Now, the facts are that at the time and place named the car was just starting, when the half-drunken man made an attempt to get on at the *rear, or tail end*, of the car, missed his footing, and was pulled down and trailed *behind*, so that if he had let go his hold the car would have left him lying in the street. The motorman knew nothing of what had happened until he received the stop signal from behind.

In consequence of this glowing newspaper report, enquiries from the men in charge of the car elicited the above facts, and although the error was pointed out to the newspaper people by one of the engineers of the tramways, no corrections were made.

I have sent you an entire page of the paper, so that you can see the source from whence it came; also a cutting from the same paper for April 4 *re* accident to Mr. Fell, and his not being able to attend to his duties, when, as a matter of fact, although confined to his room, and for many hours a day to his bed, he has all along attended to his letters and other things, his clerk attending every day; a telephone is also at his bedside, and he is in frequent communication with both his staff and his committee.

It is supposed that some disappointed incompetent is responsible for the newspaper reports, which I am somewhat late in sending you; but if of any interest to your readers, here they are—they have cost me nothing but a few groans.—Yours, etc., EDWIN W. ELSLEY.

May 12, 1900.

THE ELECTRIC POWER BILLS.

(Continued from page 669.)

On Friday the examination of witnesses for the Tyneside Power Bill was resumed.

Mr. C. MCLAREN was called, and said he was the chairman of Palmer's Shipbuilding Company, which had large works on the Tyne, at Jarrow. They used about 1,500 h.p. at the present time, and were putting up new plant to supply another portion of their works. If they could obtain a reliable supply from the Tyneside Company, they would not extend their plant further. He thought that competition would be good, and that a better supply could be given by the company than by the local authorities. His works were all on the south side of the Tyne. It would not be difficult to carry a main across from Wallsend.

Cross-examined by Mr. Wallace, Q.C., on behalf of the Durham Company, he stated that if the Jarrow Company could give him a sufficient supply at a cheap rate it would be just what he wanted.

Mr. EUSTACE SMITH was then examined, and said his company had large docks and shipbuilding works on both sides of the Tyne. They used about 800 h.p. in their North Shields works. The North Shields Corporation proposed to lay down a 500-h.p. plant to work electric tramways. The South Shields Corporation had started an electric installation, but he did not know whether they were in a position to supply their South Shields docks. These docks would require about 600 h.p. He would save about £1,800 per year if supplied with energy at the Tyneside rate of charging. He would advocate that this company should be allowed to go on both sides.

He was then cross-examined by Mr. Balfour Browne as to why a limited company at present existing under the

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name of the Tyneside Electric Power Distribution Company, Limited, could not supply him just as well as the present company, to which he could give no definite answer.

Cross-examined by the counsel for South Shields Corporation, he stated, as to asking the Corporation to supply their works, he was under the impression that the reply had been that a supply could not be given. It depended on the price charged whether he would take a supply from the South Shields Corporation. Cross-examined on behalf of the Walker and Wallsend Company, he stated that he was one of the promoters of the Tyneside Bill. The price he mentioned was according to the circular sent round by the Tyneside Company. If there were any favour shown to anyone, he hoped to get the benefit of it. Cross-examined on behalf of Tynemouth Corporation, he said he did not know that the Corporation had asked them whether they were willing to take a supply. On the charges of the Tyneside Company he hoped to save £1,800 per year. Examined by Mr. Frere, he said he hoped to get the benefit of the lumping together his electrical consumption on both sides of the Tyne in order to get the energy at the cheaper rate. In answer to the committee, he expected to get the cheap rate even if the works were supplied from different stations of the company.

Mr. T. TWEDDLE was called, and said he was chairman of the Newcastle Wholesale Co-operative Society, which also had works on both sides of the Tyne. It was now obtaining a supply from a local authority, but thought it would be better served by a large company like this. The works took about 700 h.p. at present, and would soon require another 400. They were also erecting works in Felling.

Mr. SIMPSON, the chairman of the Ryton District Council, said he was also privately interested in the district, and was a coalowner. The company would greatly benefit the district and would help the collieries, as many of these would take a supply. On the north side of the Tyne there were engines amounting to about 5,000 h.p, and on the south side to about 10,000 h.p. The owners of these would probably take a supply.

Cross-examined by Mr. Balfour Browne as to whether, as a consumer and not a promoter, he would take a supply from the Durham Company if it could supply more cheaply, he stated that it depended on the reliability of the supply. In answer to the Chairman, he said that some arrangement would, perhaps, be come to as to the supply if both were allowed on the south side of the Tyne. The rates at Ryton could not support an installation. The company should not go into a district in which the local authority was able to supply without the consent of the authority.

Mr. BROWELL, an alderman of Durham, and chairman of South Shields Rural District Council, said his Councils supported the Bill. Cross-examined by Mr. Baggallay, he thought it would be a "dog-in-the-manger" sort of thing to stop the mains passing through South Shields.

Mr. BENWELL was called, and said he was chairman of the Benwell and Felling Urban District Council. Cross-examined by the counsel for the Newcastle Supply Company, he said the Council's great object was to get a good and cheap supply in the district; he did not care from whom, and he had no preference for one company more than another.

Mr. KIRTON, of the Newburn Urban District Council, said there were many industries and collieries in his district which might take a supply.

Lord KELVIN was called, and said he gave evidence before the Electric Lighting Commission in 1879. He was a member of the international commission which in 1891 considered the utilisation of the Niagara water power. In his evidence he had stated that electrical energy could be transmitted over long distances, and safety was practically secured by the present knowledge possessed by electricians. This scheme was likely to be of advantage to the district, and the compactness of the area would be advantageous in the distribution. The Tyneside Company should not be limited to the north side of the river. There would be no difficulty in connecting both sides of the Tyne by submerged cables, and he had special knowledge on the question of submarine cables. Competition with a local authority would be bad, but competition between two similar power distribution companies would probably not be bad, as the companies competing for a contract did not lay the mains until such contract had been decided, and were thus at no loss.

Cross-examined, he stated that he should not advocate competition with a local authority, but that a supply should be allowed where works could be reached by private wayleaves. No difference in price should be made between large and small consumers. The wires could be taken in other ways than by underground conduits. They could be fastened to the houses, as at Rome, but he would not advocate this. The wires were absolutely safe in this way, except if they were blown down. The wires could be taken all over a district in this way. Examined by Mr. Baggallay, he said he thought the Tyneside Company were the better to supply on the south side of the Tyne. He thought it better that competition should be allowed. In answer to the committee, he stated that this country was much behind other countries in the employment of electrical energy. He considered it desirable that Parliament should facilitate the use of electricity, and should give a free hand in such schemes as these. The smallest quantity of power which could be produced at the most economical rate was about 4,000 h.p. or 5,000 h.p. The Durham Company would have about 5,000 h.p. in the first instance, and this was a very economical load. He thought about 5,000 h.p. would probably be absorbed on the north side of the Tyne. The chemical works could take an interrupted supply to suit the station. If the Tyneside Company competed very strongly, they would take away some of the County of Durham Company's best consumers. He thought the best place for the Durham Company's station would be the centre of their district. The great reason for England being so far behind other countries was want of water power.

Mr. PLUMMER, secretary of the Newcastle Chamber of Commerce, was called, and said he thought this cheap power would lead to the establishment of fresh manufactories in the Tyneside district. Fair competition was desirable.

Mr. JAMES SWINBURNE was then examined, and said he was not connected with the promoters of the Bill. He agreed generally with Lord Kelvin's evidence. He thought the Tyneside district was compact and suitable for a power supply. The sites for the generating stations were well selected, and that at Wallsend was well placed for supplying the whole district at first. In order to get the chemical works to take a supply, it was necessary to supply as cheaply as possible. He agreed with Lord Kelvin that 4,000 h.p. to 5,000 h p. was the most economical load. The mains with the companies on each side of the Tyne would be practically doubled, as the main arteries would naturally run along the river banks. There was no chance of the local authorities giving such favourable terms, unless they acted as middlemen to these power companies. The tendency, he thought, was that way. He agreed with Lord Kelvin as to competition.

The enquiry was then adjourned till Monday.

MONDAY.

On Monday Mr. JAMES SWINBURNE was re-examined by Mr. Frere as to the advantage derivable from increasing the size of station. He stated that from 1,000 h.p. to 5,000 h.p. was required as a minimum for economical production. Increase even up to 100,000 h.p. gave further advantage in reducing cost. Even if the coal required per unit was not much less, the distribution over large areas would result in improved load factors and economy of supply. It was to the interest of consumers to improve the load factor in this way, as would be done if both sides of the Tyne were supplied. He thought the sliding scale could be easily worked by giving a discount of 5 per cent. to everyone for every 1 per cent. increase in dividend over 10 per cent.

Prof. S. P. THOMPSON agreed with the evidence given by Lord Kelvin as regards the economy of generation on a large scale. There was at present no limit found by practice at which it would be economical to build a new station instead of to extend a large one in operation.

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It would not be economical to cut up the Tyneside district horizontally, but both sides should be supplied together.

Cross-examined by Mr. Rickards, Prof. Thompson said he did not consider that the competition with an existing company supplying in detail would be unfair. A further cross-examination resulted in the witness admitting that he did not know any of the local details. Cross-examined by Mr. Forbes Lankester as to competition generally, Prof. Thompson stated that competition in supply in bulk he did not consider unfair. Competition in detail handicapped the undertakers, and was not advantageous. He defined supply in bulk as a supply in which there was no obligation to supply every small consumer along a line of route. He did not think it unfair for the Tyneside Company to supply in a district already equipped with an electric light works and having a detail supply. It was probable that large consumers could not be supplied sufficiently cheaply by such a supply. He was not aware that the Walker and Wallsend Gas Company were practically first in the field for a large part of the district and that they would be able to supply in August. Re-examined by Mr. Frere, the witness said he understood that this scheme would do for the Tyneside what large distribution schemes had done for certain districts abroad. He had in his mind the works at Rheinfelden, Niagara, Vizzola, and Paderno. In these cases it was found advantageous that a large area should be supplied from a large station. These works had created new industries in the districts served. These were water-power stations. In answer to members of committee, Prof. Thompson said he knew of no larger works of 10,000 h.p. in England for the supply of power only, or of such a works driven by steam abroad. He did not consider that water power was of necessity cheaper than coal, as the cost of water power would rise as the demand for it increased. In the case of the City of London Electric Light Company it had been found advantageous to dismantle one of their generating stations, and to gather all the plant on the Bankside site. At Paderno the supply was given only in bulk to the city of Milan and to a group of factories. At Niagara many different enterprises were supplied, such as chemical factories, the tramways, etc.; as they were also at Buffalo and other places. The local authorities had prevented supply being given in Basle by the Rheinfelden works.

Mr. A. A. CAMPBELL SWINTON, recalled, gave evidence as to the cost of a supply of 20,000 units per annum, this being the minimum suggested by the South Wales Power Bill. He gave schedules of costs per unit showing the working of the maximum demand system, and explained that the above number of units might cost from £75 to £250, according to the maximum load and hours over which it was spread.

Mr. SQUAREY then opened the case on behalf of the borough of Tynemouth. He referred to the fact that Tynemouth was at the end of the district, and it had an installation of its own almost ready for opening. There was hence no need for a company to undertake to supply in bulk in the district or to lay mains through the district in order to reach other authorities. He quoted Sir A. Noble's evidence to the effect that these large consumers might still be supplied by local authorities, and added that the borough of Tynemouth had never contemplated supplying on anything like the large scale which the power company proposed. He complained that it would, however, be very hard if the company were allowed to supply by private wayleaves. From a letter from the secretary of the company, dated Jan. 16, 1900, the Corporation had concluded that the company would have no power to break up streets in the area.

The CHAIRMAN here interposed and expressed the views of the committee as follows: The committee wish to inform the petitioners against the Bill who are local authorities that the position of the manufacturer who is within the district of the local authority and who wants a supply in bulk is occupying their attention. That if the local authority is unable or unwilling to give such supply or to give it only at a prohibitive price, the manufacturers must go without. The examination in chief of the petitioners should be directed towards this point.

Mr SQUAREY, in the concluding part of his speech, referred to the fact that a strip of land on the north side of the Tyne in the Tynemouth district was not intersected by roads. This strip of private land would enable the Tyneside Company to supply practically all the large manufacturers.

Mr. J. F. SMILLIE, examined by Mr. Squarey, said he was the borough surveyor of Tynemouth, which had a population of 53,000 and a ratable value of £200,000. The electric lighting provisional order was obtained in 1891, and they hoped to have the station running in about two months' time. The British Electric Traction Company were going to work the trams in the district, and would take a supply from the Corporation. They had the Local Government Board's sanction to borrow £35,000, which would provide plant of 660 kw. They would be quite prepared to supply large consumers like Smith's Docks. He objected to the company being able to compete with the Corporation in such a supply, as he thought it would prejudice the success of their electrical undertaking. He contended that it was absolutely unnecessary for the company to have powers for the Tyneside area.

Cross-examined by Mr. Lloyd, Mr. Smillie stated that the municipality should have a monopoly, and it would be unfair competition for the company to take the large consumers by private wayleaves.

After severe cross-examination, he admitted that the Corporation had not had under consideration a demand such as would be required by Messrs. Cookson and Mr. Eustace Smith.

In reply to the Chairman, the witness stated that the Corporation had had a canvass taken in 1893, the results of which were unfavourable to the introduction of electric lighting. They had been nine years in carrying out their order. He did not think that the Corporation would be justified in spending sufficient money to lay down a 10,000-kw. plant unless there was a constant demand for the same. He thought that with a three-year guarantee they would be quite safe in supplying such large undertakings. The street-lighting by electricity was only being partially undertaken at the present time in view of the large number of private consumers applying.

One of the committee then asked the question as to whether the Corporation was not putting on one side the public duty of street-lighting in order to carry out commercial business, but Mr. Smillie did not agree with this view of the case. He considered that if a large increase of capital were required for electric lighting, the rateable value must also be increased.

The case of the Gateshead Council was then put by Mr. PAGE. He stated that under the present arrangement between the Gateshead Corporation and the County of Durham Electric Distribution Company, the Council had the right of repurchasing the electric undertaking within the municipal boundary after 13 years, with due consideration of the value of the undertaking as a going concern. He considered that the introduction of the Tyneside Company into the district would reduce the value of this right, and on these grounds the Council strongly opposed it.

Mr. N. TEMPERLEY, examined by Mr. Page, said he was the vice-chairman of the Parliamentary Committee of the Gateshead County Council. He had gone most fully into the arrangement between the Electrical Power Distribution Company and the Gateshead Corporation, and had considered that the arrangements made were favourable to the latter party. They also obtained a concession as to free wiring and coin meters, which would greatly facilitate the use of electricity by the resident population. This agreement had been duly passed by Parliament. If the present Bill were passed it would enable the Tyneside Company to supply all the large manufacturers in Gateshead by means of wayleaves along the North-Eastern Railway.

Cross-examined by Mr. Frere, witness said he had not compared the rates to be charged by the Electrical Power Distribution Company and the Tyneside Company.

The COUNSEL for the Gosforth Urban District Council was then heard, and the CHAIRMAN of the Council gave evidence as to the opposition brought by Gosforth against the Bill. The lines of this opposition were practically the same as those mentioned above, and it was also stated that in Gosforth there were no manufacturing works or collieries

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actually in operation. The Newcastle-on-Tyne Supply Company had arranged to give a supply to Gosforth at the same rates as supplied to Newcastle-on-Tyne.

Mr. G. HOLLINGS, surveyor to the Wallsend Urban District Council, was then examined by Mr. Shortt. He stated that the population of Wallsend was rapidly on the increase, and that the District Council had an agreement with the Walker and Wallsend Gas Company for electrical energy. His Council was advised that they had done everything to provide an efficient supply of electricity for manufacturers within their district. He therefore held that the introduction of a second company was quite unnecessary. He strongly objected to trunk mains being led through the district, as the streets were already very much crowded.

Before the proceedings closed, Mr. PEMBER, on behalf of the promoters of the South Wales Bill, expressed the fear that the committee, in giving their decision on the Bills standing first in the list, might afterwards treat that decision as a precedent affecting all the Bills. The promoters hoped that the committee would find the South Wales Bill differing so materially in its conditions that it might be treated on special lines. He hoped that the committee would not apply any principle in all the Bills until they had heard the case of the South Wales Bill.

TUESDAY.

On Tuesday, Sir JAMES KITSON stated that he wished to announce the procedure decided on by the committee with respect to the decisions to be given in all the Power Bills before them. The committee had decided to give no expression of opinion on any of the Bills until they had heard the whole of them. They had practically the direction of Parliament that there should be a uniformity in the clauses, and until the whole series had been heard they might be apt to apply principles in one Bill which would not apply in others. He also announced that the committee would not sit on Monday and Tuesday next week.

Mr. FITZGERALD then opened the case for Hebburn and Felling, which he stated much on the same lines as when opposing the County of Durham Bill. The Tyneside Bill was draughted much more widely, and allowed of a supply being given over private wayleaves, much to the detriment of local authorities having a station. This would have the effect of taking away the large consumers, and would oblige the local authorities to raise their prices to small consumers. It would also result in a differential charge to manufacturers. In consequence of this, any manufacturer who could not be reached by private wayleave would have to take a supply from the local authority, who were handicapped in the way mentioned above. He quoted the evidence of Lord Kelvin, and argued that he showed that we were behind in electrical matters in this country mainly because of the want of water power. He did not consider that Mr. Campbell Swinton's argument, that there was no member of Parliament to express the views of the company, was a valid reason for trying to evade the undertaking given by the President of the Board of Trade.

Mr. H. W. HANDCOCK was then examined as to the details of the proposed electric lighting of Hebburn. In this case the expenditure would be £21,000. He expected a total revenue of £3,749, out of which £1,797 would be for the supply of power, and £980 for street-lighting. He estimated the total cost of working at £2,149, while the interest and sinking fund at 6 per cent. would come to £1,292. These figures showed a final profit of about £300. The revenue would be seriously affected if the company were allowed to supply on private wayleaves. He also explained how money could be saved by refuse destruction.

Cross-examined by Mr. Baggallay, Mr. Handcock stated that the report was dated April 25, and that he first gave consideration to the matter in January. In his scheme he had allowed from 88 h.p. to 90 h.p. for electric lighting, and had expected rapid increase. For the expenditure proposed he expected to get about 320 h.p. for power purposes, but he had not contemplated electric traction in the near future. The rateable value was £73,000, and the debts £16,000. There was no provisional order at the present time for the Felling district, which contained the works of Messrs. Hawthorne, Leslie, and Co., and of the United Alkali Company, and other large consumers. Mr. Handcock was not sanguine that these large works would take a supply from outside. If the Tyneside Company had not powers to supply in the district, these works could not get a supply except through the streets of Hebburn and Felling, because the County of Durham Company would not be able to supply by private wayleaves. It might not be a prudent thing to undertake the supply of these large works on the supposition of the coalmining and shipping industries were likely to leave the districts, but this he did not consider probable. He thought it would be prudent for the Council to undertake the supply of such big undertakings.

In answer to the Chairman as to whether such a concern, requiring, say, £140,000 expenditure, should be taken by a small community like Felling, with a rateable value of only £170,000, Mr. Handcock again doubted whether such a large demand would arise. His figures were not obtained from works which he had carried out himself, but from electric lighting undertakings in other parts of the country. The load factor at Hebburn would be an exceptionally high one. Of the two companies, he would prefer the Durham Company, because the wayleave clause was omitted. He had not looked into the fact that in the scheduled rates the Tyneside Company would supply more cheaply.

Mr. PEMBER, on behalf of the Newcastle Corporation, raised the question of the reasons of the placing of works at Walker. The district of the company was, as a whole, on the west of Newcastle, and an electric lighting station in Whickham would be a more central position for this supply station; there were special disadvantages to taking trunk mains through Newcastle, as the streets were already crowded with pipes and mains, and the people of Newcastle would get no benefit from the inconvenience caused. The Ouseburn Valley would have to be crossed, and he found no provision in the Bill for the protection of the bridges over which the mains would have to be led. In the same way there was no provision for the company making any necessary alterations to these bridges in order that the mains could be carried across, or to ensure that the company should bear the cost of any alterations to the mains in the future. These through mains did no good to the district, and he did not think that Newcastle should be put to any expense in connection with the same. The cost of making good the streets after a trench had been opened was only temporary, as the street was permanently damaged by the work.

Mr. MORTON SMITH then addressed the committee on behalf of the Walker Urban District Council. He explained that the Council had an electric lighting provisional order, but that they were under agreement to take power from the Newcastle Electric Supply Company subject to repurchase at the end of 10 years. The local authority would provide its own mains. He proceeded to read a quantity of letters which had passed between the Tyneside Company and the Walker Council to substantiate a statement that the Council had not been fairly dealt with, both as regards terms and as regards the explanation of the real object of the Bill. The Walker Council naturally objected to the company being able to supply anyone in the district whom they could reach by the North-Eastern Railway Company.

In reply to the Chairman, he stated that while the company had not an agreement with the North-Eastern Railway, they had already approached them for permission to lay such cables.

The Rev. Father BERRY, chairman of the Walker Urban District Council, said that having obtained a provisional order the Council had been approached by both the Newcastle-on-Tyne Supply Company and the Walker and Wallsend Gas Company. The first-named had given them most favourable terms for the supply of electricity in bulk. They would be able to repurchase at the end of 10 years.

Cross-examined, he stated that they were obtaining a loan for the laying down of mains, and it was brought out that the only thing which would be repurchased would be the transformer station where the supply was taken. The Walker district was full of manufactories, which they hoped to be able to supply.

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Mr. J. M. RENNOLDSON, examined by Mr. Hans Hamilton, said he was an alderman of South Shields, and had been chairman of the Electric Lighting Committee since 1893. They had their own electric lighting station on the river in a very central position, and had paid a very considerable sum for the site. He proceeded to explain the system of supply, and showed a map giving the extent of the mains. Their capital expenditure was nearly £100,000, and they contemplated a further expenditure of £40,000 shortly. He estimated that the possible load for supplying the works along the Tyne was about 3,000 e.h.p. They had already some 2,100 e.h.p. in their station. With extensions he believed they would be able to supply quite as cheaply as the large power company. Their price to consumers was now 7d. for the first hour's maximum demand and 2d. afterwards, with a small discount for prompt payment. No formal application had been received from Mr. Eustace Smith for the supply of power. His Council had unanimously decided to oppose this Bill on the ground that competition was unfair with their own station. As regards supplying Smith's Docks, he did not think there would be anything gained from having the two docks on the one station unless they had a special cable across the river, which was practically impossible at that point. He thought that even if the company were to supply in the district, it should be through the Corporation as intermediate agent.

Cross-examined by Mr. Lloyd, Mr. Rennoldson agreed that the single-phase alternate-current system they had adopted was quite unsuitable for motor work. Single-phase motors were running satisfactorily on the Continent. His Corporation had not considered the question of a large power supply, because no such demand had been made. About £50,000 would be required to supply Smith's Docks with 850 h.p., and they would be prepared to provide this capital.

In answer to the Chairman, Mr. Rennoldson stated that it would cost the Corporation less than the company, as the long feeding mains would be avoided. They had already taken the risk of such supply in electric lighting, and were quite willing to take it in the supply of power. While the undertaking paid, he did not think the Local Government Board would object to the granting of the loans.

WEDNESDAY.

Mr. J. P. WARDLE also gave evidence on behalf of the South Shields electric light undertaking. He stated that he was the owner of a sawmill which required 100 h.p., in which electrical driving would be of great advantage.

In cross-examination, he admitted that new machinery would have to be laid down in the electric light station in order to supply a motor load, but he was quite confident that the Corporation would do this.

Mr. J. A. JECKELL, examined by Mr. Hans Hamilton, said that he had advised the Corporation of South Shields from 1893. The present site of the lighting station was selected on the river because of the convenience of water supply, cheap coal, and also because it would enable them to supply power. He selected the single-phase alternate-current system because it was the best at the time, as the Board of Trade did not then allow the present higher limit for low-tension distribution. He agreed with Lord Kelvin's evidence that when plant for 5,000 h.p. was in a station electricity could be generated very cheaply, and he considered that South Shields alone would provide this load. The site of their station was big enough to contain an 8,000-h.p. to 9,000-h.p. plant. They supplied power at 2d. per unit, but this was for small motors, and special terms were given for large motors. Mr. Jeckell then gave comparative results of the cost of working the Newcastle District Supply Company's station and the South Shields undertaking. These showed that in 1899, although the Newcastle District Company had sold twice as much energy as the South Shields Corporation, the costs were higher. The figures were: Newcastle District Company, total cost, 1·9d. per unit; South Shields Corporation, 1·7d. per unit. The average price obtained at Newcastle was 3·79d., and at South Shields 3·7d. per unit. These favourable results were obtained in spite of the fact that the Newcastle Company had much the better load factor. The Newcastle works were organised by Mr. Parsons, who was the managing director, and who was also a promoter of the present Bill.

Cross-examined by Mr. Frere, Mr. Jeckell stated that they would probably put down polyphase plant for supplying power. The 850 h.p. required in Smith's Docks would cost, with reserve plant, £17,000. The present capital cost of the South Shields undertaking averaged £60 per electrical horse-power. He could not say what would be the details of the arrangement with Mr. Smith, or as to whether he would have to pay when not using the power.

In answer to the Chairman, Mr. Jeckell stated that the position of their station would enable them to supply manufacturers without the intervention of a transformer station. There might be some advantage in taking a supply from the company, providing the company would give them a supply at rates below those charged to manufacturers, but in the Bill this was not provided for. In answer to Colonel Long, the witness stated that he would expect a supply to manufacturers at from ¾d. to 1¼d. per unit. He attributed the favourable results at South Shields to the high efficiency of the plant they had.

Mr. J. M. HAYTON then gave some figures as to the financial liabilities and assets of the South Shields borough.

Mr. HANS HAMILTON, addressing the committee on behalf of South Shields, emphasised the fact that the Corporation were obliged to supply all applicants for light and power, whereas the Tyneside Company would have no such obligation. He urged that the Corporation had already proved themselves capable managers of an electric light undertaking, which gave more satisfactory results than that of Mr. Parson's own works in Newcastle. He also brought the case of the Corporation of Jarrow before the committee, in which case the County of Durham Electrical Power Distribution Company owned a provisional order. The Jarrow authorities objected to the Tyneside Bill, and desired to see the County of Durham Bill passed. They preferred to trust to the provisions of the Electric Lighting Act for the reduction of charges rather than to the sliding scale in the present Bill, which was very indefinite in its arrangements.

Mr. MOON then addressed the committee on behalf of the Durham Electric Distribution Company, owning orders in Gateshead and Jarrow, and it had also an application before the Board of Trade for a Whickham order. The result of competition between the two companies now proposing to supply in bulk would be that his company would have to pay more to the Durham Power Company for its supply in bulk. Also they might have closer competition if the local authority were to pass a resolution allowing the Tyneside Company to break up streets indiscriminately. This would entail competition in detail, which should not be allowed except under a direct Act of Parliament. His company had been termed middlemen and it was stated that the Tyneside Company would save the middlemen's profit, but he considered that the middleman fulfilled a useful object in taking the supply to smaller consumers. If his company were found to charge too much, that could be remedied quite easily by Parliament in the future.

Mr. J. D. FITZGERALD then opened the case of the Walker and Wallsend Gas Company, who by their Act last year are authorised to supply electricity in Walker and Willington Quay. Under the provisions of this Act the price had to be reduced by a sliding scale when 5 per cent. was paid, and when the maximum price was 1d. per unit the maximum dividend allowable would be 11 per cent. They had entered into an arrangement with the Newcastle-on-Tyne Electric Supply Company by which they would co-operate in the use of a large station. These works were now being constructed with machinery of 5,000 h.p. He urged that it would be of no benefit to the Walker and Wallsend districts for the present company to come in and open the streets and to compete in detail, which was not advisable. There was not a single local authority in the district supporting the Tyneside Bill.

Mr. C. H. MERZ, examined by Mr. Forbes Lankester, said he was advising, as electrical engineer, the Walker and Wallsend Gas Company. He had had considerable experience in similar undertakings in London,

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Croydon, and Cork. In Cork they were supplying consumers with power at as low a rate as 1d. and 1⅛d. per unit. A large area of supply was only advantageous in so far as it gave a large demand. A large station and a compact area was much better for an economical supply. Most of the manufacturers in their district had asked them to design their installations, and he had gone into the matter with Messrs. Wigan, Richardson, and Co., Messrs. Armstrong, Walker Shipping Yard, and the North-Eastern Marine Engineering Company. These firms would take a large amount of power, but he thought the promoters of the Tyneside Bill exaggerated the quantity required. They estimated, for instance, that Wigan, Richardson, and Co. would require 1,500 h.p., whereas their maximum amount was not likely to exceed 600 h.p. He had looked into the question of the cost of distribution over a great distance which would be found with the Tyneside Bill, and arrived at the conclusion that in one case the cost of transmitting the power would be 0·1d. per unit, which was a very appreciable figure in the total cost. The Walker and Wallsend Gas Company under his advice had placed contracts for cables exceeding £30,000, and had ordered 5,000 h.p. in generating machinery. They expected to commence supplying in August. Their cables were being laid in iron troughing with an iron cover outside, and were being arranged in duplicate, and as far as possible on duplicate routes, so as to avoid the chance of breakdown. They were arranging to supply manufacturers with installations at a fixed rental per annum for keeping the motors, etc., in order. In their agreements they proposed a maximum rate of 4d. for the first hour per day and 1d. afterwards, but they expressly stated that these were maximum rates, and that they hoped to reduce them. He did not see how the Walker and Wallsend Gas Company could have taken more active steps for the supply of power in the district than they had done.

(To be continued.)

MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

(Continued from page 672.)

On the resumption of the consideration of the Manchester and Liverpool Electric Express Railway Bill by Sir John Kennaway's Committee on Thursday—not Wednesday, as stated in our last issue—the 10th inst., the Right Hon. THOMAS BRIGGS, Lord Mayor of Manchester, gave evidence. He voiced the feelings of commercial men in Manchester that more frequent and rapid communication between that city and Liverpool was desirable, and he was of the opinion that if this additional accommodation were provided it would be very extensively used.

Mr. ELLIOT COOPER, M.I.C.E., subsequently went into some details as to the new line, and expressed it as his opinion, based on experience, that the vibration of a train was not perceptibly increased by the increase of its speed. The subsidence of one end of a sleeper to an ordinary train would be disastrous, but on the mono-rail the effect would be nil.

On the following day (Friday) M. GERARD, engineer-in-chief of the Belgian State Railways, stated that by direction of his Government he made a careful examination, extending over a considerable period, into the experimental line on the mono-rail system in connection with the Brussels Exhibition of 1897. The general result of this and other investigations was to convince him that upon this system an express passenger railway could be constructed between Manchester and Liverpool upon which a speed of from 100 to 110, and in some parts of the line 120 miles an hour could with great safety be run. Such a line would not cost more to establish, taking everything together, than an ordinary railway of the same class intended to secure the same traffic.

Several witnesses gave evidence as to the advantages which would accrue to the public from a more frequent and rapid communication between Manchester and Liverpool.

Sir WILLIAM H. PREECE, formerly engineer-in-chief and electrician to the General Post Office, said that, in his opinion, the proposed system of distributing the electrical power was eminently suitable for the purposes to be served. It had been amply tried in America and Switzerland, and also on the tramway system in Dublin. It was perfectly reliable and safe. If the trains were run as proposed, with a 10 minutes' service, a constant load would be maintained, and this was conducive to the greatest possible economy. It would be quite possible to attain the high speed desired. There were no electrical risks, nor did he see any mechanical ones. As to brakes, he admitted the seriousness and difficulty of the problem, because we had no experience of brakes operating on trains going at 110 miles an hour. The experience of air brakes had not extended to trains going at a speed of more than 70 miles an hour, and how far the Westinghouse brake would act at 110 miles an hour was a question of experience and not of opinion. It was quite practicable, he thought, to do as Mr. Behr proposed, which was to throw out louvres—that was to say, wings or a kind of shutters—in front, and so increase materially the air resistance to the train when so desired. The air resistance at these high speeds must be very great. It would be possible, he thought, so to reduce the speed and bring the train within the range of the ordinary brake. He was of the opinion that one of these trains going at 110 miles an hour could be stopped within 1,500 yards. He had not taken into account the gradients in approaching the station at either end. He was assuming there was some obstruction or that for some reason the driver desired to pull up. The estimate he had given was an outside one. It was based on a calculation of the effect of the air brake and the Westinghouse brake. But if an electric brake were applied as well, the skidding of the wheel would help to stop the train in a shorter distance. There being no points, no switches, and no junctions, he saw no necessity for signals, except at Manchester, Warrington, and Liverpool, and these would be on the latest system, known as the lock-and-block system. It would be quite practicable for the conductor to make use of the telephone and speak to Warrington and Liverpool, or Manchester for assistance. In his opinion this project was sound from the engineering and commercial point of view.

The committee hereupon adjourned until Monday, when Sir W. H. Preece continued his evidence in explanation of the electrical arrangements and working of the line. Generally these arrangements would comply with the requirements of the Board of Trade and would not be dangerous to life.

Mr. COTTRELL, engineer and manager of the Liverpool Overhead Railway, expressed the opinion that the scheme was feasible, but doubted whether it was possible to attain a speed of 110 miles an hour. He put the maximum, which could only be reached on certain sections of the line, at 100 miles an hour, and the ordinary speed at 90. It would be possible to stop the train within 500 yards, but only at great inconvenience to the passengers. It could be stopped comfortably within 900 yards, and that could be done without difficulty by short-circuiting the motors, which would have the effect of applying what was practically an electric brake.

Mr. PARSHALL, electrical engineer to the Central London Railway, said that from experiments he had made he believed that 110 miles an hour was both a practicable and a safe speed.

Mr. E. HOPKINSON, managing director of Mather and Platt, Salford, expressed the same opinion. The construction of the proposed line would afford absolute immunity from derailment. In cross-examination, he said that he should put the limit of speed attainable at 120 or 130 miles an hour. It depended on the strength of the materials used. The cost of the electrical equipment of the line would be between £450,000 and £500,000.

Evidence was subsequently given by several business men belonging to Manchester and Liverpool as to the advantage the line would confer upon them.

The committee then adjourned till Tuesday, when, on the resumption of evidence, Mr. A. STENNING, surveyor, expressed the opinion that the line had been laid out to avoid as far as possible important properties, about 32 miles passing through agricultural land. He agreed with the estimate of £451,000 for the purchase of property.

Several witnesses next gave evidence as to the values of the proposed line, and Mr. H. FAIRCLOUGH testified to the unsatisfactory mode in which existing railway companies dealt with local and goods traffic, and said that when a line of the character now proposed was in operation, they would be able to give improved facilities in this direction. Mr. W. MATHER, M.P., also spoke in favour of the scheme, whereupon the case for the promoters concluded.

Evidence was then called on behalf of the various opposing authorities, and the hearing was continued on Wednesday, the 16th inst.

Institution of Electrical Engineers.—On Wednesday last Mr. A. W. Heaviside delivered, at Newcastle-on-Tyne, the inaugural address to the local section of the Institution. This address we hope to give fully in an approaching issue. The subjects treated of were wide-reaching, but special references were made to those electrical inventions connected with the district. A large gathering of electrical engineers was present at this opening meeting, and a hearty vote of thanks was passed to Mr. Heaviside for his address as first chairman.

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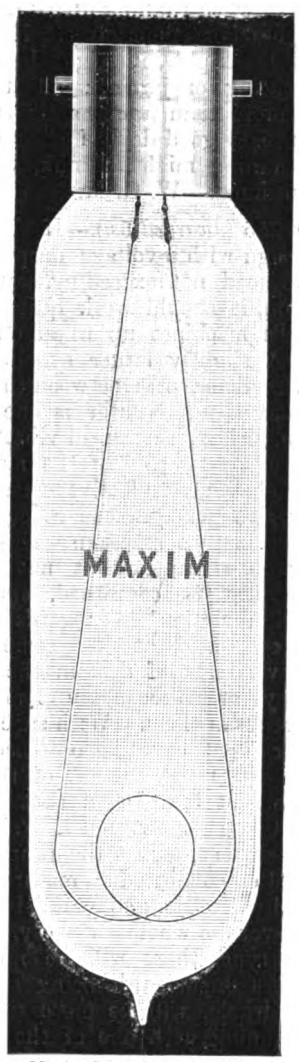
MAXIM LAMPS.

The Hiram S. Maxim Electrical Corporation, Limited, have sent us their list of incandescent electric lamps. For these it is claimed that no more than three watts per candle is required at any part of the life of the lamp. This high efficiency is also said to be accompanied by a long life. In addition to the ordinary candle-power lamps in low and high voltage the company manufactures high candle-power lamps for the lighting of large areas and all descriptions of outdoor lighting, and can supply such lamps up to 2,000 c.p. Lamps in fancy bulbs, flame, olive, and cylindrical in shape, are stocked in various voltages, also the standard shape of bulb in coloured glass for decorative purposes. The illustration herewith shows one type of these fancy bulbs, and of the filaments used in them. It is of



Maxim Incandescent Lamp.

a 32-c.p. lamp for a 100-volt circuit. There should be a large demand for the Maxim lamp on its merits, as mentioned above.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

Questions.

271. What is the most convenient and practical method of carrying out tests on the heating, voltage drop, and insulation of a transformer with the usual apparatus available in a central station? —E. B.

272. Give sketch and detailed description of a good form of "section" street pillar for tramway work.—P. H.

Answers.

Question No. 261.—Describe a periodical routine of testing for a system of underground mains, the instruments necessary, and method of keeping records.

Best Answer to No. 261 (*awarded* 10*s.*).—In practical work neither conductivity nor capacity tests are made on the mains. Methods of testing the insulation resistance of mains vary considerably. It depends upon the type of main laid which system prevails, and, it may be added, upon the type of man in charge of the mains. Take the case of the simplest form of mains, a two-wire low-tension network. For this the continuous test to earth through a pair of incandescent lamps cannot be called periodical, neither is it of much use if both positive and negative contact earths; but it is the test most generally used. With systems of distributing mains that are jointed solid, without testing facilities anywhere, it is almost a farce to do any testing at all, so impossible is it to distinguish the weakened insulation on a consumer's premises from a fault on the mains. The usual plan is to trust in Providence, burn out the faults as they appear, and locate them by consumers' bad language. Some engineers who use good cable, well laid, and who wish to keep maintenance expenses down, consider that periodic testing is not worth the trouble, especially after a few months have elapsed since commencing a public supply. There are others who have kept up the main tests daily, to the writer's knowledge, for over a year. The Board of Trade enjoin that tests must be made every week, except where one conductor is earthed. But it is wise to disregard the Board of Trade's leniency as to the latter clause, and make things even by assuming the week to be a "contractor's week." Given a system of mains which can be subdivided into reasonable lengths, and can be easily disconnected from consumers at the service joint, there is good reason why tests should be taken once a month. Assume high-tension alternating-current feeders, low-tension distributors, and series arc circuits: a portable testing set, comprising 50,000-ohm resistance coil, shunts up to $\frac{1}{499}$, a galvanometer with a compensating magnet, and a 200-volt battery on a truck (Silvertown pattern) is quite accurate enough.

High-Tension Feeders.—Cut out transformers and disconnect earth wires, if concentric system with outer earthed. Test between poles and to earth on each. This test is best made on Sunday mornings, as current must be shut off, unless more than one feeder supplies the network, when the transformer's low-tension fuses must be taken out also to avoid "feeding back."

Low-Tension Distributors.—If it is possible to cut off consumers, test between poles; if not, test to earth on both poles separately. This can be made a stock job for fine mornings, as there is little danger in disconnecting low-tension cables.

Arc Circuits.—Open the circuit at farthest lamp, and test between, then test to earth on both poles. A high test on this need not be looked for, but if unusually low, switch off all lamps and test again. N.B.—Be careful that the trimmers cut off the lamps they are working on, as the usual testing voltage of 200 may throw them off the posts.

The above is a rough method of testing, and should be permissible only when things are busy. As the mains are laid and jointed, a record of the insulation of the cable length between each joint should be kept, and more particularly a record of the insulation between each disconnecting box, which should come about every quarter mile. These records should be entered in the test-book against the name or number of the quarter-mile section, and curves should be made. If a particular curve shows a prolonged drooping tendency, the joints on the section should be looked at, and broken, if necessary, for further testing, until the defective place is located and repaired. The weak spots

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on new mains take time to develop, according to their wet or dry location; and, however well a main tests at first, it is no guarantee of permanently good insulation. There are other methods, in which Cardew voltmeters, electrostatic voltmeters, vacuum tubes, and milliampere-meters figure, for testing while current is on, but these are superficial, although mostly garnished with formulæ. A double pressure test on the high tension on occasional fine Sunday mornings is worth much of them.—J. H. C. B.

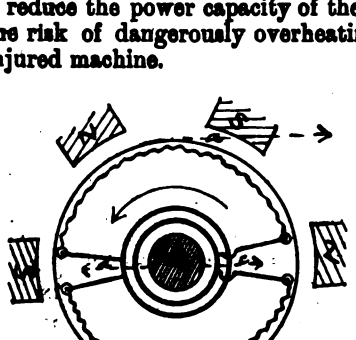
Question No. 265.—The armature of a stationary-field alternator has its halves connected in parallel. One of these halves is injured, and is completely disconnected. Explain what would happen if the alternator were now paralleled with the other machines.

Best Answer to No. 265 (*awarded* 10*s.*).—If when the engine is running at its normal speed, and the field is adjusted to the usual amount, the faulty alternator shows the same voltage at its terminals, and has the same periodicity as heretofore, then, from an electrical point of view, we may consider it quite possible to synchronise and switch into parallel as before the accident. Let us examine if this is the case. The voltage at the terminals of the sound alternator would have been expressed by the formula

$$E^v = K \times p \times n \times C \times N \div 10^8;$$

where K = constant depending on ratio of pole-pitch to pole-breadth;
p = number of pairs of poles;
n = number of revolutions per second;
C = number of armature conductors in *series*;
N = magnetic flux per pole.

Now, it is evident that K, p, n, and N will not be affected in any way by disconnecting half of the armature; C is the only term that could be interfered with, and this also remains unchanged, for, although half of the conductors have been cut out, the number in "series" remains as before. The voltage of the alternator, therefore, would be the same after as before the accident. The periodicity $= p \times n$, and this also remains unaffected; therefore, it should be quite possible for the injured machine to be run in parallel. By cutting out one-half of the armature you reduce the effective cross-section of the conductors, and consequently the current-carrying capacity to one-half its former value. The engine, if suitable for driving the alternator in its former condition, will be now capable of giving out power at least equivalent to twice the safe maximum output of the faulty machine. The governor will have to be regulated, therefore (if it is capable of such regulation), so that the engine may not fully respond to the demands made upon it when running in parallel, otherwise you will reduce the power capacity of the whole plant, or else run the risk of dangerously overheating the armature of the injured machine.



Now to look at the question from a mechanical point of view. The field generated by the magnets of an alternator causes a strong resistance to the motion of the armature conductors when carrying current. The resultants of this resistance in either half of the armature are represented in direction in the figure by the arrows *a* and *b*. This resistance is overcome by the power transmitted through the shaft from the engine, and reacting forces occur, the resultants of which are represented in the figure by *c* and *d*, which each tend to force the shaft against the bearings in its own direction. When the machine is in perfect condition the field is symmetrical, and the current passing through either half will be approximately equal, then *a* will be equal to *b*, and the reactions *c* and *d*, will be also equal, and being opposite in direction, will neutralise one another; so that practically the only force tending to make the shaft bear harder in one direction than another will be the weight of the armature itself. If we take the case in question, where only one-half of the armature is carrying current (let us suppose in the figure it is the upper half) the resultant, *b*, and the reaction, *d*, will practically disappear. There certainly will be a small resistance due to eddy currents, but very slight in comparison with *a*. We shall now have the force, *c*, unopposed, and this, revolving as the armature revolves, will tend to make the shaft bear with great pressure against the bearings in its own direction. What effect this will have when running in parallel depends very much upon the bearings themselves. If there is a good top bearing and little play, it might be possible to run without much heating or jarring; but if the cap of the bearing is little more than a cover (as is sometimes the case), and if there is a good deal of clearance allowed, the consequences of running might, I think, be too serious to allow it to be continued.—W. G. M.

Answer to No. 265 (*awarded* 5*s.*).—If the alternator is of good modern design with a voltage drop from no load to full non-inductive load not exceeding, say, 10 per cent. at constant excitation, it should work quite satisfactorily in parallel with other machines up to an output of half its rated current. A slightly larger synchronising current than usual may, however, pass between the machines. If, on the other hand, the alternator is one having a large armature reaction, serious mechanical vibration of armature or field may be set up due to half the magnet poles at a given instant, not having any active armature conductors near them, being stronger than the other half, which are weakened by the armature reaction. This would produce a force varying in strength, but not in direction as far as the armature is concerned, and varying both in strength and direction as regards the field, and moving round the field at the same speed as the armature. This variation of flux in the magnets would also, unless they are thoroughly laminated, produce serious eddy currents in them. With such an alternator a small amount of current could be obtained, but it should not approach half the rated current of the machine. In these considerations it is assumed that the armature is so wound that the coils cut out lie side by side on one half of the periphery, whilst the round coils cover the other half. Parallel connected armatures are, however, sometimes wound with the two parallel sets of windings both distributed over the whole periphery. If the armature is of this latter type, there will be no danger of the mechanical stresses mentioned being set up, and the machine, on the whole, will be more suitable than the other type for running with one of the parallels disconnected.—Q.

Question No. 266.—What would be the best plan for arranging a negative booster on an extended system of tramways where several routes require to have the current on rails, as it were, sucked back by these apparatus? Would it be satisfactory to have the negative feeders connecting on to a 'bus bar, or to have a number of boosters working on each feeder separately?

Best Answer to No. 266 (*awarded* 10*s.*).—It would not be satisfactory to have the negative feeders connected to a 'bus bar which is supplied by one negative booster, for this reason: If the booster is designed to add, say 100 volts, to the negative side when a current of 50 amperes is flowing, then suppose there is a tram close to the feeding point A, which is taking 50 amperes, and there are no trams near to B and C, if the point A is at earth potential, B and C will be negative to earth to the extent of 10 volts. On the other hand, suppose there is a tram close to each of the three feeding points, A, B, and C, and they each take 50 amperes, then the booster will add 30 volts to the negative side, and as the drop in each feeder is only 10 volts, each of the feeding points A, B, and C, will be 20 volts negative to earth. This state of things would be much worse than having no negative feeders at all, as the electrolytic troubles would be very much worse if the

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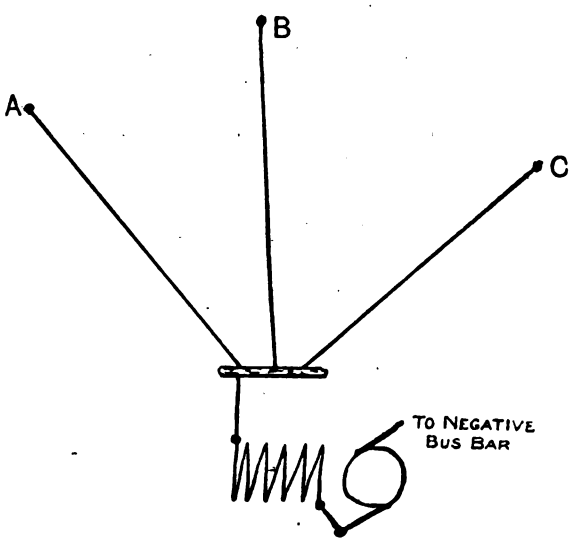
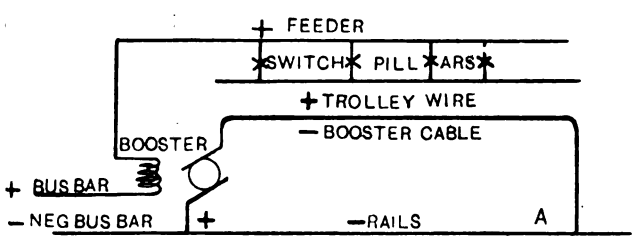
earth currents flowed from the generating station earth-plate to the rails than if they flowed from the rails to the



earth-plate. The conclusion to be drawn, therefore, is that if you must have negative boosters, you will require one for each feeder, and it must be adjusted to meet the requirements of that feeder.—J. R. P. L.

Answer to No. 266 (*awarded* 5*s.*).—A negative booster is used for lowering the drop of volts in the rail return of a tramway in order to comply with Board of Trade rules, which only allow a drop of seven volts in any particular circuit. This question may be divided into two parts: (*a*) separate boosters on each feeder; (*b*) one booster for all the feeders.

(*a*) The connections are shown below. The booster is run at constant speed, but the strength of booster field is varied by a coil in series with the trolley wire. Now drop in voltage in a circuit is proportional to the current in the circuit, the resistance being constant. Suppose a car is started at A, it follows that there will be a drop in voltage



on the rail return, and it is at this point the negative booster is useful. When more current is required on the trolley line the booster field is strengthened, and 10 to 20 volts are generated. This new current flows in the opposite direction to the main current, and opposing the return of current through the rail forces it through the booster cable. It will be seen from the above that the negative booster depends for efficient working on generating and applying an upsetting voltage to any portion of the rail which is taking a large amount of current. Working under these conditions—that is, a separate booster to each feeder—these boosters are very successful.

(*b*) If a number of boosters are connected on a 'bus bar they act as one booster, so for simplicity we will consider one booster to all feeders. In a power station the machines supply several feeders, and if the booster is to regulate for all the feeders, the regulating winding on the booster will have to take all the current generated so as to alter strength of field to any of the different routes taking current. Suppose, now, one feeder, as shown in (*a*), was taking current, the booster will supply a current in the opposite direction opposing the earth return, but in this case we have a number of feeders connected on a common 'bus bar, and the current generated by the booster will traverse the path of least resistance—*i.e.*, the one without any opposing current in the rail; but this is just the opposite to what is wanted, so it will be seen that by grouping the boosters together we defeat the main object for which these negative boosters are designed, and instead take a current from the 'bus bars, which is simply wasted. From the above it will be evident that each feeder must have its own booster.—F. M. MOODY.

PHYSICAL SOCIETY.

At an ordinary meeting of this society, held on Friday last, the discussion of Prof. Lodge's paper, "**On the Controversy Concerning Volta's Contact Force,**" was commenced by **Prof. Armstrong**, who expressed his indebtedness to the president for putting forth clearly what they were trying to understand, and said that it was hardly time for chemists to enter the discussion when physicists themselves differed. There had apparently been a change in front, since the effect was supposed to be due to (1) chemical action between metals or (2) oxidation. Prof. Lodge's view was intermediate, but approximated to the second. Prof. Armstrong said that from a practical point the existence of the effect was unknown because sufficient precautions had never been taken to prevent chemical action. He urged the continuance of experiments similar to those carried out by Mr. Spiers, and stated that modern ideas of chemistry were favourable to the view which Prof. Lodge had taken up with regard to the Volta effect.

Mr. Glazebrook made some remarks upon the meaning of the term E which occurred in the expression for the Peltier effect at the junction of two metals. If they confined their attention to an infinitesimal cycle at the junction of two metals at slightly different temperatures they got the equation for the Peltier effect, in which E was the potential difference at the point considered. If, then, assuming reversibility, they summed up all the infinitesimal cycles round a circuit and got a finite cycle, the E.M.F. of the circuit was a function of the two temperatures between which it was working. Differentiating with respect to temperature the total E.M.F. of the circuit, they got an equation which applied to the circuit as a whole, and in which E was the total E.M.F. round the circuit.

Mr. Price asked if any critical experiment could be suggested to settle the question.

Dr. Lehfeldt called attention to some experiments which had been performed to measure the potential difference between an electrolyte and a gas. The electrolytes considered were chiefly aqueous solutions, and the potential differences observed varied largely. The surface tensions of the liquids were measured, and it was shown that the variations in the potential difference were very similar to those in surface tension This suggested, in the case of electrolytes, true physical surface effects and not chemical action.

The **Chairman** remarked that Dr. Lehfeldt evidently looked upon the metal-ether boundary as being the effective one. The experimental evidence was not sufficient to say exactly which was the effective contact, but it seemed to show that the metal-ether effect was of the same order of magnitude as the oxygen layer effect. According to Helmholtz, they ought to be related, and they apparently were.

The **Chairman** then read a paper by **Mr. J. B. Taylor** on "**The Heat of Formation of Alloys.**" Experiments had been made upon alloys of lead with tin, bismuth, and zinc, and of zinc with tin and mercury. The method employed consisted in dissolving (1) the alloy and (2) the corresponding mixture of metals in mercury, and measuring the heat of solution in each case. On the assumption that the solutions obtained were identical, the difference between the heat of solution of the mixture and that of the alloy was the heat of formation of the latter. The calorimeter was a thin glass tube silvered on the outside, and supported by a stouter tube silvered on the inside. Suitable arrangements were adopted for the introduction of the metals or alloys, which were used in the form of filings. Solution was often complete in less than a minute, and rarely took more than 2½ minutes. The alloys first experimented upon contained their constituents in equivalent proportions, and the heats of formation were found to be small in comparison with those found for brass by Galt and Baker. It was thought that only a small percentage of the atoms present had entered into definite chemical combination, and that more reliable results would be obtained by dissolving a small quantity of one metal in an excess of the other, and calculating from the experimental results the heat of formation of the gramme molecular weight of compound upon the supposition that the whole of the small quantity of metal had entered into chemical combination by the exercise of its normal valency. Using these numbers so obtained to find by Kelvin's theory the potential difference which should exist between the metals concerned when put in contact, results were arrived at which agreed neither with the Volta effect or the Peltier effect, but which were considerably nearer the former than the latter.

A paper on "**The Want of Uniformity in the Action of Copper-Zinc Alloys on Nitric Acid**" was read by **Dr. J. H. Gladstone.** Experiments have been made by dissolving copper-zinc alloys in nitric acid, following the method of Dr. Galt, and adopting the precautions mentioned by him. The reaction between nitric acid and these metals or alloys was very complicated, and there was a difference between the products in the case of an alloy and in the case of the equivalent mixed metals. The gases evolved being

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small in the experiments performed, attention was directed to the determination of the substances remaining in solution—*i.e.*, the nitrous acid and ammonia. The alloys gave much more nitrous acid and less ammonia; in fact, two of the alloys employed produced no ammonia. Discrepancies in results might be due to the fact that the zinc and copper in contact formed a zinc-copper couple which, in the presence of acid, set up a vigorous action, and produced a different evolution of heat. Difficulties arise in the investigation, because the alloys used might not be definite chemical compounds, but mixtures of two or more alloys with uncombined zinc and copper. The alloy with 38·38 per cent. of copper appeared to be fairly uniform. Different observers disagreed as to the amount of heat produced by any reaction, but the excess of calories in a zinc reaction over those in a copper reaction appeared to be fairly constant. Starting with 640 calories, the value, according to Galt, when copper was dissolved in nitric acid of specific gravity 1·360, they should have 1,357 calories when zinc was dissolved, provided the chemical action was the same in each case. All the calometrical results from the different specimens of alloys would theoretically lie upon the straight line drawn between 604 and 1,357. This was practically so from pure copper to the copper 70 per cent. alloy, but beyond that there was less heat produced than that indicated by the straight-line law, the maximum deviation lying at about copper 37 per cent. The specimen containing 38·38 per cent. copper, which was not far from the alloy $CuZn_2$, showed a loss of 32 calories. The only way in which that deficit could be accounted for was by supposing that the action of that alloy on nitric acid produced a larger quantity of nitric oxide than in the case of pure copper. But allowing full force to that argument, it could not account for as much as 10 calories of the deficit. There was therefore a residual deficit as yet unaccounted for on chemical grounds. The author stated that it was desirable that experiments should be conducted on the zinc-copper alloys with solvents which gave a simpler chemical action than that produced by nitric acid.

The Chairman pointed out that the results obtained by Galt for an alloy which appeared to a chemical compound, were in close agreement with what would be expected from the existence of the Volta contact force.

Prof. Armstrong said that the action of nitric acid on brass or zinc and copper was a function of the quantity of acid present, its strength, the temperature, and the pressure, and that therefore it was unsatisfactory to conduct experiments using nitric acid as a solvent. He suggested the use of a solution of bromine, in which finely-powdered zinc, copper, and brass were easily soluble with a simple chemical reaction.

Mr. Tomlinson pointed out that it was impossible to use the ordinary formula for the calculation of the Volta effect from the heat of formation of alloys unless they knew exactly the chemical composition of the alloy which was produced.

Mr. W. R. Cooper, referring to Mr. Tayler's paper, said it was difficult to see that anything could be proved by the application of the Kelvin theory to a metallic contact unless there was ground for believing that some particular alloy of fixed composition was always formed. There was also a further difficulty in converting heat of formation into E.M.F. in cases where the metals had different valencies, for there was no reason why one valency should be selected rather than the other. Referring to Dr. Gladstone's paper, Mr. Cooper said that it was possible that the difference in the reducing powers of mixtures and alloys might be due to local action, which would be more pronounced in the case of alloys. More hydrogen would be evolved and the reduction would be more complete.

Prof. S. P. Thompson then showed an "**Electromagnetic Experiment.**" A circular coil capable of carrying a strong current was placed with its axis horizontal in a tank of water. Into the tank were also placed some small magnets in sealed glass tubes so adjusted as to have a density approximately equal to that of water. The magnets just floated or just sank. On running a current through the coil it was possible to "fish" for the magnets, which, acted upon by the magnetic field, immediately made their way to the coil. When the current was carefully reversed upon the approach of a magnet, repulsion instead of attraction took place, and the magnet retreated. In general, however, reversal of the current produced reversed polarity in the magnet, and attraction still persisted.

The society then adjourned until May 25.

LEGAL INTELLIGENCE.

CHAMBERLAIN AND HOOKHAM v. THE MAYOR, ETC., OF BRADFORD.

This case was tried before Mr. Justice Farwell. Mr. J. Fletcher Moulton, Q.C., M.P., Mr. A. J. Walter, and Mr. Gray appeared for the plaintiffs; and Mr. C. A. Cripps, Q.C., M.P., Mr. Bousfield, Q.C., M.P., and Mr. J. C. Graham for the defendants.

The trial of this case lasted through the greater part of seven days. Judgment has not yet been given. There will be no necessity to detail at any great length the evidence, the case if we may say so, being at once simple and complex, but reducible to a short summary. In 1887, Mr. Hookham was granted letters patent (No. 4,225) for a motor meter. Under this patent current meters have been made and extensively used for direct currents; but although the patent specification contains allusions to an alternate-current motor meter, we do not gather that any alternate-current meters under this patent have been put on the market. The Bradford Corporation use a Thomson-Houston energy motor meter, and it is claimed that this meter is an infringement of Patent No. 4,225 of 1887. The trial was partly to determine the following conundrum:

An energy meter measures volts × amperes = watts.

A current meter measures ampere-hours.

When an energy meter is used upon circuits with volts constant, does it become merely a meter to measure the variable factor left, and nothing else? and partly, does Patent No. 4,225 sufficiently disclose an alternate-current meter so as to bring a subsequently constructed meter within such disclosure? The plaintiffs have previously obtained a favourable judgment as regards the validity of the patent before Mr. Justice Wills.

The evidence of the witnesses on the plaintiffs' side went to show (1) that the Hookham meter was the first practical motor meter put upon the market; (2) that in its construction it embodied new features (*a*) a form of magnet of great power and constancy, (*b*) large diminution of friction; (3) that the specification indicated how to construct an alternate-current meter (having consideration of the knowledge at the time), although its details and drawings were more particularly directed to the construction of a direct-current meter.

Mr. Hookham, in his evidence, described the principles and construction of a motor meter, which consist essentially of two parts, the motor and the brake. Assuming the field of the motor constant, the armature movement would be proportional to the current. If the armature is driving a disc in which Foucault currents are generated and doing no other work, then the resistance of the Foucault disc will be proportional to the speed. Hence, under these conditions, the rotation of the disc will be proportional to the current. This supposes that the losses due to friction of the apparatus are negligible. One of the improvements introduced by Mr. Hookham was to decrease such friction to a minimum. He did this by the use of friction wheels, mercury contacts, and compound windings. With regard to the construction of powerful and constant magnets, Mr. Hookham in his specification describes both electro and permanent magnets, preferring to use in his meter permanent magnets, which were to form as nearly as possible a closed magnet system, in which the polar ends were to be very large in comparison with the distance separating those ends in which the brake disc or armature disc would have to revolve. When electromagnets were used under certain conditions they would be saturated, but the specification indicated that under other conditions saturation was not necessary. With reference to the Bradford works, he understood that the voltage was very constant, and the witness explained the functions of the various parts of the motor meter used at Bradford, pointing out that there was shunt winding upon the field coils, a small shunt wire being used to give a starting force against the friction of the armature, and that there was a small current always passing through the armature, that the armature did not rotate till the current passed through the field coils.

In cross-examination, witness said that in circuits with both factors inconstant the energy meter would give a measure of that inconstancy, while the current meter would not do so. The current meter does not take notice of change of pressure. It is designed on the assumption that changes of pressure need not be taken notice of, whereas the energy meter chronicles the result of both current and pressure. He admitted that, so far as the arrangements were concerned, the defendants' meter was materially different from the Hookham meter. A good many questions were asked concerning power and constancy and method of making powerful magnets. In order to show certain anticipatory instruments, a reference was made to Siemens's energy measure and certain papers of M. Marcel Deprez and Mr. Uppenborn, these two latter papers not having been before Mr. Justice Wills. It was admitted that Profs. Ayrton and Perry had given a theory of such meters, that M. Marcel Deprez had also given a theory of motor meters, that Messrs. Siemens had constructed a meter to which M. Marcel Deprez suggested the addition of a Foucault disc similar to that used in his speed indicator. It was admitted that the defendants' motor arrangement was practically the same as the Siemens motor arrangement except for the compound winding device. It was subsequently argued that, although Messrs. Siemens had a wattmeter and M. Marcel Deprez and Mr. Uppenborn had discussed the requirements, and both they and Profs. Ayrton and Perry had given the theory, that no practical instrument was made from that knowledge, therefore the knowledge was insufficient to invalidate the plaintiffs' patent. It was admitted that, although Messrs. Thomson and Houston's system was a practical combination of Seimens's instrument and Deprez's suggestion, it needed certain modifications before it could become a practical instrument, and that a silver commutator with silver brushes had been added and a modification in the brake magnets made.

Mr. Swinburne agreed that Mr. Hookham's meter was a current and not an energy meter, that it consisted essentially of two parts: the motor, whose speed depended upon the current; and the brake, whose torque depended upon its speed. Combining the two he obtained a straight-line law result. In examination and cross-examination he went through the anticipatory literature and patents, and held that nowhere was there indicated the way to make a practical motor meter, and that, although meagre, there was sufficient indication in the plaintiffs' specification to enable an alternate-current meter to be constructed.

Mr. Dugald Clark thought that Mr. Hookham was the first to invent a practical motor meter. Asked as to his views on the

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infringements, he said: "They infringe the first claim, because they have a meter consisting of two parts. One part is a motor having the straight-line law; the other part is a magnetic brake having the straight-line law. Both motor and brake work in a powerful and constant field, and that is what I understand the first claim claims. They work in a powerful and constant field; they have the motor, and they have the brake just the same. Then the third claim I consider to be infringed, because they use a magnetic brake for the purpose of an electric meter, so constructing the magnet as to maintain constancy and power—that is, that large pole-pieces closely approach to each other, and that, as I understand, they do, and that I believe to be Mr. Hookham's invention."

Mr. Walter: In use upon the circuits of the Bradford Corporation, what in fact does the instrument measure?

Witness; Current; I am sure about that. There is a great trouble in all instruments in which there is a starting coil running away without any current passing through the lamps at all. There is a great deal of trouble in connection with all meters of that class. A comparatively small variation of potential will make the starting force so large as to run the meter, and it is quite a common thing in meters of that class for them to be running when there is no current going through them at all. The consequence is that any meter of that class must be made for a very small range of potential. If it were made for a large potential range, either of two things would happen: either you could not start with a low current, or if you went over the potential, the meter would over-run.

(To be continued.)

BULSTRODE AND OTHERS v. JULIUS SAX AND CO., LIMITED.

This case was tried before the Lord Chief Justice of England and a special jury last week, and judgment was given on Friday last. It was an action for libel arising out of a circular issued by the defendants, in which it was stated that Messrs. Bulstrode and four other members of the staff of Julius Sax and Co. had been discharged, and casting imputations on them. These five gentlemen had left the firm and started in business for themselves. They then issued a circular reading as follows: "The firm of Julius Sax and Co. Limited, having gone into voluntary liquidation, we, the undersigned, being the heads of the various departments named below, have formed ourselves into a syndicate to carry on the business of electrical engineers and electric light contractors at the above address, assisted by several of the late employés of the old company, working on the lines of the old firm, manufacturing the best articles, and putting in first-class work only. Trusting for a share of your support, which shall receive our best attention, we remain." The libellous circular was issued by the defendant company in answer to this. It commenced: "It has come to our knowledge that certain former employés of the firm who were discharged by us have sent out to our customers a circular containing misleading statements which may possibly be injurious," and went on to state that "the business will be carried on precisely as heretofore at the above address by a thoroughly competent staff and under the guidance of well-known electricians, while at the same time the services of such of the former staff who have proved themselves capable and competent have been retained," and then, lastly, "In order to prevent servants whose services we have not thought it right in the interests of the company to retain from prejudicing our customers, we think it is only necessary to call your attention to the above facts."

The jury awarded the plaintiffs £250 in all, or £50 each, and certified for a special jury.

TROUBLE ABOUT A DYNAMO.

In the Westminster County Court on Monday, his Honour Judge Lumley Smith, Q.C., tried the case of Cunnington *v.* Buxton, in which the plaintiffs, a firm of electrical engineers carrying on business at 93, St. Martin's-lane, W.C., sued the defendant, the proprietor of premises at Whitehall, to recover the sum of £39 19s. 6d. in respect of electrical work carried out to his instructions. The defendant set up a counterclaim of £45. 12s. damages alleged to have been suffered owing to the defective manner in which the work was carried out.

Mr. Drake (barrister) appeared for the plaintiffs, and said the claim was in respect of certain work done to the defendant's dynamo, which, at the time it was handed over to the plaintiffs, was so defective as to necessitate its removal for repairs. When the work was completed the machine was returned to the defendant, who, through his manager, refused to accept it.

Mr. Joseph Smith Cunnington was called, and said the defendant complained of the dynamo making too much noise, and upon his examining it he found that the bearings were out of gear. He also found that the plummer blocks were wrongly fixed, and that a good deal of work was required to be done. When the machine was completed it was delivered at the defendant's place, but he refused to accept it.

The **Defendant** was called, and said his case was that the plaintiffs' charges were excessive, inasmuch as when he consulted them on the subject they told him that the defects could be put right in about three hours. As a matter of fact he had suffered severe loss in his business by being deprived of the use of the dynamo, and that was why he was counterclaiming for damages.

After a lengthy hearing his Honour gave judgment for the plaintiffs for £20 and costs, and also judgment in their favour on the counterclaim.

TRADE SECRETS.

At Clerkenwell, Frederick Purton, 27, a clerk, of Ruthin-road, Westcombe-park, was charged with stealing from 39, Hartham-road, Holloway, two letters, value 5s., the property of the Jandus Arc Lamp and Electric Company, Limited. Mr. A. Jones, the manager, stated that he believed that the trade secrets of the firm were being revealed, and he suspected that two letters addressed by him to one of the directors of the company, describing details of some valuable experiments, had been appropriated by Purton. The latter had admitted the offence, and when his lodgings were searched by Detective Powell, Y Division, a mass of correspondence containing secrets in connection with the company's business had been found. The defendant said the letters were handed to him to copy by another clerk. He took the letters for his own use and information and not to reveal trade secrets to another firm. He did not think he was doing wrong. In reply to the magistrate, Mr. Jones said the majority of the letters found at the prisoner's lodgings were copies and not originals. Mr. Chapman said that the prisoner had perhaps been guilty of a breach of trust in revealing trade secrets, but he did not think a charge of felony could be sustained. The prisoner would be discharged.

COMPANIES' MEETINGS AND REPORTS.

NEW GENERAL TRACTION.

The fourth annual general meeting of the New General Traction Company, Limited, was held on the 16th inst., at Cannon-street Hotel, E.C., Captain Francis Pavy (the chairman) presiding.

The **Chairman**, in moving the adoption of the report, already noticed by us, gave a historical sketch of the Company's history during the last four years. Then, he said, they had only £50.000 of preference capital. Since that time an additional £200 000 had been subscribed, and more was required before they could finish the works in hand, and reap the full benefit of what they had been doing. They had in their treasury now about £100,000 in the Coventry Electrical Tramway, £165,000 in the Norwich Electrical Tramway, £21,000 in the Douglas Southern Electric Tramways, £1 973 in the Light Railway Syndicate, and £76,000 in the Philadelphia, Morton, and Swathmore Street Railway Company. The Coventry tramway was opened last January, and it was too early to say with any accuracy what would be the result of the working of it. The Norwich line was completed, and he hoped that within the next three weeks or a month they would be able to ask the Board of Trade to pass the work, and that in the course of six weeks the line would be running. The Philadelphia, Morton, and Swathmore Street Tramway was a line of about 20 miles in the neighbourhood of Philadelphia. Baron Emile B. D'Erlanger had visited the same four or five months ago, and was perfectly satisfied with it.

Baron Emile B. D'Erlanger seconded the motion.

Mr. Kitchen suggested that the preference dividend should be paid half-yearly, and that the directors should furnish a report every six months.

The **Chairman** promised that a report and statement of accounts should be submitted at the end of each six months, and a dividend paid if there was any.

The resolution was carried.

Captain Francis Pavy was re-elected a director of the Company, and Messrs. Deloitte, Dever, Griffiths, and Co. were reappointed auditors.

An extraordinary general meeting was held subsequently, at which the following resolution was passed: "That the articles of association be altered in manner following: (*a*) The following article shall be substituted for Article 82—namely, the chairman shall be entitled to receive by way of remuneration £400 per annum, and each of the other directors £200 per annum; and the Board shall be entitled to receive by way of additional remuneration in each year 5 per cent. of the net profits of the Company remaining in that year after payment to the holders of ordinary shares of a dividend of 8 per cent. on the amounts paid on their ordinary shares; such additional remuneration shall be divided among the directors in such proportion and manner as they shall from time to time agree, or, in default of agreement, equally. The Company, in general meeting, may increase the amount of such remuneration, either permanently or for a year or longer term. (*b*) In Sub-Clause E of Article 84 the words 'one-half' shall be deleted."

Leith.—New difficulties have arisen with regard to the purchase of the tramways. The Edinburgh and District Street Tramways Company and the Leith Company have agreed to leave their offers open for some time, but the latter have refused to deduct £2,000 from their offer of £90,000 as the price of the undertaking as requested. In the event of the Corporation not seeing their way to adopt £90,000 as the basis of purchase, no recommendation will be made to the Council at this time to accept the offer of the company.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Dundee.—The Town Council invite tenders for the supply of copper bonds. Tenders by May 22. Details in our advertisement columns.

Dundee.—The Gas Commissioners invite tenders for the supply of small coal and electricity meters. Tenders by May 31. Details in our advertisement columns.

Vladivostock (Siberia).—The Russian Government invite tenders for the concession of constructing and working electric tramways and light in the town.

Walthamstow.—The Urban District Council invite tenders for the erection of arc lamps and the supply of incandescent lamps and accessories, etc. Tenders by May 29.

Glasgow.—The Corporation invite tenders for indiarubber-covered and lead-covered branch cables and carbons for one year. Tenders by May 19. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each. Tenders by June 12. Details in our advertisement columns.

Wick and Lybster.—Tenders are now being asked for the work of constructing the Wick and Lybster Light Railway, which will extend from Wick station to the village of Lybster, 13½ miles.

Newcastle-upon-Tyne.—The Corporation invite tenders for switchboards, underground feeders, and pumping apparatus. Tenders by May 25 and June 1. Particulars in our advertisement columns.

Southampton.—The Corporation invite tenders for the supply and erection of one water-tube boiler, with steam and other pipes, and sundry ironwork. Tenders by May 28. Particulars in our advertisement columns.

Devonport.—The Corporation invite tenders for the supply, delivery, and laying of electric light and traction feeders, distributors, boxes, etc. Tenders by May 25. Particulars in our advertisement columns.

Edinburgh.—The Corporation invite tenders for elevators and conveyors for coal and ashes in connection with McDonald-road electricity supply station. Tenders by May 21. Details in our advertisement columns.

Chelmsford.—The Town Council invite tenders for lighting the public streets and public clock within the borough with electricity, gas, or other illuminating power, for three or five years from March 25, 1901. Tenders by 22nd inst.

Bradford.—The Corporation invite tenders for the construction and delivery of two steam-engines and two dynamos of 1,000 kw. capacity each for their electricity works, Valley-road. Tenders by May 24. Details in our advertisement columns.

Crewe.—The Town Council invite tenders for the wiring of the municipal offices, market hall, and corn exchange, and for supplying lamps and fittings for electrically lighting the same. Tenders by June 11. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the delivery and erection of coal-conveying apparatus and hoppers, also of ash-conveying apparatus, at their electricity works, Valley-road. Tenders by May 31. Details in our advertisement columns.

Partick.—The Corporation invite tenders for the construction, supply, and erection of dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced-draught appliances. Tenders by June 8. Details in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for two or three (at the option of the committee) 630 kw. two-phase generators; and one or two (at the option of the committee) sets of surface-condensing plant. Tenders by May 28. Details in our advertisement columns

London.—The Streets Committee of the Corporation of London invite proposals from firms or persons experienced in the manufacture and use of electric motorcars for the hire of an electrically-driven dustcart. Tenders by June 1. Full particulars in our advertisement columns.

Bradford.—The Corporation invite tenders for the supply and delivery of electric motors (enclosed type) of 4½ h.p., 7 h.p., and 10 h.p., for a period of 12 months commencing July 1, 1900, and terminating June 30, 1901. Tenders by May 24. Details in our advertisement columns.

Wolverhampton.—The Tramways Committee invite tenders for the construction of tramway track and contingent work in Dudley-road, Cleveland-road, Bilston-street, Piper's-row, and Fiveways, amounting to a route length of about one mile seven furlongs, mainly double track. Tenders by June 26.

Dundee.—The Town Council invite tenders for the overhead equipment of the following routes: (Section 1A) Perth-road (extension) route; (2A) Lochee (extension) route; (3) Blackness-road route; (4) Princes-street and Forfar-road route. Tenders by May 31. Details in our advertisement columns.

Crewe.—The Town Council invite tenders for the supply and laying down of about 25,000 yards of three-core cable for street-lighting extensions, and the supply of upwards of 500 lampholders and reflectors for adapting the existing lamp-posts for electric light. Tenders by May 26. Details in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for two or three (at the option of the committee) 630 kw. two-phase generators, comprising triple-expansion engines and alternators, and one or two (at the option of the committee) sets of surface-condensing plant. Tenders by May 28. Details in our advertisement columns.

Bridgwater.—The Town Council are prepared to receive tenders for the supply and erection of boiler-house plant (boilers, fittings, steam and exhaust pipes, etc.), engine-house plant (steam dynamos, pumps), switchboards, etc., underground mains, lamp-posts, etc., accumulators, meters, and crane. Tenders by June 7. Details in our advertisement columns.

London, S.E.—The South London Electric Supply Corporation, Limited, invite tenders for the complete installation of 3,000 lights on the premises of 500 consumers in any part of the area of the company's supply, and also for the installation of two arc lights on the premises of any consumer in the same area. Tenders by June 2. Details in our advertisement columns.

Worksop.—The Urban District Council invite tenders for steam dynamos, balancers, boosters, and motors, Lancashire boilers, steam, exhaust, feed-water and condensing-water pipes, fuel economiser, condenser, and feed pumps, switchboard, accumulators, cables, joint boxes, arc lamps and posts, and overhead travelling crane. Tenders by May 23. Details in our advertisement columns.

London, W.—The Central Electric Supply Company, Limited, invite tenders for the supply, delivery, and erection of two 1,200-i.h.p. Willans engines, each direct coupled to a three-phase H.T. generator; six three-phase H.T. motors, each direct coupled to a L.T. continuous-current generator; and switchboards and connections for above plant. Tenders by May 22. Details in our advertisement columns.

Brussels.—The Council of St. Jilles, lez-Bruxelles, will receive tenders for the installation and the setting to work of a distribution of electricity upon a part of its district. Conditions of contract, with plan, may be obtained on payment of 3fr., at the office specially dealing with the above, No. 14, Parvis St. Jilles, St. Jilles (Brussels). Tenders should be addressed to the Mayor of St. Jilles, lez-Bruxelles, before 2 p.m. on Sept. 19.

Madrid.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Ambassador at Madrid, stating that tenders are invited by the Spanish Government, to be received not later than July 7, for the concession of an electric tramway from the Puerta de Hierro, Madrid, to Aravaco and Pozuelo. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

London, S.W.—The Asylums Committee of the London County Council invite tenders for (1) the installation of electric lighting and power (except generating plant); (2) the installation of telephones, tell-tale clocks, fire-alarms, and call bells at the Horton Asylum, near Epsom, Surrey. Tenders, endorsed "Tender for Electric Lighting, Horton Asylum," or "Tender for Telephone, &c., Installation, Horton Asylum," by 10 a.m. on June 16. Details will be found in our advertisement columns.

Port-y-waen and Llangynog.—The Cambrian Railways Company invite tenders for the construction of a light railway, about 15 miles long, 4ft. 8½in. gauge, commencing by a junction with the branch of the Cambrian Railways at Port-y-waen, in the county of Salop, and terminating at Llangynog, in the county of Montgomery. Plans can be seen, and copies of specification and quantities obtained, on payment of £1. 1s., at the office of Mr. A. J. Collin, engineer to the Tanat Valley Light Railway Company, Oswald road, Oswestry. Tenders by June 5.

Sutton Coldfield.—The Corporation invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, etc., pipework, etc., in engine and boiler house, three steam dynamos (vertical enclosed high-speed engines) and motor boosters, storage batteries, main switchboard and connections, eight-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed) and posts, and station lighting. Tenders by June 21. Details in our advertisement columns.

RESULTS OF TENDERS:

Cardiff.—The tender of Edwards and Armstrong, at £286, for wiring and fitting up the electric light in the new fish market, has been accepted.

Halifax.—The Guardians have accepted the tender of Mr. R. Middleton for installing the electric light at the new Skircoat Hospital, at £1,787.

Keighley.—A tender has been received from the Pendleton Ironworks, Manchester, for constructional steelwork in connection with the buildings for electricity works, amounting to £1 112. 1s. 6d.

Liverpool.—The Select Vestry have accepted the tender of Messrs. Campbell and Isherwood, 30, Regent-road, Bootle, Liverpool, for an installation of about 100 lights in connection with the nurses' home of the workhouse, Brownlow-hill.

Plymouth.—The Corporation have received the following tenders for the supply and erection of the overhead electric equipment of the Compton section of the tramways: British Insulated Wire Company, £3,270; R. W. Blackwell and Co., £3,433 (accepted).

Fulham.—One hundred meters are to be obtained from each of the following firms: British Thomson-Houston Company, Limited (Thomson meter); General Electric Company, Limited (Aron meter); Messrs. Venner and Co. (Chamberlain and Hookham), at an estimated cost of £1,505. 9s., subject to their agreeing to supply the lesser number at a price *pro rata* to that which they quoted for the 250.

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BUSINESS NOTES.

TRACTION.

Darwen.—The profit for the past year on the tramways amounted to £1,054.

Blackpool.—The new line through the park will probably be opened before Whit-week.

Trawden.—The Light Railway Commissioners have granted the Colne and Trawden light railway order.

Dukinfield.—The Council have sealed a joint application with Hyde to the Light Railway Commissioners for an order for a light railway.

Farnworth.—Colonel Yorke has fixed upon to-day for his inspection of the Horwich and Hulton and Farnworth and Kearsley sections of the tramways.

Compagnie Generale de Traction of Paris.—The increase of capital to 30,000,000fr. by the issue of 100,000 new shares of 100fr. each has been sanctioned.

Central London Railway.—Trial trains are running daily on the Central London Railway. It is expected that the end of next month will see the opening to the public.

Experiments on the Underground.—The experimental electric motor train is now running between Earl's Court and High-street, Kensington, between the hours of 9 a.m. and 4 p.m.

Govan.—The Lower Ward District Committee have agreed to support the application by the Glasgow Corporation for powers to construct a tramway on the Govan and Renfrew road.

Scarborough.—The Corporation have decided to obtain expert opinion as to the feasibility of making a tramway on the north side, from the top of the North Cliff to the Clarence Drive.

Sedgley.—The Tramways Committee's report states that the positions of the span poles and other fittings to be erected by the British Electric Traction Company have been considered and dealt with.

Greenock.—The agreement between the Police Board and the directors of the Greenock and Port-Glasgow Tramways Company for leasing by the company of the lines within the burgh was signed on the 15th inst.

Hull.—The Corporation's workmen have now started setting back some of the frontages on the Beverley-road. This is a preliminary to commencing the laying of the electric tramlines in that main thoroughfare.

Wolverhampton.—The Tramways Committee have reconsidered their former decision, and decided to commence the laying down of the new lines from Snowhill to the Fighting Cocks with the gauge already decided upon for all the different routes.

Northampton.—The Town Council are in favour of a light railway from Northampton to Kettering, *vid* Kingsthorpe, Kingsley Park, Abington, Weston Favell, Moulton, Overstone, Sywell, Holcot, Harrington, Walgrave, and Broughton.

Cork.—The County Council have accepted a proposal from the tramway company in connection with the extension of the electric tramway system to Blackrock, guaranteeing the payment of £50 annually to the County Council for the maintenance of the roads.

Kingston.—The Light Railway Commissioners will hold an enquiry at the Assize Courts on the 22nd inst. as to the expediency of granting the application of Messrs. Greenwood and Batley, Limited, for an order authorising a light railway for Kingston, Surbiton, and district.

Bath.—The report recommending that joint application be made to the Light Railway Commissioners for order to construct overhead tramways in the city has passed the Town Council. The parties who will enter into the agreement are Sir James Sivewright, K.C.M.G., and Mr. Leopold Hirsch.

Swadlincote.—The matter of electric trams has created a good deal of interest in the Swadlincote Urban District Council's area, and public opinion is in favour of the scheme, but there is a divided feeling as to whether it would be better to municipalise the scheme or let a private company introduce it.

Thornhill.—The District Council have resolved to ask the British Electric Traction Company for an interview either in London or at Thornhill, preferably at Thornhill, at an early date, as the Council could not allow the proposed order to pass in its present form with reference to their right of purchase of the undertaking.

Burnley.—At a recent meeting of the Corporation Tramways Committee a resolution was passed that it was desirable to relay the tramway lines within the borough as soon as practicable after the acquisition of the tramways by the local authorities. The borough surveyor and the electrical engineer were instructed to prepare preliminary plans and specifications for the carrying out of the work.

Birmingham.—The Tramway Sub-Committee have been asked by the Birmingham and Midland Tramway Company to allow them to erect overhead electric wires on the Dudley-road route. The committee will first ascertain the opinion of the Smethwick Town Council. The Public Works Committee of the City Council has been visiting Liverpool for the purpose of inspecting the various overhead systems.

Farringdon-street Tramways.—At the last meeting of the Court of Common Council, the London County Council's proposal to construct a new tramway from Farringdon-road to Ludgate-circus was discussed. It was said that it should be made clear whether it was to be electric traction or otherwise. Finally, the letter was referred to the Streets Committee to consider the matter fully and to report to the Court.

Ashton-under-Lyne.—A joint meeting of representatives of the boroughs of Stalybridge, Dukinfield, Mossley, and Hyde has been held, at which representatives were present from each town. The consulting engineer presented a draft report upon the tramway scheme, which was favourably considered, after which the meeting was adjourned in order that a scheme for the financial arrangements might be prepared. The Council have resolved to exercise the statutory powers of purchasing such part of the undertaking of the Manchester Carriage and Tramways Company as is within their borough.

Kirkcaldy.—The Town Council have adopted the Tramways and Electric Lighting Committee's recommendation that the Council should proceed at once to establish both tramways and electric light, and that it be remitted by the Council back to the committee with powers to proceed with the work, including power to engage an engineer and to incur all the necessary initial expenses. It is understood, however, that before the contracts for the building of the power station, the construction of the tramways, and the introduction of the electric light are entered into, the committee shall report to the Council.

Coatbridge.—The Town Council have decided to enter into an agreement as to a tramways scheme submitted to them by Mr. Murphy, whose scheme has been adopted at Paisley. The line is to be a double one in the main portion of the town, and the promoter binds himself to construct a tramway from the Whitelaw Fountain along Sunnyside-road to the Redbridge, when the concern is earning 5 per cent. He will have the right to construct a line by way of Dundyvan without any extra payment. He undertakes to begin the work within two years of the Act receiving the Royal assent. The fares are not to exceed ½d. per passenger per half mile, and there will be half-mile stages.

Light Railways.—The Light Railway Commissioners have submitted an order to the Board of Trade for the construction of a light railway from Ravensthorpe to Cleckheaton, and for the construction of light railways in the borough of Barnsley, and the urban districts of Worsborough and Monk Bretton, in the West Riding, Yorks. Applications have been made for light railway orders for lines to be constructed from East Dereham to Hellesdon, and Costessey to Hellesdon, and from Bury St. Edmunds to Stanton, Stanton to Attleborough, Stanton to South Lopham, and South Lopham to Diss. An enquiry will be held at Leeds on June 7 to hear the applications made by the Electric Traction Company, Limited, for powers to construct tramways in certain districts of the West Riding.

Glasgow.—The Tramways Committee's minutes having reference to the proposed extension of the tramways to Paisley and to Renfrew have been agreed to. The Glasgow Corporation have parliamentary powers to construct a line to the eastern boundary of Paisley. An arrangement has been entered into with the Paisley authorities whereby the latter have agreed to construct a line from the centre of the town to connect with the Glasgow Corporation line at the boundary, and to lease this line to the Glasgow Corporation. In regard to the Renfrew extension the report stated that the Tramways Committee had agreed with the Lanarkshire County Council to jointly oppose the present Bill in Parliament, and to jointly ask Parliament in a future session for powers to enable the Glasgow Corporation to continue their line of tramways to the boundaries of Renfrew.

Paisley.—The amended agreement, the acceptance of which we noticed in our last issue, lays it down that Paisley shall construct the eastern section of the main line from the Cross and lease it to Glasgow Corporation, so that they may run cars direct from Glasgow. Mr. Murphy is to have a lease, so that he can run cars from the west to the eastern boundary, each paying rent *pro rata*. Then, while Paisley Corporation shall at the end of 25 years have power to apply to Parliament, with the support of the company, for the right to acquire the whole tramways scheme, including the branch lines outside the burgh boundaries, in the event of Parliament refusing sanction for anything beyond the boundaries, Mr. Murphy shall retain these outside sections and have running power over the Paisley burgh lines. The county, burgh, and city authorities have supported the Bill, the railway companies remain against the same.

Hammersmith.—The Law and Parliamentary Committee of th Hammersmith Vestry, after having carefully considered a pl:n submitted by the London United Tramways Company showing positions of lines, street poles, cable-ways, with manholes and feeder pillars for the portion of their system between Young's-corner and the Broadway, and a letter asking for the Vestry's approval thereof, so as to permit of them proceeding with their overhead system in King-street, Glenthorne-road, and Beadon-road, *pari passu* with the passage of their Bill in Parliament through its preliminary stages, recommended that the plans be approved on condition that the existing passing places in King-street between the Broadway and Studland-street be removed and the carriageway restored, and that it be referred to the chairman, solicitors, and surveyor to prepare the agreement to carry this into effect. The report has been adopted by the Vestry.

Ayr.—A report was submitted by the Tramways Committee at the meeting of the Town Council on the 14th inst. The committee were unanimously of opinion that the overhead trolley wire system of electric traction was the most suitable and economical for the proposed tramways in Ayr. The length of the proposed tramway was equal to four miles seven furlongs of single tramway track. The gauge of the lines would be 4ft. 8½in., and the gradients and curves presented no difficulties. For an efficient car service (allow-

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ing a proper proportion of reserve cars) 12 cars, each carrying 57 passengers, would be required. The line could be constructed and open for traffic in from 12 to 15 months. The committee had carefully considered the estimated cost of a tramway line from St. Leonard's Church to Prestwick Cross. They did not recommend the construction in the meantime of the tramway line from St. Leonard's Church to Burns's Monument, as they were of opinion that that section would be unremunerative at first and a burden on the undertaking. The estimated cost of a complete installation of tramways on the electric overhead trolley system was £57,000, made up as follows: permanent-way construction, £31,000; overhead construction and electrical equipment, including cars, £13 200; car-shed, £3,800; and buildings of power station, generating plant, etc., £9,000. The committee unanimously recommended that the Corporation undertake the formation of the line and the working of the tramways themselves, and that immediate steps be taken for the initiation of the undertaking. The recommendations of the committee were adopted, and they were given powers to appoint an engineer, prepare specifications, and receive tenders for the construction of the line.

Southwark.—At the last meeting of the Vestry of St. George-the-Martyr Mr. Wilson brought up an important report concerning the Baker-street and Waterloo Railway Bill. The committee having petitioned against the Bill, the company asked that the Vestry would submit clauses embodying the requirements of the Vestry. Clauses were accordingly prepared. The principal proposals of the company affecting the parish were the construction of a line of underground railway underneath Westminster Bridge-road, St. George's-circus, and London-road to the Elephant and Castle, with a station in London-road and a subway connecting the London-road Station with the Elephant and Castle Station of the City and South London Railway. A branch line was also to be constructed from a point in Westminster Bridge-road, gradually approaching the surface underneath the portion of St. George's-road between Westminster Bridge-road and Lambeth-road, and coming to the surface in the grounds of the School for the Indigent Blind, which the company propose to acquire as a generating station. The committee were of opinion that it was very undesirable that the railway should be constructed so near the surface as was proposed at the junction of St. George's-road and Lambeth-road, as it would affect the sewers of the Vestry. Upon this point, however, the company declined to give way. In connection with the subway joining the London-road Station and the Elephant and Castle Station of the City and South London Railway, it was suggested that the company should construct a series of subways immediately under the roadways converging at the Elephant and Castle, and that the company at the same time should construct their station underground, close to the Vestry's convenience in St. George's-road, instead of on the site suggested in London-road. Plans of the proposed station and subway were prepared by the engineer of the company and the Vestry's surveyor, and the general outlines of the scheme had now been arranged. After several interviews between representatives of the committee and the representatives of the company, the company had agreed to the proposals of the Vestry, and the Vestry had withdrawn their opposition to the Bill. The chairman, the clerk, and the surveyor were heartily thanked by the Vestry for all they had done in the matter.

LIGHTING AND GENERAL.

Harrow.—The Harrow electric lighting order has been passed by the House of Lords.

Preston.—Another enquiry will be held shortly with regard to the new site adopted by the Council for the electric lighting station.

Worksop.—The Rural District Council have made their application for a loan in connection with the electric lighting of the town.

Hindley.—A sub-committee has been appointed by the District Council to obtain information as to the supply of electricity by the Council.

Yeadon.—The District Council spent nearly 3½ hours on Tuesday night discussing the electric lighting question, but no decision was arrived at.

Horsham.—The Electric Lighting Committee have presented a report on the tender received for carrying out the various schemes of electric lighting.

Cheltenham.—The proposed extension of the electric light mains to Cleeve Hill has been stopped by the action of the Prestbury Parish Council.

Woking.—The application of the National Telephone Company for permission to lay underground cables has been referred to the General Purposes Committee for report.

Mile End.—A special committee of the Guardians has been appointed to consider and report as to how the Board's electric lighting installation may be made successful.

Maesteg.—A motion that steps be taken to secure a provisional order for the electric lighting of the town was discussed at the last meeting of the District Council and lost.

Glasgow.—The Corporation's municipal telephone exchange offers an unlimited service at £5. 5s. a year, or, for occasional users, a toll service at £3. 10s. a year and 1d. for each call.

Woolwich.—The London County Council have sanctioned, subject to certain conditions, the proposal of the Woolwich District Electric Light Company to lay mains along a part of Thomas-street, Woolwich.

Bermondsey.—The Vestry have referred to the Electric Lighting Committee the tenders for the erection of a chimney shaft in connection with the electric lighting and dust-destructor works. The lowest tender was £2,581.

Ashton.—Mr. Vincent has prepared a report on the electricity plant generally, and the same is to be printed together with Mr. Clirehugh's report. A special meeting of the committee will then be held to consider the reports.

London Gazette.—A first and final dividend of 5s. 7d. per pound has been declared in the estate of W. H. F. Bowman, 3, Foster-street, Gainsborough, payable at the Official Receiver's Office, 31, Silver-street, Lincoln, on May 16.

Ogmore and Garw.—A letter from Mr. T. W. Granville Lewis, agent for an electric light syndicate, suggesting that the Council should consider the lighting of the Garw Valley through the agency of his company, is before a committee.

Edinburgh.—The Electric Lighting Committee have agreed to adhere to the former recommendations to increase the charge per unit for private lighting from 3½d. to 3¾d., and to reduce the charge on public lamps from £14 to £13.

International Advertisement Exhibition.—An exhibition is now open at the Crystal Palace where posters and other advertisement "dodges" may be studied with great advantage. The exhibition will remain open until June 2.

Larne.—The contract with the Electric Light Works, Limited, for the public lighting having expired on April 30, the Lighting Committee has been asked to report as to the steps to be taken in connection with the future lighting of the town.

Stirling.—The electric light is to be installed at the County Buildings during the summer months, a report from Mr. Hanson, the electrical engineer of Stirling, who estimated the cost of wiring and fitting at £160 to £190, having been adopted.

Holborn Workhouse.—The Guardians have instructed Mr. Enright to prepare the necessary plans and detailed specification for the installation of electric light at the City-road Workhouse. The total cost of the work, including engineer's commission, is £7 623.

Sudbury.—Major General H. D. Crozier, R.E., has held an enquiry into the application of the Corporation for a loan of £650 for purposes of electric lighting. Mr. W. C. C. Hawtayne, M.I.E.E., said the cost of lighting would be a little under 2d. per unit, which was equivalent to 1s. a thousand cubic feet of gas.

Melton Mowbray.—The electric lighting company have offered to light the streets at 7,500 c.p. for £370 per annum for five years, in addition to the costs of the posts, for which they would be willing to lend the money and accept the repayments by instalments. The gas company's offer to supply lights to the extent of 6,000 c.p. is £340. 11s. At Wednesday's meeting of the Council it was contended that the gas company had been charging £383 for 2,142 c.p. lighting, and now offered to give 6,000 c.p. for £43 less. Finally, the tenders were referred to the Lighting Committee to fully investigate, and a special meeting of the Council will be called for next Wednesday evening.

Appointments Vacant.—Applications for the appointment of an assistant superintendent in the telegraph department of the Government of India, on a commencing salary of Rs.3 600 a year, will be received by the Secretary, Public Works Department, India Office, Whitehall, London, S.W., up to June 30 next.—The Corporation of Cardiff invite applications for the appointment of tramways electrical engineer; commencing salary, £500 per annum.—Applications are invited for the post of Drapers' Company's assistant lecturer and demonstrator in electrical engineering at the University College of North Wales, Bangor; salary £120. Full particulars of these vacancies and others referring to a works manager, a canvasser, and a working foreman, etc., will be found in our advertisement columns.

Parliament.—During the last week in the House of Lords the following Bills were read a second time: Exeter Corporation, London County Council Tramways (No. 2). The following Bills were read a third time and passed: Falkirk Corporation, Cork Electric Tramways, Charing Cross, Euston, and Hampstead Railway, and the Whitechapel and Bow Railway. In the House of Commons the following Bills were read a second time: Blackpool, St. Annes, and Lytham Tramways, Ipswich Corporation Tramways. The Bradford Corporation, Kingston-upon-Thames Corporation, and the Vale of Rheidol Light Railway Bill were read a third time. The following Bills have passed their various Select Committees of the House of Commons: City of London Electric Light Corporation, Limited, Southport and Lytham Tramroad, London United Tramways Extensions, District Railway Company (Electric Traction), Nottingham Corporation, Charing Cross and Strand Electricity Supply Corporation (generating station at West Ham), Walsall Corporation, and South Lancashire Tramway Company. The following electric lighting orders have satisfied the Examiner of Private Bills: Newark, Boston, Long Eaton and Sleaford, and Cleethorpes with-Thurnscoe. The Barnsley Corporation Bill came before Lord Morley's Committee of the House of Lords as an unopposed measure. The Sheffield Corporation Bill came before the Earl of Jersey's Select Committee, who ultimately allowed the Bill to proceed in its amended form to third reading in the Upper House. The Rotherham Corporation Bill was allowed to proceed to the third reading in the Upper House. The House of Lords have appointed Lords Llandaff, Wenlock, Welby, and Purbright to join with the Select Committee of the House of Commons to consider the Dublin Corporation and the Clontarf Urban District Council Bills.

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Machinery Users' Association.—The annual general meeting of the association was held on Tuesday at the Westminster Palace Hotel, Sir William Houldsworth, Bart., M.P., in the chair.

Burnley.—The Buildings Committee of the Guardians have resolved to consult an electrical specialist with respect to the proposed electric installation at the workhouse and infirmary.

Accrington.—The electricity works will probably be ready at Michaelmas next. It is stated that the price fixed by the committee for the electrical supply is lower than that in any of the surrounding boroughs, and as low as in any of the boroughs of the country.

Twickenham.—An application received by the Highways Committee from the National Telephone Company for permission to lay underground cables along Richmond-road, King-street, Heath-road, and part of Staines-road to the Green has been referred to the clerk for report.

Hetton-le-Hole.—The District Council have agreed to an application of the National Telephone Company for permission to erect 13 poles for the carrying of telephone wires. The company offered to pay an acknowledgment of 1s. per annum, and remove the poles at six months' notice.

Whitechapel.—The District Board of Works has received a communication from the Board of Trade intimating that they have decided to grant electric lighting provisional orders to the Vestries of Mile End Old Town and St. George's-in-the-East, and to the Limehouse District Board.

Waterloo-with-Seaforth.—A motion that a sub committee be appointed, consisting of Councillors Cookson, Howarth, Dr. German, Bingham, and Taylor, to ascertain if the Liverpool District Lighting Company, Limited, would sell their Waterloo and Crosby undertaking, and, if so, at what price, has been referred back for reconsideration.

Sunderland.—Colonel C. H. Luard, R.E., has held an enquiry into the application of the Corporation for sanction to borrow £4,500 for the purchase of land for purposes of electric lighting. Mr. J. F. C. Snell, borough electrical engineer, said that the estimated net profit for the current year was £500, after paying over £3,000 sinking fund and interest.

Evesham.—The increase in the price of coal and the fact that they have borrowed nearly as much money as their power permits, has induced the Town Council to consider the advisability of adopting the electric light, and they have now decided to enquire into the cost. Considerable power for generating, it is said, could be obtained from the River Avon.

Holborn.—The St. Giles Board of Works are in correspondence with the agents for the Bedford Estate on account of a circular letter recently issued by the National Telephone Company to its subscribers, stating that they would have to remove all their wires on the Bedford Estate if the authorities persisted in demanding so high a price for wayleave.

Heckmondwike.—At the last meeting of the District Council the report of the Electric Lighting Committee was confirmed. It recommended the acceptance of tenders for the whole of the works, including house connections, buildings and land, and expert services, amounting in the aggregate to £14,842, being an increase on the original estimate of Mr. Hawtayne of £1,500.

King's Lynn.—The resident engineer's last report states that there are now applications from 192 private consumers, being an increase of seven during the month; the number of lamps applied for was 6,226 of 8 c.p. or equivalent, being an increase of 92, and that there are 352 pairs of incandescents in the streets and 22 arcs. The positions of 37 lamps in the districts of Austin-street, Wyatt-street, and Highgate had been fixed, and the positions of other altered.

Chislehurst.—At the last meeting of the Council a letter was read from the National Telephone Company stating that, provided they obtained the necessary consent of the Bromley Urban District Council and the Chislehurst Urban Council, they would place the wires under the railway arch underground. It was decided to reply that, subject to the company obtaining the consent of the Bromley Urban Council, the Council would give their consent to the work being done.

Stock Exchange.—Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to the Alliance Electrical Company's 7,000 5 per cent. cumulative preference shares of £10 each, fully paid. The committee has further been asked to allow the New General Traction Company's further issue of 20,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 54,001 to 74,000, to be quoted in the official list.

Darwen.—At the last meeting of the Town Council, it was stated that the electricity works had been fairly satisfactory, though not quite as good as expected, for there was a loss of £820 on the seven months' working. Yet that was not so bad as it appeared, because while it only referred to seven months' working, they had had to pay 12 months' sinking fund. They had made interest out of the undertaking, but had lost on the sinking fund, the revenue charges on the latter being much against them.

Cheshire Commercial Undertakings.—The Northwich correspondent of the *Financial Times* telegraphs that Mr. Scotter's light railway syndicate, whose undertaking will shortly be the subject of a Commissioners' enquiry, intends making a complete electrical tramways system between Warrington and Northwich, and also in the latter town. The United Alkali Company has bought Wimholdsley estate for £130,000, and intends erecting chemical works there, while at Middlewich the company is building a factory for new electrolytic process.

St. Annes.—The laying of the electric lighting cables is proceeding rapidly under Mr. Tiddeman's direction. Councillor Stansfield has been re-elected chairman of the Electric Lighting Committee. Application is to be made to the Local Government Board for their consent to acquire fresh sites for an electric lighting station, town's yard, and public abattoirs. The question of induced draught in connection with the electric lighting works is being considered.

Hereford.—The electric light was switched on for the first time at the free library last week. Mr. Carless, the chairman of the Free Library Committee, said the citizens were much indebted to the mayor for the work he had done as chairman of the Electric Lighting Committee, and he particularly drew attention to the able, conscientious, and untiring work given by the city electrical engineer, Mr. F. G. Poulton, in connection with the installation. The committee could not say too much for it. They were also much pleased with the way in which the work had been carried through by the contractors, Messrs. Read and Jenkins.

Gloucester.—We understand that it has been found necessary to postpone the official opening of the Gloucester electricity supply station, which had been provisionally fixed for the 24th inst. The engineering portion of the work is so well forward that it is hoped to have current available for private consumers in the course of a week. The structure will not, however, be ready for the official opening until after the date originally decided upon. The Mayor, who has been invited to perform the opening ceremony, will be away from the city for a time, and it is believed it will suit his convenience to switch on the light about the middle of June.

Yarmouth.—The quarterly statement shows that the receipts for electric light were £1,767, and after repaying capital, interest, and all charges there was a clear profit of £65. The statement for the past year shows a profit balance of £437. After deducting the loss of £57 brought forward from the previous year, there was a clear profit of £380. The accountant presented a statement from 1895 to 1900, which showed that the total profit on working was £7,348, but taking the five years through, the total loss was £1,950, less £428 balance of profit last year, making a net loss of £1,522. The light is being installed upon the Wellington Pier and in the Pavilion at a cost of £70

Greenock.—During the month ended May 4, 1900, the number of units generated were 9,372, and the estimated number sent out were 5,333. The number of lamps applied for up to the present by private consumers is equivalent to 6,258 8-c.p. lamps, and this, with the arc lamps, brings the total up to 7,152, or an increase of 710 8 c.p. lamps since last month's report. The number of consumers to be supplied with electric energy now amounts to 97. The Police Board have appointed the Sub-Committee on Electricity to confer with the Water Trust engineer on a suggestion to utilise water for power in connection with future extension of the electricity works, which are likely to be required for tramway traction.

New Issue.—The joint committee of management of the Kensington and Knightsbridge Electric Lighting Company, Limited, and the Notting Hill Electric Lighting Company, Limited, are issuing £100,000 4 per cent. debenture stock, part of an authorised issue of £200,000, at the price of 103 per cent. The two companies, who were empowered by the Kensington and Notting Hill Electric Lighting Companies Act, 1899, jointly to acquire land, and thereon to construct and equip a new generating station for the purpose of supplying electrical energy for the undertakings of both companies, have appointed a joint committee of management for that purpose, and for the working of the station, and of raising the capital required.

Lowestoft.—The Town Council have adopted a report from their General Purposes Committee stating that Mr. Hawtayne and Mr. Pridmore had informed them that the walls of the electric light station in the front and back gables had settled, and that the side walls had also bulged. This settlement had apparently been caused by pumping operations during excavations which were being made for the engine beds. Mr. Hawtayne suggested that a concrete raft should be formed upon which the engines will stand, and which would also be available for future extensions, and Mr. Pridmore suggested that buttresses should be formed for the support of the outside walls. Mr. Hawtayne was directed to provide for the lighting by electric arc lamps of the London-road South as far as Pakefield road.

Londonderry.—The Corporation have received a proposal from the British Thomson-Houston Company, Limited, in which they state that (1) they are prepared, on obtaining the consent and co-operation of the Corporation, to construct and work an electric tramway system over routes to be mutually agreed upon; (2) from the power-house erected by them for the working of the tramways they are willing to supply the Corporation with electrical energy at a rate to be agreed upon the exact rate to be a sliding scale depending upon the hours of demand; (3) the Corporation could themselves lay down the mains and put in the house connections, charging the consumers a price sufficient to cover the cost, maintenance, and renewal of same. The consideration of the letter will take place at a future meeting of the Council.

Westminster Electric Supply Co.—An extraordinary general meeting of the shareholders of the Westminster Electric Supply Corporation, Limited will be held at the registered office, Eccleston-place, S.W., on May 28, at 11 a.m., when the subjoined resolution, which was passed at the recent extraordinary general meeting of the Company, will be submitted for confirmation as a special resolution: "That the capital of the Corporation be increased from £399,500 to £550,000 by the creation of 30,100 ordinary shares of £5 each, and that such shares be issued at par to the share-

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holders *pro rata* according to their holding in the Company." The result of the poll, taken on the 11th inst., on the resolution proposed by Mr. R. W. Wallace, Q.C., at the extraordinary general meeting of shareholders held on April 11 last, is that such resolution has been carried by the requisite majority of three-fourths of the total votes polled.

Stockport.—Mr. R. H. Bicknell has held an enquiry into the application of the Corporation to borrow £23,468 for the purpose of electric lighting. Mr. S. Mounier, electrical engineer and manager of the Corporation gasworks, said the loan was required for new feeders, distributing mains, for the fitting up of consumers, and for the supply of two boilers. The supply of electric current commenced on Dec. 9, 1898. At that time the consumers numbered 30, with an equivalent of 1,596 8 c.p. lamps. On Jan. 1, 1900, the number of consumers had increased to 120, with an equivalent of 7,700 8-c.p. lamps, and at the present time the figures were—129 consumers, equivalent in 8-c.p. lamps to 8,903. There was one 60-h.p. motor and one 1 h.p. motor. In addition to these, installations at the infirmary, baths, free library and market hall, and the technical school, representing 1,356 lamps, would shortly be completed. The unaudited accounts for the year showed that the undertaking had been financially a success, as, after payment of interest and sinking fund, a slight profit had been realised.

Dalkeith.—The Burgh Commissioners have appointed Bailie Chisholm, Bailie Dalgleish, and Commissioner R. Brown as a committee to fully enquire regarding a scheme for the lighting of Dalkeith and Eskbank by electricity, in connection with a report submitted by Bailie Chisholm from a London firm of electric lighting engineers. The Electric Supply Corporation, Limited, have made an offer to supply electrical energy in Dalkeith at 7d. per unit for the first hour, and 4d. per unit for any current required beyond the first hour, on the maximum demand system. The price to be charged for electrical energy for power purposes and for heating and cooking would be 3d. per Board of Trade unit, and the same rate would be fixed for the public lighting of the burgh, this sum being equivalent to gas at 2s per 1,000 cubic feet. The Commissioners of Dalkeith would be entitled to purchase the undertaking if they desired at the expiry of 8, 15, 22, 29, or 42 years on certain conditions. The proposals are to be enquired into with a view to the careful consideration of the scheme by the Commissioners.

Dunfermline.—From the report of Mr. A. W. Bell, the burgh engineer, who recently visited a number of English towns where destructors have been erected, it appears that with 20 tons of refuse per day an available supply of 116 h.p. could be obtained. The steam could be applied for lighting up the streets with electric light. The cost of lighting last year was £670 for a total of 8,750 c.p. The energy from the steam would work a dynamo with 80 per cent. efficiency, which would supply 69 kw. of electric energy. This would give 170 arc lamps of about 500 c.p. each, or about 1,150 incandescent lamps of 16 c.p. each. By the adoption of an accumulator the energy could be stored so as to give, at the worst time of the year, a supply of about 1,500 incandescent lamps of 16 c.p. each. This would give a total of 24,000 c.p. in the streets, instead of 8,750 c.p. as at present. It was, therefore, possible to light up the streets of the city with electric light, give twice the light there was at present, and only utilise about 100 h.p. out of the 116 h.p., and that without using one ounce of coal. The report will be considered at a special meeting of the Commissioners next week.

Southampton.—The Corporation have received from the Local Government Board a letter with reference to the application of the Town Council for sanction to the borrowing of £55,000 for purposes of electric lighting, and complying with the application so far as it relates to the borrowing of £50,655. The Corporation is censured for previous shortcomings, the letter stating that the Board learn from their inspector's report that while the works for which the previous loan was sanctioned have cost £7,069 in excess of their estimated cost, a further sum of £34,088 has been expended upon large extensions of those works in anticipation of the Board's sanction, and without submitting to the Board any particulars of these extensions until they were actually completed. The Board regard the action of the Town Council in this matter as most unsatisfactory, and they trust it will not be repeated. Otherwise the Town Council cannot expect the Board in future to sanction the borrowing of large sums to defray the cost of the important works which have been carried out without reference to the Board, the Town Council well knowing that the sanction of the Board would be required to enable them to borrow the moneys required.

Fulham.—At the meeting of the Vestry on Wednesday last, a report was submitted from the consulting engineer, stating that all the contractors are making normal and satisfactory progress with their contracts, so that probably next week the British Insulated Wire Company (sub-contractors to the General Electric Company) may be drawing cables into the ducts in the streets in which these have been laid down. It was also recommended that tenders be invited for the lighting of all the buildings being erected on the Vestry's site at Townmead-road. A detailed specification of all the work required in carrying out a proper lighting scheme has been prepared. The cost is estimated at between £500 and £600. The installation will include 12 arc lamps and about 160 incandescent lamps. The clerk of works (Mr. Ferguson) reported that since the last meeting three applications for current had been received equivalent to 80 8-c.p. lamps. A report by the medical officer of health on complaints respecting the smoke emitted from the chimney of the Hammersmith Vestry electric light works has been referred to the Law and Parliamentary Committee with a recommendation to take proceedings against the Hammersmith Vestry. The Vestry are advertising that they will shortly be in a position to supply electricity for lighting, power, and heating purposes. The charge for lighting purposes has been fixed at 5d. per Board of Trade unit. The charge for heating or power purposes will be 2½d. per Board of Trade unit. No rent will be charged for the use of meters.

London County Council.—At the meeting of the Council on Tuesday special reports of the Highways Committee were to be submitted recommending that notices be served upon the London, Deptford, and Greenwich Tramways Company, and upon the South London Tramways Company, requiring them to sell to the London County Council, under the conditions and in the manner provided by Section 43 of the Tramways Act, 1870, the whole of the tramways, works, and undertaking authorised by their respective Acts. The reports were not reached. The Council sanctioned the following applications under Electric Lighting Acts and orders to lay mains, etc.: St. James and Pall Mall Electric Light Company—the works in question affected Regent street, Piccadilly, and several other streets in the immediate neighbourhood of those thoroughfares; Westminster Supply Corporation, mains in Haunch of Venison-yard; County of London and Brush Provincial Electric Lighting Company, under the Camberwell Order, 1896, high and low tension mains along and across a portion of Cormon-road; Blackheath and Greenwich District Electric Light Company, low-tension mains across and along a portion of Montpelier-vale; Brompton and Kensington Electricity Supply Company, high and low tension mains along a portion of Lexham-gardens; Kensington and Knightsbridge Electric Lighting Company, low-tension mains along Queen's gate, Prince Consort-road, and Prince's-gate; Vestry of Hampstead, mains in Belsize-crescent, Ornan-road, West Hampstead-avenue, and Birchington-road, and sub-station at the corner of High-road, Kilburn.

Mix and Genest, Limited, of Berlin.—The eleventh general meeting of the shareholders of this Company was held last Saturday, when the directors submitted a most satisfactory report. The balance-sheet shows a gross profit of £30,090, which, after making provision for depreciation on plant, tools, and buildings to the extent of about £11,800, leaves a net profit of £18,290. The shareholders receive a dividend of 12 per cent., £1,000 go to a reserve, which now stands at £36,000, directors' fees and gratifications to managers and engineers absorb £4,300, and £800 are given to their workmen's sick fund, while £432 are carried forward to the new account. In their report the directors are able to state a progressive development, mainly due to the large extension of the telephone system in Germany, which brought also during the last year to them important orders for multiple switchboards, telephone instruments, etc., and which requirements of the German Government they prognosticate to be still larger in the future on account of the adoption of the metallic circuit system. A further impetus has been given to the telephone industry by the German General Post Office allowing subscribers' private installations to be connected to the Government telephone system, free of charge, the only stipulation being that the instruments used on such private installations should be equal in quality to those used by the Government, and as the greater portion of the Government instruments are made and supplied by Mix and Genest, the sales to the trade have considerably increased. All departments are not only fully occupied for a long time, but the volume of business to be dealt with necessitated a further extension of the factory, which now employs 1,500 hands.

Canterbury.—The town clerk's report upon the first full year's working of the electricity undertaking shows 195 consumers as compared with 106 on March 31, 1899. The number of public lamps now connected is 12 arc lamps and 243 incandescent lamps, and 19 additional incandescent lamps are awaiting the completion of the extension machinery. The revenue account shows a gross surplus for the year (actually nine months as far as incandescent lamps are concerned) over the actual working expenses of £1,913. 2s. 7d. The report states: "Placing yourselves for a moment in the position of a private company, this gross surplus would have been available for dividend on your company (a company do not, of course, repay their capital year by year as we are bound to do). Taking, therefore, your capital at £33,435, or say, roughly, at £34,000, this surplus of £1,913. 2s. 7d. could have been applied as follows: dividend at the rate of 4½ per cent. on £34,000, £1 445; amount carried to a reserve fund, £468. 2s. 7d.—making a total of £1,913. 2s. 7d. Had the incandescent public lamps been connected for a full year this balance would have undoubtedly been increased at least (after allowing for a proportionate increase in the works' cost) by £150. The undertaking is, however, in your hands, saddled with the obligation of paying instalments of principal and interest every year, and from the net revenue account you will observe that the gross surplus is applied first in payment of interest on loan £673. 12s. 8d. and capital £833. 9s. 11d., thus leaving a balance of £406 for application as you consider expedient. Upon the question of loan repayments, I would also remind you that the extension loan of £12,850 was taken up in August, 1899, and although the whole of the extension plant is not yet in working order, and you have, therefore, not had the use of the same, you have paid a half year's instalment of principal and interest upon this loan. Loans to the amount of £34,000 have been sanctioned, and the expenditure in excess of that amount is £399. 1s. 7d."

Court of Common Council.—At the last week's meeting the Court discussed a report from the Streets Committee on the recent action in regard to the validity of the agreements with the City of London Electric Lighting Company. The committee recommended that an appeal be lodged against Mr. Justice Farwell's decision. The counsel employed by the Corporation—Mr. Swinfen Eady, Q.C., Mr. Danckwerts, and Mr. Walter—were of opinion that the

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judgment of Mr. Justice Farwell was erroneous. It also appeared to them that the result of the judgment would go far beyond the immediate controversy in the case, and that, according to the learned judge, it was possible for any aldermen and councillors to become pecuniarily interested in contracting companies. Mr. Hudson thought the judgment should be appealed against on public grounds on account of far-reaching effects. Mr. Deputy C. T. Harris, Mr. Ellis (Aldersgate), Mr. Lile (Farringdon Without), and Mr. Brooke Hitching (Farringdon Within) opposed the recommendation. The latter said that the committee asked the Court to take up what was not an honest position. The Streets Committee had consistently led the Court in the wrong direction, and had brought opprobrium upon the Corporation. Mr. Deputy Johnson (Bishopsgate), Mr. Deputy Sayer (Billingsgate), and others supported the committee. Mr. Morton (Farringdon Without) said no corporation could rest content with the opinion of one judge on such an important matter. The Pioneer Company was at the root of this question, as £26,000 was made out of the formation of that company, and some members of the Court had a share. The question before the Court was simply whether or not some members had been directly or indirectly interested in the formation of those companies. Everyone knew that what they had done was wrong, and deeply regretted the action of their colleagues in the matter. Mr. Wallace (Vintry) believed that the Act of 1851 governed the controversy, and that Mr. Justice Farwell realised this. Mr. Algar (Candlewick) said it was more a declaration than a judgment, and probably Mr. Justice Farwell had an idea that the judgment would be appealed against, as he gave his judgment at so early a date. The argument of Mr. Cripps, who appeared for the company, was to the effect that it relied upon one Act, and that had been ignored altogether. He had been informed by one of the counsel for the Corporation, that under that judgment it was quite possible for members of the Corporation to farm contracting companies themselves, and make money out of them. The Sewers Act of 1851 referred to three companies only—namely, gas, water, and paving companies. Mr. Algar said that Mr. Swinfen Eady concurred in the later contention. The old Metropolitan Board of Works had been swept away for reasons well known to his colleagues, and if it became known that members could attend that Court, vote as interested members, and make profits, he ventured to say that it would be a sorry day for the Corporation. Mr Burnett (Candlewick) said he could not understand how the Corporation could seek to take advantage of a wrong committed by one of its own body. Mr. Kimber (Langbourn) thought that Mr. Justice Farwell deserved the thanks of the Corporation for having got it out of a very difficult position. The report was carried by 119 votes against 33.

PROVISIONAL PATENTS, 1900.

MAY 7.

8382. Improvements in electric switches. Theodore Waldemar Madsen and Frantez Meinert Madsen, 18, Southampton-buildings, Chancery-lane, London.

8384. Improvements in means for supporting overhead conductors for electrically-propelled tramcars. Joseph Higson and John Hargreaves, 17, Hanover-street, Keighley.

8398. Improvements in automatic telegraphic receiving instruments for Morse characters. Luigi Cerebotani and Carl Moradelli, 111, Hatton-garden, London. (Complete specification.)

8427. Improvements in and connected with electrical presses. Otto Kammerer, 37, Chancery-lane, London.

8433. Process for the production of electrically conductive illuminating bodies. Fritz Dannert, 40, Chancery-lane, London. (Complete specification.)

8434. Process for the production of electric incandescence bodies. Fritz Dannert, 40, Chancery-lane, London. (Complete specification.)

MAY 8.

8439. Improvements relating to intercommunication by means of electro-mechanical typewriting or printing instruments. Spencer Welles Richardson and Richard Perry Elliott, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8449. Improvements in transmitting power and in electric motors and generators therefor. Rankin Kennedy, 89, Gathorne-terrace, Leeds.

8457. Improvements in means for electrically lighting light-ships and other stationary vessels. Jurgen Hinrich Junge, 15, Water-street, Liverpool. (Complete specification.)

8465. Improvements in or relating to electric motors. Alfred Julius Boult, 111, Hatton-garden, London. (Patrick Joseph Collins, United States.) (Complete specification.)

8471. Improvements in electrical accumulators. Louis Renaud, 33, Cannon-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Dec. 6, 1899, being date of application in France.) (Complete specification.)

8475. Improvements in alternating electric current motive apparatus. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (Charles P. Steinmetz, United States.) (Complete specification.)

8476. Improvements in induction electric motors. The British Thomson-Houston Company, Limited, and Henry Metcalf Hobart, 83, Cannon-street, London. (Complete specification.)

8479. Improved electrical starting switch. Edward John Staples Wheatcroft and Edward Bentall Gray, 1 and 4, Mitre-court-chambers, Fleet-street, London.

8486. Method of and apparatus for duplicating phonograph records. Thomas Alva Edison, 23, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8524. Improvements in coin-freed mechanism applicable to gas, electricity, and like meters. Stephen Simpson, 28, Victoria-street, Westminster, London.

MAY 9.

8531. Improvements in trolleys for electrically-driven tramcars, motors, and the like. James Townsley Pearson, 8, St. James's Hall, Burnley.

8544. Improvements in electromagnetic mechanism. Walter Frederick Jones, Albert Works, Hammersmith.

8558. Improvement in electric incandescent lamps. Richard Bruno Roxby, 18, Featherstone-buildings, Holborn, London.

8575. The manufacture of an improved material for insulating electrical conductors, waterproofing fabrics, and for other purposes. Frederick Greening, 4, South-street, Finsbury, London.

8576 Improvements in and connected with electric lamps for lighting billiard tables. Alfred Hebblethwaite, 4, South-street, Finsbury, London.

8584. An improved system of electric traction by surface contact. Giorgio Tosi, Marco Tullio, De Felice, and Alfredo Parboni, 6, Lord-street, Liverpool. (Complete specification.)

8586. Improved galvanic battery. Charles Martin, 22, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 10.

8610. Improvements in chains for electric light fittings. Harry Cheshire, 42, St. Paul's-square, Birmingham.

8611. Improvements in electrical apparatus. Walter Frederick Jones, Albert Works, Hammersmith, London.

8642. Improvements in means for regulating pressure in electric mains. Herbert William Butler, 47, Lincoln's-inn-fields, London.

8656. Improvements in connection with cut in and out electric switches for accumulator systems. William Arthur Stevens and Reginald Alfred Barker, 55, Chancery-lane, London.

8668. Improvements in electric arc lamps. The Interstate Electric Company and Joseph Melzer, 18, Buckingham-street, Strand, London.

8671. Improved construction of electric switch. Edward Schulz, 166 Fleet street, London.

8678. Improvements in or relating to electrical signalling apparatus. Alfred Upton Alcock, 46, Lincoln's-inn-fields, London.

8682. Improvements in apparatus for measuring electrical resistances, and chiefly intended for testing the electrical resistance of rail joints in the tracks of electric railways. Roger Winthrop Conant, 11, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Nov. 13, 1899, being date of application in United States.) (Complete specification.)

MAY 11.

8704. An apparatus for facilitating the photometry of arc lamps and like sources of light. Frederick Wm. Carter, 82, Hampton-road, Birchfield, Birmingham. (Complete specification.)

8705. A photometer whose adjustment depends on observing the distinctness of a diagram. Frederick Wm. Carter, 82, Hampton-road, Birchfield, Birmingham. (Complete specification.)

8719. Improvements in electric circuit breakers. Frederick William Golby, 36, Chancery-lane, London. (August Beyer and Robert Schönfelder, Germany.)

8727. Improvements in telephones, ear trumpets, stethescopes, and the like. Clarence Fenton Slater and Stanley Read Slater, 2, Dyer's-buildings, Holborn, London.

8754. Improvements in electric switches. Michel Farkas, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

MAY 12.

8779. Improvements in electric switches and fuses. James Whitcher, Arthur H. Lea, and Cecil H. Warren, Glenroy Works, Kettering.

8780. Improvements in dynamo-electric machines. Edward Eugene-Brown, 16, Simpson-street, Newcastle-upon-Tyne.

8781. Improvements relating to electric cash register tills. William Snelgrove, 18, Southampton-buildings, Chancery-lane, London.

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8827. Improvements in or connected with electrical batteries. Herbert William Butler, 47, Lincoln's-inn fields, London.

8829. Improved safety lock with electrical door-opening device. Johann Skopec and Nicolaus Heid, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on June 2.

1899.

7284. Telegraphic, telephonic, and like systems, and automatic switching apparatus therefor. Dardeau. (Date applied for under International Convention, Oct. 10, 1898.)

8693. Converting transformers. Abel. (Soc. Anon. pour la transmission de la Force par L'electricité.)

9382. Electric lighting apparatus especially applicable for railway and other vehicles. Preston and Gill.

10029. Controlling of shop window illuminating electric lamps and the like. Douglas.

10241. Electrical incandescence lamps with osmium filaments. Imray. (Oesterreichische Gasglühlicht und electricitäts-Gesellschaft.)

11166. Electrolytes for deposit of metals. Marino.

11747. Telephones, phonographs, and such like apparatus. Bowley.

12949. Connection of house service or branch conductors to electric mains. Andrews and Glass.

13136. Appliance for telephone pay stations. Kingsbury. (Western Electric Company.)

13194. Method of winding coils for continuous-current dynamo and motor electric machines. Tomkins.

13561. Means to be employed in electric traction. Barreau.

13939. Electric railways and tramways on a sectional conductor system. Milnes.

14010. Means for use in the production of radiation and light by electricity. Swinburne and Stearn.

14328. Insulators for the overhead conductors of electric tramways. Wise. (Actiengesellschaft Electricitätswerke, vorm. O. L. Kummer und Co.)

14468. Submarine cables. Hardingham. (Firm of Felten and Guilleaume.)

15809. Insulating electrical conductors. Colley.

15795. Electric meters. Barker and Ewing.

16854. Connection fittings for various electrical purposes. Hall.

24646. Apparatus for effecting locked step-by-step rotary motion from a reciprocating motion, especially applicable to counting trains. Evershed and Vignoles, Limited, and Evershed.

1900.

6069. Generation of direct electrical currents and apparatus therefor. Lundell.

6218. Machines for electrically heating, welding, or working metals. Coffin.

6308. Electric incandescent lamps. Fessenden.

6488. Apparatus for simultaneously actuating from one point the controlling switches of the several electrical motorcars of a train. Siemens Bros. and Co., Limited. (Siemens und Halske, Actien-Gesellschaft.)

6684. Electric coherers. Dervin.

6878. Electric arc lamps. James.

6893. Phonographs. Bobne.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	May 12	4,297	4,164	+ 133	77,560	73,572
Blackburn Corp'rat'n	—	—	—	—	—	—
Blackpool Corporatn.	,, 10	285	288	- 3	2,191	1,724
Blackpool-Fleetwood	,, 12	331	362	- 31	4,584*a*	4,722
Bradford City Tramw.	,, 13	420	305	+ 115	2,689	2,063
Bristol Tramways Co.	,, 11	2,850	2 863	- 12	—	—
City & South London	,, 13	1,380	926	+ 454	23,625	20,243
Dover Tramways ...	,, 12	178	154	+ 24	3,020	2,885
Dublin U.T., elec. cars	,, 11	3,452	1,130	+2,322	—	—
Dublin S.D. Electric	,, 11	822	819	+ 3	—	—
Halifax Corporation	,, 13	634	431	+ 203	3.931	2,657
Hull Corporat'n E.S.	,, 12	1,150	—	—	6.408*a*	—
Liverpool Corporat'n	,, 5	7,380	6,867	+ 513	124.341	108 276
Liverpool Overhead	,, 13*b*	1,416	1,339	+ 77	26,752	25,628
Sheffield Corporation	,, 13	2,097	—	—	—	—
South Staffordshire	,, 11	680	625	+ 55	12 278	11,720

a Since April 1. *b* Partly electrical.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	13/16-15/16
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 6½
—— 5 per cent. Mortgage Debentures	100	—	98-102
British Electric Works, Ordinary, 50,001-95,000	1	—	¾-1
—— 6 per cent. Cum. Pref., 1-50,000	1	..	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	—	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5½
Brush Electrical Engineering, Ordinary	2	—	1½-2
—— Non. Cum., 6 per cent. Pref.	2	—	2-2½
—— 4½ per cent. Debenture Stock	100	..	108-112
—— 4½ per cent. 2nd Debenture Stock	100	..	103-105
Callender's Cable, Debentures	100	—	112-116
—— Ordinary	5	—	14½-15½
—— 5 per cent. Pref.	5	..	5½-6
Crompton and Co.	2	..	3½ 4
—— 5 per cent. Debentures	—	—	100 103
Edison and Swan United, Ordinary	2	—	2-2½
—— 5 per cent. Debentures	5	—	3½-4½
—— 4 per cent. Deb. Stock, Red.	100	..	95-95
Electric Construction	2	..	2-2½
—— 7 per cent. Cumulative Pref.	2	..	2⅝-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	103-106
W. T. Henley's Telegraph Works, Ordinary	5	—	13½-14½
—— 4½ per cent. Preference	5	..	5½-5¾
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-23
—— 4 per cent. Debentures	100	..	100 103
Telegraph Construction and Maintenance	12	..	34 38
—— 5 per cent. Bonds	100	—	102-105
Telegraph Manufacturing, Ordinary	5	—	10-11
—— 5 per cent. Cum. Pref.	5	..	5½-6
Willans and Robinson, Ordinary, 1-20,000	5	..	11½-12½
—— 6 per cent. Cum. Pref., 20,001-60,000	5	..	7-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	7-7½
Charing Cross and Strand	5	..	8½-9½
—— 4½ per cent. Cum. Pref.	5	—	5½ 6
Chelsea Electricity Supply	5	—	6½-7½
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9½-10½
—— 6 per cent. Cum. Pref.	10	..	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	109-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	2	..	1½-2
—— 6 per cent. Pref.	5	..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1½-1⅝
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	6½-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6½-7
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	$ 00	..	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$ .00	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	8½-9½
Westminster, Ordinary	5	—	14½ 15½
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-Shares	5	..	4½-5½
—— ,, ,, deferred	5	..	5-5½
City and South London, Consolidated Ordinary	100	..	61-64
—— Ordinary	10	—	5½-6½
—— 4 per cent. Debenture Stock	100	—	125-130
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	..	13½-13¾
Waterloo and City, Ordinary	100	..	100 103
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17-18
Brisbane Tramway	100	..	102-104
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	9½-10½
British Electric Traction, Ordinary, 1-30,000	10	..	15½-16½
—— 30,001-75,000	10	..	15-16½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	12½-13
—— 5 per cent. Perpetual Debenture Stock	100	..	124-127
B. Ayres & Belgrano Tram., "A" 6 per cent. Cum. Pf., 1-40,000	5	—	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	104 107
Isle of Man Electric Power, 1-95,000	1	..	⅜-7/16
—— 6 per cent. Preference, 100,001-170,000	1	..	⅜-7/16
Kidderminster and District Lighting and Traction, Pref.	10	..	9½-10½
New General Traction, Ordinary	5	..	3½-4
—— 6 per cent. Cum. Pref.	5	..	5-5½
North Staffordshire Trams	6	..	
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— Preference	10	..	10½-11½
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9½-10½
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	½-¾
National Telephone, Ordinary	5	..	4¾-5¼
—— 6 per cent. Cum. First Pref.	10	..	13-15
—— 6 per cent. Cum. Second Pref.	10	..	13-15
—— 5 per cent. Non. Cum. Third Pref.	5	..	5½-5¾
—— 3½ per cent. Deb. Stock, Red.	100	..	96 99
Oriental Telephone and Electric Company	1	—	15/16-1 1/16

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NOTES.

Calcutta Tramways.—The tramways company have, we learn, taken their first practical step towards the introduction of electrical tramways in that town. It is to be hoped that the fate of these tramways will be better than that of the electrical tramways in Madras.

Telegraphists' Grievances.—A meeting was held on Thursday week to ventilate the grievances of the Government telegraphists. The chief cause for the meeting was that the salaries of senior telegraphists are only £160, while the agitation was for a maximum of £190. There was no resolution passed, but the meeting seemed unanimous on the point that the maximum should be increased.

Our Volunteers.—The Electrical Engineer Volunteers who left England under the command of Major Crompton have, we learn, gone to Bloemfontein, and it is stated that both officers and men are well. The fear that they would be employed to "light up" the Boer prisoners to prevent them from escaping at night, and that they would not go to the front, has not been realised, and they should now be in a position to do really useful service for their country.

Train-Lighting.—We have in several issues referred to the method of lighting trains from dynamos connected with the car axles. It is interesting to note that in the new corridor train just equipped by the Great Western Railway this method of lighting is used. As in the methods previously described, a reserve storage battery is carried for use when the speed is very low, or when the train is stationary. The lighting itself is effected by means of double lamp pendants suspended from the roof.

Fire.—Yesterday week a fire broke out on the Central London Railway subway at the Royal Exchange. The fire originated in a building apparently used as a general store, and before being got under involved some 50ft. of the subway. It is reported that, in addition to the destruction of the first building attacked, some 20 yards of the subway was very seriously damaged. We hope that the damage resulting from this outbreak of fire will not delay to any extent the opening of that portion of the line.

Budapest.—Some interesting experiments, it appears, are at present being conducted in Budapest with high-pressure rotary current for working an electric railway on a system introduced by Messrs. Ganz and Co. It is stated that, despite the high working pressure of 3,000 volts which is used, the system ensures complete safety even in its application to main-line working. Experimentally, the system is to be introduced on to the Valtelina stretch of the Italian State Railways, which has a length of almost 66 miles. The length of the cars which are worked by the new system amounts to 60ft., while the speed attained is about 37 miles per hour.

The Boom in Iron.—The great rise in the price of iron is illustrated in the contracts entered into for boilers between the Sheffield Corporation and Messrs. Brown and Co., for the supply of marine boilers for their power station. About five years ago a boiler of exactly the same type and size was purchased by the late Sheffield Electric Light and Power Company for £1,450. Eighteen months back two more were bought for the power station, this time the price being £1,950 per boiler. The three recently purchased, however, have risen to no less than £2,850 each, an increase of £1,400, or nearly 100 per cent. on the price of five years ago.

Conference.—We notice that the Shoreditch Vestry have had under consideration the question of the large premiums exacted from the local authorities for insurance, especially for electricity works. They are of the opinion that the sum total of municipal insurances of local authorities in London has reached a sufficiently large amount to warrant the establishment of some scheme for mutual insurance with a reasonable prospect of success. In order to further this proposal they have decided to call a conference of various London local authorities, and many have already signified their willingness to be represented.

Philippine Cables.—The American Signal Corps are apparently making great efforts to provide a good telegraphic service in the Philippine Islands. Thus we learn that they have laid a new cable between the islands of Cebu and Leyte, in the southern part of the archipelago. This should tend to improve the trade in hemp, which is the staple product of these islands. In addition to this cable a telegraph line has been constructed from Manila to Aparri, on the north coast of Luzon. There was formerly a line existing between these two places, but the Philippinos entirely destroyed it. Its reconstruction is very important at present for military purposes.

The Heat by an Incandescent Lamp.—A German contemporary remarks that the heat generated by an ordinary incandescent lamp is greatly underestimated by the general public. Experiments have proved that a small incandescent lamp placed in a vessel containing half a litre of water will heat the latter up to boiling point within less than an hour. An incandescent lamp placed in contact with celluloid will ignite the same in five minutes. It is also very dangerous to place incandescent lamps in the proximity of cotton wool, for after a very few minutes the wool is scorched and ignited. Silk is less inflammable, but even this is scorched at a distance of 3·9in. in from eight to ten hours.

British Institution of Draughtsmen.—At the half-yearly meeting of the council of this institution held recently in London, it was decided to accept the resignation of Mr. J. Gillaird, of London, as hon. secretary and treasurer. Mr. C. L. Groundwater, of Manchester, and Mr. J. F. Wakeham, of Newcastle, were unanimously elected hon. secretary and hon. treasurer respectively in his place. The thanks of the members of the institution are due to Mr. Gillaird for the very able and courteous manner in which he discharged his duties. At the same meeting it was decided to alter the title of the society from "British Association of Draughtsmen" to that of "British Institution of Draughtsmen."

Vienna.—The Vienna City Council recently decided to erect two central generating stations. One of these is designed to supply power for working the street railways of the town, and is to be equipped with five electrical generators of 3,000 h.p. capacity each, while the second station is to contain three generating sets of like output for supplying energy for lighting and power, other than traction purposes. The equipment of the station has been entrusted to the Austrian Schuckert Company. It is interesting to note the tendency of Continental engineers towards the adoption of large and uniform units of plant, a tendency which is to be observed especially in connection with recent designs of German central stations.

Shooting Competition.—The prize-shooting season is just commencing, and we notice that the technical colleges of London are not behind others in producing good shots. Thus, we gather from the *Times* that teams composed of four members each from the Central Technical College, University and King's Colleges, the Royal School of

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Mines, and the Crystal Palace Engineering School met last Wednesday week at Runnymede Range to shoot for a cup presented by the professors of the various colleges. The conditions were 10 shots each at 500 and 600 yards, the possible points being 400. The Central Technical College team won the cup with a score of 297, the other colleges following pretty close behind. The cup was afterwards presented to the winning team by Prof. J. Perry, president-elect of the Institution of Electrical Engineers.

Electric Concessions in Russia.—The Municipal Council of Vladivostock has intimated to the various consuls in that town that it is proposed to grant a concession for constructing an electric light and tramway system in Vladivostock. The tramway is to run through the Svetlanski and Alentski streets, and will be altogether about 12 miles long. There has at present been no time stated as to the limit for sending in proposals, and there is also no preference to be shown on the ground of nationality. A considerable number of lights will be required for lighting the city, and several large commercial firms would probably require their premises fitted. The city, it is stated, is to be made responsible for payment. The letter also informs us that, in addition to the electric lighting and trams, the question of the construction of a new reservoir and waterworks is soon to be brought forward.

Electricity in India.—We gather from *Indian Engineering* that the municipality of Simla have applied for the services of the Government electrical expert, Mr. Meares, in order to report on the practicability of an electric lighting scheme for their town. We are pleased to note that so many of the towns in India are recognising the value of electricity for lighting purposes as compared with other illuminants. Electrical power is also not being neglected in India, and it is interesting to see that the Government has issued orders for installations of electric fans in the barracks and all the larger military stations, thus having a really good cooling system, and dispensing with the punkah coolie, who usually does his work in a very half-hearted manner. It is not stated where the power for these electrical installations is to come from, but it is suggested that the criminals in the local gaols should be made to supply it through the agency of the treadmill.

Specific Gravity of Tellurium.—The following is an abstract of a paper by Messrs. V. Lehner and J. Livingston R. Morgan, contributed to the *Journal* of the American Chemical Society. The abstract, which reads as follows, is abstracted in the *Journal* of the English Chemical Society: For the determination of the electrical resistance of tellurium, the molten metal was allowed to solidify in glass tubes of narrow bore jacketed by outer tubes also containing melted tellurium. Great difficulty was found, however, in obtaining uniform results, the values for the specific resistance varying from 279 to 1,152; the mean is about 500, but the authors consider that the lower results are probably the more correct. The value obtained by Matthiesen was about 2,000, so that the structure has an enormous influence on the conductivity. It was observed that the metal expands slightly after solidification, all the tubes cracking at this point, no matter how slowly they were cooled.

Electrical Progress in China.—We stated in a recent issue that a small lighting station had been installed in Pekin. The following details of the plant are just to hand. In anticipation of transmission to a distance, a rotary-current generating plant has been adopted, so that if required the current may be transformed up. Though at present of very modest capacity, ample provision has been made for ultimate extension of the station on a large scale. The generating plant already installed consists of a 50-h.p. steam set, while a second set of 100 h.p. is on the way, and room is left for a third set, without extending the buildings. Arrangements have also been made to educate the Chinese in the uses of electricity for domestic and other purposes, and to this end a showroom has been attached to the generating station, in which lamps and motors, etc., may be seen in their application to various purposes. Full credit for this enterprise must be accorded to Messrs. Siemens and Halske, of Berlin, which firm not only supplied the necessary plant, etc., but also promoted the local company into whose hands the undertaking has now come.

Electric Lighting in New York.—According to the *Electrical World* of New York, the following are the equivalents in 8-c.p. lamps of the loads on April 1 last by the various electric lighting companies in New York City. Thus, the Edison Company had connected on its system the equivalent of 2,310,524 8-c.p. lamps, including private plants using the company's services as an auxiliary, this service amounting to the equivalent of 204,058 8-c.p. lamps. The New York Gas, Heat, Light, and Power Company, which now covers the boroughs of Manhattan and the Bronx, had connected with its system on April 1 the equivalent of 2,751,652 8 c.p. lamps. This latter figure includes the Edison figures, but not the lamps connected on the circuits of the United Electric Light and Power Company, which amount to the equivalent of 500,000 8-c.p. lamps. The plants on the Brooklyn side of the East River will probably add to the above the equivalent of 10,000 8-c.p. lamps. It is interesting to compare the gross total with the equivalent number of 8-c.p. lamps now connected to the mains in the London metropolitan area, which is about 2,500,000.

Gas Bills.—The House of Commons Committee last week gave some important decisions on a number of Bills affecting the gas interests in the metropolitan area. Amongst these was a Bill promoted by the London County Council to legalise the use of a portable photometer for testing. This Bill has been rejected. The evidence brought by the engineer of the South Metropolitan Gas Company on this vexed question is worthy of careful attention, and is to the effect that, in order to obtain the standard illuminating property, it is necessary in London to enrich the gas which is obtained from the retorts. It seems that this enrichment is very apt to be lost on the way to the consumer, and in consequence of this, the South Metropolitan Gas Company have promoted a Bill, the preamble of which has passed the committee, to authorise a lower standard of illuminating power. The reduction will be from 16 c.p. to 14 c.p., with a corresponding decrease in price. The Gaslight and Coke Company's Bill to authorise debenture issues of 2½ millions seems likely to be thrown out, on the grounds that this company has not done anything to comply with the recommendations of the committee of enquiry which sat last year.

Aluminium Bronze.—From an article appearing in the *Annales Telegraphique*, Mr. E. Massin describes some experiments made on the employment of aluminium bronze for telephone wires, from which he concludes that this cannot be up to the present said to be as suitable for telephone purposes as silicon bronze. In spite of their pliability, good conductivity, and low market price, the alloys of aluminium present great inconvenience in working. Beyond this, the action of the weather on aluminium alloys is considerable, oxides being formed which seriously affect the conductivity of the wires. Mr. E. Massin tried

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the effect of acids and alkalies on lengths of aluminium bronze. He used a 10 per cent. solution, and the weight of the wire immersed in the solution was 1·44 grm. After four months the loss of weight was as follows: in sea-water, 0·019 grm.; acetic acid, 0·024 grm.; sulphuric acid, 0·341 grm.; potassium hydrate, 0·859 grm. Another piece of wire exposed to air was found to have increased in weight by 0·056 grm., which corresponded to a transformation of 0·031 grm. of aluminium into oxide. The author also concludes that the physical properties of the alloy are not so favourable to telephone work as the alloy known as silicon bronze.

The Opera Telakouphanon. — The publication entitled "An Evening with Punch," now being supplied by Messrs. Bradbury, Agnew, and Co., of 10, Bouverie-street, contains the following interesting prophecy which was written by Tom Taylor, and appeared in *Punch* on Dec. 30, 1848: "Our attention has been directed to an article made of guttapercha called the telakouphanon, or speaking trumpet, a contrivance by which it is stated that a clergyman having three livings might preach the same sermon in three different churches at the same time. Thus, also, it would be in the power of Mr. Lumley, during the approaching of the holiday time, to bring home the opera to every lady's drawing-room in London. Let him cause to be constructed at the back of Her Majesty's Theatre an apparatus on the principle of the ear of Dionysius, care having been taken to render it a good ear for music. Next, having obtained an Act of Parliament for the purpose, let him lay down, after the manner of pipes, a number of telakouphanon, connected (the reader will excuse the apparent vulgarism) with this ear, and extended to the dwellings of all such as may be willing to pay for the accommodation. In this way our domestic establishments might be served with the liquid notes of Jenny Lind as easily as they are with soft water, and could be supplied with music as readily as they can with gas."

The Institution of Junior Engineers.—At a meeting of the Institution of Junior Engineers last Friday a paper was read by Mr. Charles H. E. Rush and Mr. Basil H. Joy, entitled "A Short Review of the Motorcar Industry, Past and Present." The authors pointed out that the shortness of time at their disposal for the reading of a paper obliged them to confine themselves to a description of oil-driven vehicles only, other systems being only briefly alluded to. The enormous advantages to be gained by using motor instead of horse-drawn vehicles were summarised as follows: (1) economy in working; (2) increased possibilities in speed; (3) greater safety; (4) infinitely greater radius of action; (5) humanity; (6) economy in road repairs; (7) cleanliness in streets; (8) increased volume of trade; (9) fewer unemployed. It was shown how restrictive legislation had hampered progress in the industry under consideration, giving our Continental rivals a great lead over us. In comparing the merits of the various motive powers which can be employed, compressed air and gas were not considered, but steam was shown to have many advantages, which for heavy haulage made it supreme; electricity, except for very limited purposes, was regarded as impracticable at the present time; while oil, or rather petroleum spirit, in spite of its many disadvantages, was shown to be the motive power for light tradesmen's vans and all light vehicles where long distances were to be covered.

Accumulator Electrodes. — While hitherto the employment of sulphurous acid solutions has been looked upon as unsuitable for the forming of peroxide of lead plates of the Planté type, experiments carried out by Mr. H. Beckmann, and published in the *Elektrotechnische Rundschau*, have shown that the formation of peroxide of lead from metallic lead by an electric current acting through free sulphurous acid proceeds much quicker and in a far more advantageous manner than in the process of forming Planté plates hitherto employed. In applying the process, the metallic lead, in the form of positive electrodes, is immersed in a solution of free sulphurous acid, and thereupon subjected to the influence of an electric current. The solution may be produced by feeding free dioxide of sulphur into water, or by dissolving in water a salt which, in combination with an acid, generates dioxide of sulphur, and subsequently combining it with an acid. The great advantage attaching to this method is that no products, such as chlorine or saltpetre, which may be detrimental to the durability of the electrodes, are employed. It is therefore unnecessary after the forming process to cleanse the plates, which may be used at once. Neither is it necessary to overcharge the plates for a long time during the initial charge of the completed accumulator. When formed according to this method, it is claimed that a period of 30 hours will suffice to give the plates so thick a coating of peroxide that the same may be used as plates in an accumulator.

Electromobile Competition in Germany.—The competition instituted by the Mitteleuropäischen Motorwagen Verein between various types of electrically-propelled vehicles, to which we briefly referred in our issue of May 4, has been brought to a successful conclusion. In continuation of the particulars already given, it may be mentioned that the weight of the passenger vehicles on trial varied between 18cwt. and 33cwt. unloaded, and that of the freight cars, unloaded, between 30cwt. and 78cwt. A general report on the trials appeared in the *Elektrotechnische Zeitschrift* for May 10, from which it appears that the detailed results had not then been fully ascertained. It is interesting to learn, however, that the most favourable result, so far as capacity is concerned, which a superficial comparison of the tests disclosed, was the equivalent of a working output of about 60 watt-hours per ton of rolling weight over a distance of ·621 of a mile. Steering and brake tests were also made with different speeds and conditions. These tests proved on the whole very satisfactory. A freight car was found to possess the most efficient brake, which, with the car travelling at the rate of eight miles per hour, pulled up dead in 4·67 yards. Other cars, travelling at speeds varying between 11 and 12 miles per hour, were pulled up in an average of about 10 yards. In testing the extreme possible speeds of the competing vehicles, one of the passenger cars travelling at the rate of 11·7 miles per hour showed a battery capacity of 87 watt-hours per kilometre-ton. It is satisfactory to learn, says the *Elektrotechnische Zeitschrift*, that, despite the fairly heavy strain to which the vehicles were subjected during the competition, no great damage was done, nor did any serious breakdown occur. The trials may be said to have proved, concludes our contemporary, that, provided a battery of sufficient durability (upon which point the trial runs certainly yielded no reliable data), the electromobile is even now a vehicle of practical utility. But it is just this question of a battery of sufficient durability, when working over bad roads, we might add, upon which depends the future of accumulator traction, and we are still without reliable proof of the satisfactory solution of this difficulty.

Obtaining Work.—A paper read by Mr. J. W. Alvord before the Illinois Society of Engineers and Surveyors has been published in a number of American journals, and is interesting reading to consulting engineers. The author considers the question of consulting engineers pushing forward their schemes to obtain work, and as to whether

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professional men should wait for the work to come to them rather than going for the work. The author's conclusion would not find favour with the Institution of Civil Engineers, but there are certain members of the Institution of Electrical Engineers who are already exceedingly well up in the theory. The rules read as follows: (1) "Find your job. This is quite necessary. I have completely discarded the theory on which I started in, that your job should find you. It may work once in a while, but as a rule a needy engineer out of work is a great deal keener hunter than a lonesome job is. After you have found jobs for a good many years, it is possible that some stray jobs may find you, but I wouldn't count on it. (2) Know a great deal more about how that job ought to be done than anybody else around. There is no doubt at all but that this is a very important requirement, indeed, in the practice of getting jobs, but it is one which I feel almost ashamed to mention, and, indeed, would have foreborne to speak of, had it not been that occasionally I have met enthusiastic and confident engineers eager and willing to lend a hand in the great work of harnessing the forces of nature, but a little uncertain as to the difference between the breeching and bellyband. This delightful trait of ambition in our profession should be commended, could it only be turned into proper channels. (3) Know the men who have the jobs to give. This last rule seems also to be one of those delightfully simple propositions in theory which are found so difficult in practice. The theory of the thing is that an engineer's reputation ought to precede him everywhere. In practice he is usually exceedingly glad if it will only follow him at a respectable distance. People with jobs to give want to see you, poke your ribs, and put you through your paces, as I have elsewhere intimated. And if you would like to be their 'hired man,' it is best for you to go and submit yourself to the process as gracefully as you can. I believe, however, that it is quite possible to do all this and still be modest. There is no money in being bashful, but to be suitably modest, at the proper time and in the proper amount, is an art whose worth to the fortunate possessor cannot be over-estimated."

Toll Telephone Lines.—We notice in Mr. Carl Hering's digest in the *Electrical World* an abstract of an article by Mr. Clausen, and appearing in the *Telephone Magazine*, on the design of a toll-line system between a number of scattered towns with several branch lines. The author deals with the problem of "signalling simultaneously a large number of telephones connected to a pair of wires in bridge." He describes two methods for increasing the efficiency of instruments for connection in parallel; in one, the smallest amount of current is used at the caller's station in sounding his own bell; the magneto-generator and 1,000-ohm ringer are connected in series, this being the position normally assumed by the signalling system, with the exception that the generator winding is shunted out of circuit, thus leaving the ringer magnets alone connected across the line; when the caller intends to transmit a signal, a shunt circuit is established, cutting out the 1,000-ohm ringer to such a degree that only a very small portion of current passes through them, while the greater portion of the current generated passes out to line over the comparatively low-resistance shunt coil. The other method is a modification of the first. Neither solves the problem of the particular toll lines in question. He then describes the solution adopted in practice for that purpose. The construction of the instrument was similar in most respects to the regular bridging type telephone, with the exception, however, that no specially powerful magneto-generator was required; one side of the magneto-generator is connected to earth and both sides of the line circuit are brought in connection with the automatic generator shunt in such a way that when the magneto-generator is driven for the purpose of transmitting a call, the line wires are short-circuited and a current sent through the circuit over both line wires in parallel and through the annunciator drop at the switchboard to ground. The switchboard jack is of special construction, being normally short-circuited. With this system, and with each line wire measuring, say, 2,000 ohms, which would make a total of 4,000 ohms for ordinary bridging signalling circuits, there is but one-fourth of this resistance to signal through by virtue of using both of the line wires in parallel, and there are no by-paths with the resultant division of currents, the line-drop receiving practically all the current generated. Another feature of the system is that no subscriber's bells are sounded while the switchboard operator is receiving an incoming call, and under no circumstances are the subscribers able to signal among themselves, this duty of signalling between the subscribers being placed with the operator.

The Electro-Chemical Equivalent of Copper and Silver.—The following abstract, which appears in the *Journal* of the Chemical Society, is of a paper contributed by Messrs. T. Richards, E. Collins, and G. W. Heimrod to the *Zeitschrift fuer Physikalische Chemie*. The abstract reads as follows: An examination of the irregularities of the copper voltameter leads in general to results agreeing with those of Foerster and Seidel. Copper plates become lighter in acidified copper sulphate solutions, owing to the solution of the copper and the simultaneous formation of cuprous sulphate; this action increases as the temperature rises. Copper plates in neutral copper sulphate solutions become heavier by the deposition of cuprous oxide, formed by the hydrolysis of cuprous sulphate. With regard to the copper voltameter, the author points out that (1) the solution must be as cold as possible; (2) the solution must be acid to prevent hydrolysis; (3) the solution must be as dilute as possible, whilst the liberation of hydrogen is avoided; (4) air must be carefully excluded. Foerster and Seidel's plan of saturating the solution from the beginning with cuprous ions is criticised as giving too heavy a deposit of copper: this view is borne out by experiment. Comparison of the copper deficit in the copper voltameter with the current density at the cathode shows: (1) that a high current density gives far too low a deposit of copper, owing doubtless to the separation of hydrogen; (2) that the loss of copper due to solution in the copper sulphate is approximately proportional to the extent of the electrode surface. By taking, then, the actual weight of copper deposited in any given case, and extrapolating to the electrode surface zero, a value is obtained which will correspond closely with the amount of electricity that has passed through the cell. A series of experiments, treated in this way, and based on a comparison of the copper voltameter with the ordinary silver voltameter, gave the mean value 63·563 for the atomic weight of copper, distinctly less than the value 63·604, obtained by purely chemical methods. As regards the silver voltameter, it appears from the work of numerous observers that some substance, connected with or proceeding from the anode, causes too large a deposit of silver at the cathode. Experiment having shown that the cathode deposit was not contaminated by mother liquor, the authors adopted the device of inserting a porous cell between the anode and the cathode. This arrangement of the silver voltameter gives, under similar conditions, a smaller deposit of silver than any other of the forms used. The quantity of silver deposit is less affected by change of temperature in this porous cell form of the voltameter than in Lord

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Rayleigh's form, and the authors consider their results the more correct. When the necessary correction is made on the ordinary silver voltameter, the atomic weight of copper, deduced from the experiments described above, now lies between 63·598 and 63·615. The electrochemical equivalent of silver is corrected to 0·0011172 gramme per ampere-second, and that of copper to 0·0003292 gramme per ampere-second.

Accumulator Traction.—Many points in connection with the treatment and control of accumulators employed for traction purposes are still subject to differences of opinion, says Mr. P. Weber in the *Centralblatt für Accumulatoren und Elementenkunde*, and it is desirable to obtain unanimity as far as possible with regard to these points. Differences in the number of cells (40, 42, or 44) adopted for a certain corresponding charging pressure of 110 volts are of little importance, being governed by the different makes of plate—especially in so far as the internal resistance of the cells is affected thereby—the highest permissible terminal pressure per cell, etc. But of greatly underestimated importance for the well-being of the battery is the method of connecting the controller. One frequently hears the opinion expressed that the disadvantages of starting up with the two halves of the battery connected in parallel are greater than the advantages offered by such an arrangement, series connection throughout being, therefore, preferred. The disadvantages of a parallel arrangement are supposed to consist in that an unequal strain may readily occur in the two halves, and that in switching one half out the other half discharges itself into it. On the other hand, it must be taken into consideration that, as a rule, the paralleling of the two halves is accomplished at the controller, which is only used temporarily. Unquestionably it is of especial advantage if the heavy demand at starting can be divided between the two halves of the battery. Besides this, the pressure given by the battery, which in the case of series connection must be reduced by switching in artificial resistance and thereby entailing a loss of energy, is, of course, diminished by one-half upon paralleling the two sides of the battery, thus ensuring steadier starting. It is, however, going too far to insist upon the sub-division of the battery into four parallel groups, as individual engineers have done. With regard to the speed of the car, it is important for the life of the battery that the graduations should be moderate. Mr. Weber thinks four to five graduations of speed should suffice for ordinary purposes. Another point concerns the determination of the requisite power of the battery. In going into this question it should be borne in mind that the battery in practical use for traction purposes will behave otherwise than when in a state of rest in the laboratory. According to observations made by Mr. Weber, cells when subjected to a thorough shaking showed a lower capacity than when in a state of rest, although in consequence of the better circulation of the acid in the former case, the reverse might have been expected. The shaking, however, to which the experimental battery was subjected—being designed to test the solidity of the plates—was far more violent than would be met with in practice, even on bad roads. The causes of the extraordinary fall of capacity which is sometimes observed in comparing laboratory tests with the results obtained in actual practice, are mainly due to the temporary heavy demands on the battery, which in practice frequently amount to as much as 1½ to 2½ times the normal. This points to the necessity of providing the car to be propelled with a considerable reserve accumulator capacity. For ordinary purposes this should not be less than 40 per cent., and firms constructing electromobile cars should allow for this surplus power, both in determining weights and dimensions.

Carbon.—Prof. Elihu Thomson is writing a series of articles on the properties of carbon in electrical work, which series is appearing in the *Electrical World* of New York. In the first article he points out that although numerous other substances have been tried, even including mixtures of such substances with carbon, the pure carbon holds its own for arc lighting. Prof. Thomson points out that the value of carbon for the electrodes of arc lights depends upon its absolute infusibility and its high temperature of sublimation. It has never been melted, and appears to be incapable, like arsenic, of existing in the liquid state at normal pressures. It could probably be melted if heated electrically under enormous pressures in an inert gas. Estimations of what pressure would be needed are of the order of 15 to 20 tons per square inch. This high sublimation temperature results in a good efficiency, as about 10 per cent. of the heat energy is radiation consisting of luminous rays. The author proceeds to review the work, showing that before the carbon is vaporised, it is first converted into plumbago. This fact he proposed to utilise as far back as 1882 for the manufacture of plumbago electrically. Another good property of carbon is its low conductivity for heat, which prevents the rods used in arc lamps from increasing very much in temperature, with a consequent great increase in resistance, as would be found if a metal would be used for the electrode. The author proceeds to review the advantages of the enclosed arc lamp, and then passes on to the consideration of the carbon filament of incandescent lamps. The depreciation of these filaments is due to a gradual evaporation of the same, the particles evaporated being deposited on the bulbs of the lamps. It is stated that if air is admitted into the glass bulb, it will be found that the black coating burns off at an exceedingly low temperature, showing that it is oxidisable at a lower temperature than ordinary carbon. After reviewing the operations of manufacturing in such lamp filaments, Prof. Thomson refers to the great advantage of the flashing of these, in that it provides a coating of high-conductivity carbon over a hard core. In this way the bulk of the current is carried on the skin, and thus heating of the inside is avoided. In a coarse filament, an equal rate of energy delivery throughout the section would be liable to overheat the interior, and produce cracks and fissures, if not vapour pressure. The effect may be illustrated by the following experiment. Let a thin strip of carbon, such as a lamp filament, be immersed in liquid gasoline and an electric current passed through it so as to bring it to a high temperature under the liquid, which goes into the spheroidal state, and virtually surrounds the hot carbon with a layer of vapour. In this case the filament gradually thickens by carbon deposition. As its diameter increases, more and more current will be required to keep up the temperature. In this way the filament may receive such a thick deposit that it may reach, say, 1cm. in diameter. It might be supposed that a dense hard rod of good conducting carbon had thus been obtained. Upon examination, however, it will be found that the interior of the thick rod is quite spongy and soft. The carbon of the interior, originally dense and hard, had later become overheated owing to the outer deposits preventing cooling. The result of the overheating is to reduce automatically the conductivity of the interior carbon by vaporising it in part and rendering what remains soft and spongy, like soft porous graphite. The various parts of the section thus adjust the rate of energy delivery to them in accordance with their ability to dissipate heat.

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MESSRS. FERRANTI'S HOLLINWOOD WORKS.

(Continued from page 695.)

We may now proceed to the switch and rectifier department, where a bewildering amount of interesting work attracts our attention. Figs. 8 and 9 show the switchboard and rectifier ends of this department respectively. Ferranti switch gears especially are obtaining universal application on their merits alone, and we shall therefore venture to bestow a considerable amount of attention to the switchboard section of this department. But, first of all, a few notes on the evolution of the Ferranti rectifier may not prove out of place. As previously remarked, the Ferranti rectifier has been very extensively adopted, and is consequently well known in a certain sense, but the type originally introduced was very different from that of to-day, hence the progressive improvement which the rectifier has undergone since its advent as a machine of practical utility may advantageously be illustrated by comparisons, as there are doubtless many of our readers who are unacquainted with any but the earlier types of this rectifier. The Ferranti rectifier system was first installed at Portsmouth in 1894, where five rectifiers were put down, each capable of supplying rectified current to 45 12-ampere arc lamps in series. In this type, as will be seen from Fig. 10, the synchronous motor has on either end of its spindle a single-break commutator. Each commutator is connected with a secondary coil of the constant-current converter below, the commutators themselves being connected in series. The constant-current converter is of what is usually called the bellows type, the movable coils being so suspended that the weight of one set of coils balances that of the other. The arc light switchboard, shown on the left of the illustration, contains ammeters to show the magnitude and indicate the direction of the rectified currents. On each circuit there is also a throw-over reversing switch, by which the current is reversed if necessary, and plugs with flexible connecting cords, whereby any rectifier may be made to feed any circuit.

Fig. 11 represents the first rectifier installed at Blackpool, and it will be noted that it is a considerable improvement on those at Portsmouth. It possesses only one commutator, and this is made double-break, and therefore capable of dealing with much higher voltages. The constant-current converter has also been much modified, the coils being wound on two horizontal cores, and the movable ones swing on knife-edges. By this means copper is economised, the ventilation and the cooling surface much increased, and the friction of the moving coils reduced to a minimum. Further, the whole apparatus is rendered very compact and entirely self-contained. Several years' experience of this design led to a modification shown in Fig. 12, which represents the standard Ferranti rectifier of to-day. In this type the movement of the coils is in a horizontal plane on steel ball bearings, whence the friction with the coils wide apart is no greater than when they are close together. The motor bearings are lengthened and all the connections enlarged and improved, besides being duplicated in the case of the low-tension brushes. The danger to the attendant is practically done away with, as all connections and terminals are highly insulated. The high-tension commutator is protected by a glass shield, the number of brushes reduced, and the long flexible leads done away with. When the rectifier is running there is no necessity to touch the high-tension parts at all, as the adjustment of the spark, which formerly was done by moving the high-tension brushes, is effected by rocking the motor armature instead. The water-break switch has been made double-pole, and so constructed that while operating it, it is impossible to touch accidentally any high-tension part. The ventilation is improved by putting the rectifier on special foundations, which are connected with a ventilator outside the building, thereby causing a current of cool air to pass over the coils.

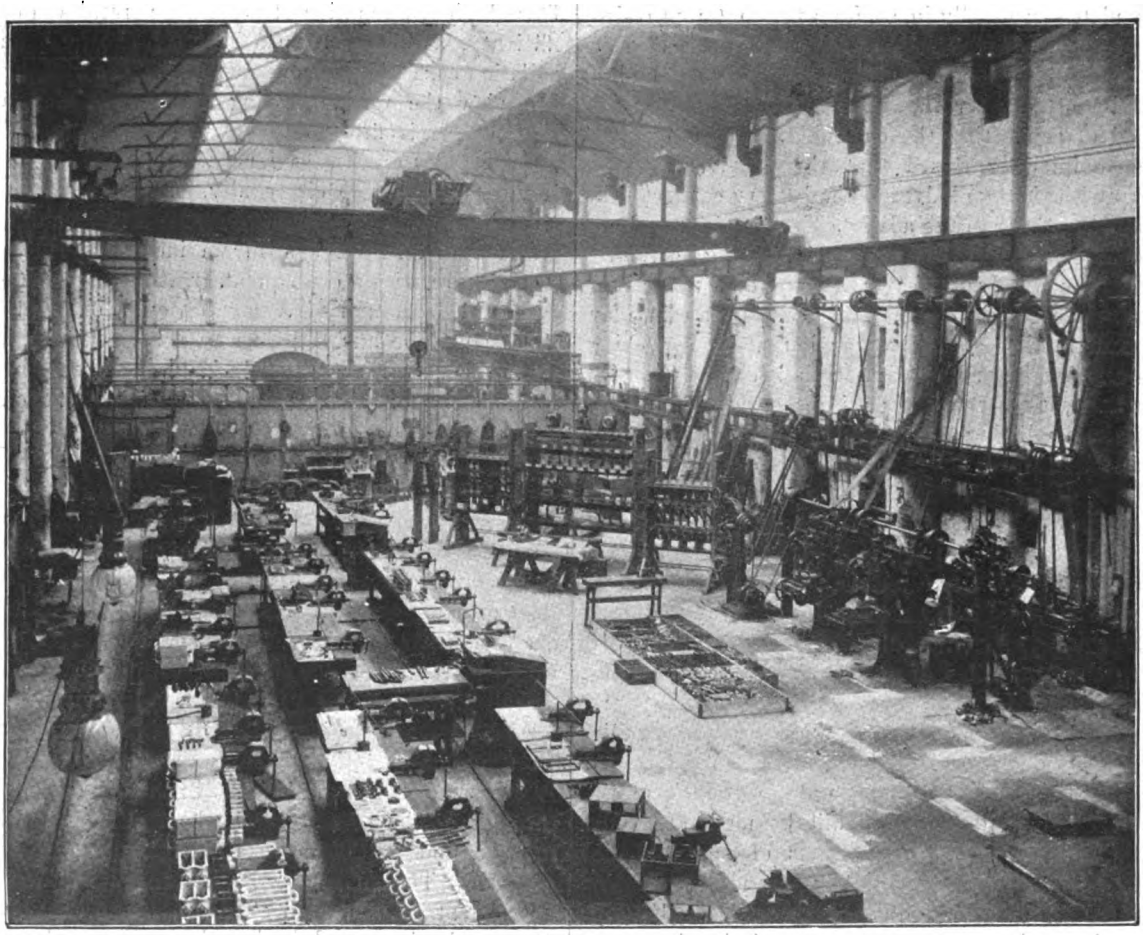

FIG. 8.

In virtue of these several distinct modifications of the original design, it is claimed, amongst other advantages, that the standard-type rectifier of to-day combines automatic regulation of the transformer without adjustable weights, greater reliability of the synchronous motor, better insulation and shielding of high-tension parts, better mechanical design, better ventilation, and greater compact-

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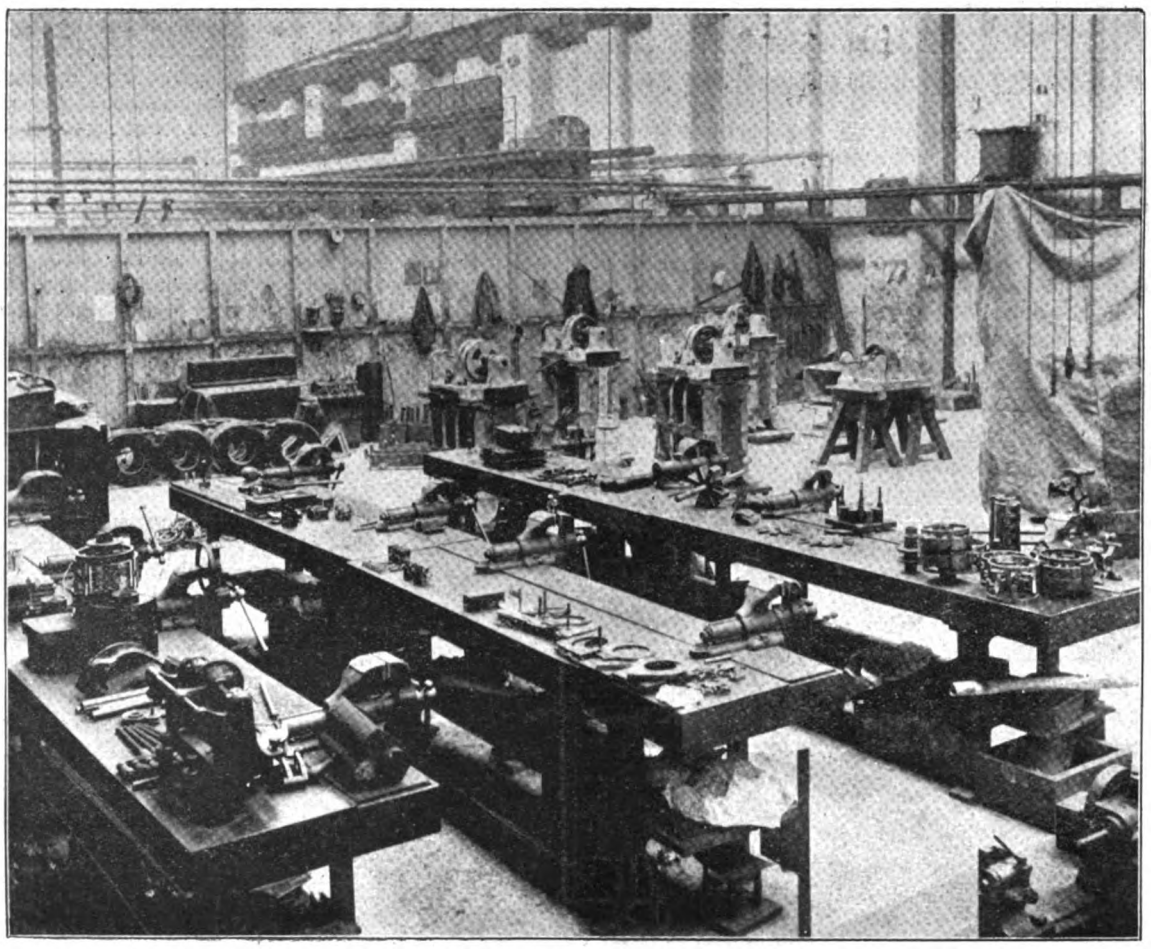

FIG. 9.

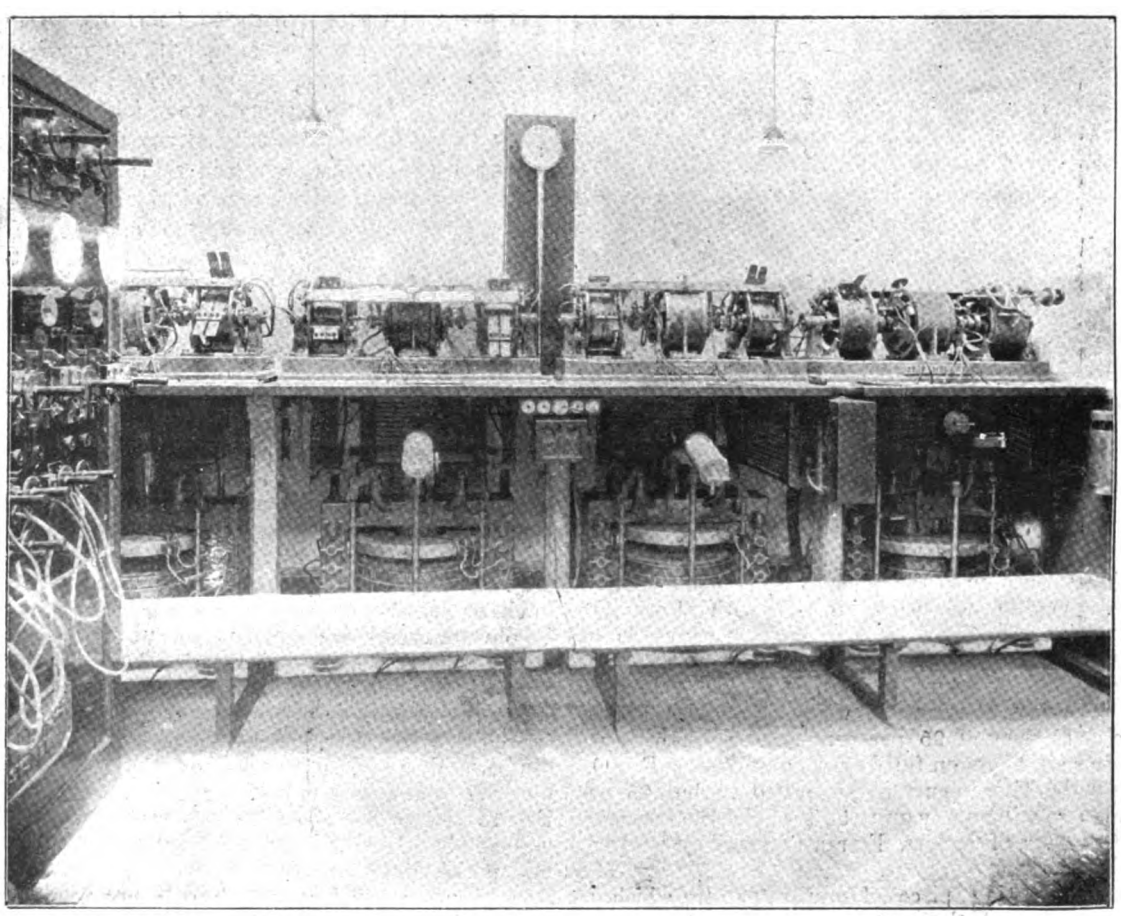

FIG. 10.

ness. This rectifier is made suitable for feeding any number of arcs up to a maximum of 15 12-ampere lamps. It may be interesting to give the actual tested efficiencies and power factors obtained:

	Efficiency.	Power factor.
Full load	88 per cent.	..... ·9
Half load	78 ,,	..... ·5

These rectifiers are being run daily on periodicities from

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40 to 100, and in conjunction with nearly every type of engine and alternator extant.

The switchboard which has been specially designed for dealing with rectified currents, is shown in Fig. 13. It receives the alternating current from the main 'bus bars through oil fuses, and distributes the rectified current through the ammeters and indicators shown to the circuits. The design is claimed to afford complete immunity from danger to the attendant. It allows any circuit to be connected to any rectifier, or two circuits to be connected in series on any one rectifier. The high-tension voltmeter is arranged to read the pressure across any of the arc light circuits, the instrument being protected by oil-break fuses. Practical experience, which is, after all, by far the best test of merit, has sufficiently proved the mechanical reliability of the switch gear, no trouble whatever having been encountered.

A side issue in connection with the manufacture of rectifiers has sprung up in the demand for constant-current converters alone, for use in conjunction with alternating lamps in series. A 45-kw. constant-current converter of this type, designed to feed 50 20-ampere alternating-current lamps in series, each lamp being provided with a compensating coil taking 2½ amperes, when tested at full load showed an efficiency of 96 per cent., and a temperature increase after six hours on full load of only 70deg. F. On short-circuit the rise in current amounted to but 25 per cent. This size will supply up to 50 kw., and the constant-current converter of Messrs. Ferranti's standard rectifier up to 30 kw.

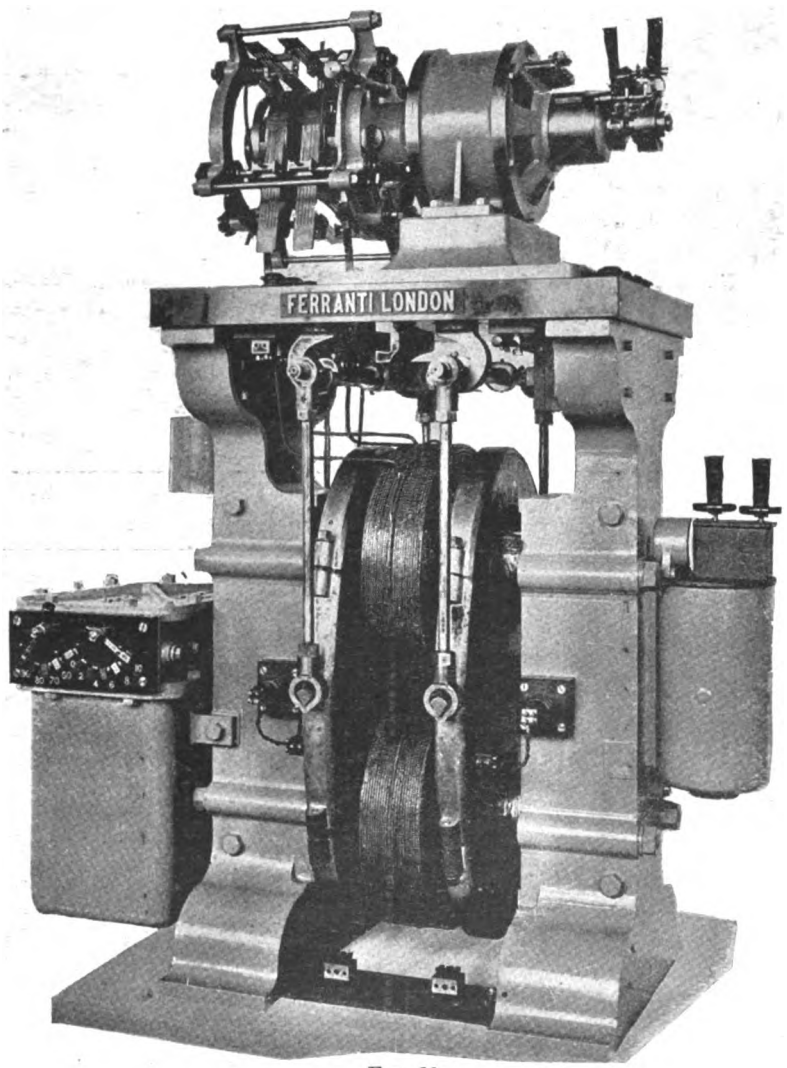

FIG. 11.

Another interesting piece of apparatus, to which is devoted a portion of the switch and rectifier department at Hollinwood, is undoubtedly the Ferranti open-type rheostat. We noticed compact sets of resistances of this type in various stages of completion. It has hitherto been, and is still, in many cases a common practice in switchboard work to mount a sliding switch or regulator on the same slate base as used for carrying main switches, instruments, and other devices for controlling the dynamo or motor circuit as the case may be. These sliding switches usually consist of a handle, bridge, bridge contact, and a number of small terminal stops, the latter varying in number according to the regulation required. The actual resistance wire is usually coiled on various types of frames, and connected at intervals in its length by means of cables to terminals on the sliding switch. It many cases it is necessary to place the resistance some distance away from its switch, and then long lengths of connecting cable are required. Many difficulties have been experienced with this arrangement. The bundles of cables are clumsy, and, unless very well insulated, are liable to break down. The resistance coils may sag and touch, and if overloaded will break, and thus open the field circuit of the machine. Moreover, these resistances are frequently placed in inaccessible positions behind the switchboard, thereby rendering repairs difficult, chances of fire imminent, and entailing the constant attention of those in charge of the station, besides causing continual worry. To obviate these disadvantages, and to provide a resistance which is both neat and compact, Messrs. Ferranti have adopted what they term their open-type rheostat. Fig. 14 shows the various component parts of this standard design, as well as a complete finished rheostat. These resistances can be used singly, or any number of them may be geared together and connected either in series or in parallel. Fig. 15 shows two rheostats so coupled. The resistance wire employed is the outcome of extensive experience. It is a special alloy, having a high resistance with a very low temperature coefficient, which will not oxidise even if exposed in a damp cellar. The wires wound to an insulated framework are in continuous lengths, there being no joints or sharp bends to break. By this means coils are also avoided, and trouble due to sagging thus entirely eliminated. The stops are connected in a special way directly to the resistance wires, whereby the usual

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bundle of inflammable cable connections is avoided, and labour saved in connecting, as well as prime cost of the cables. At the same time the number of terminals is reduced to two only, which are required to connect the

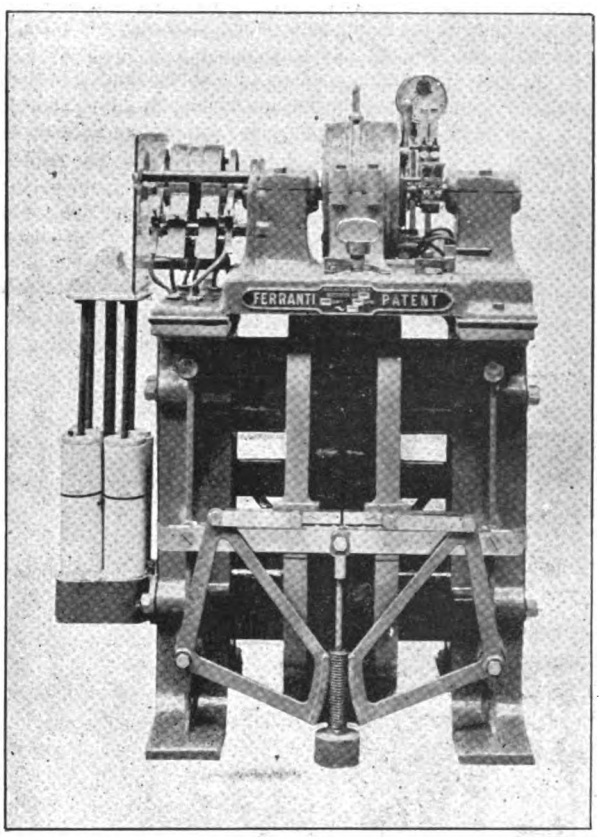

FIG. 12.

resistance to its circuit. The slider is designed with ample contact surface, and is made so that it cannot jump off the stops. A large radiating surface is obtained by winding the resistance with a number of small wires in parallel.

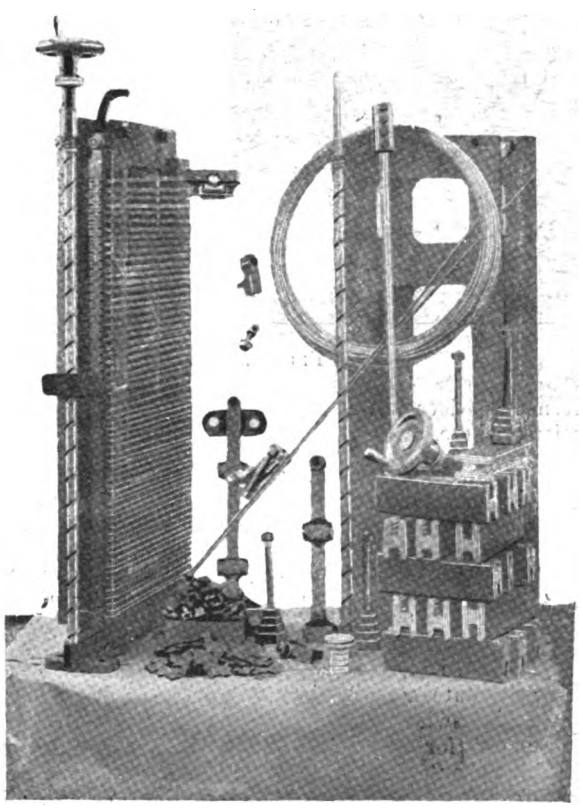

FIG. 14.

This special feature renders any alteration easy to the capacity of the resistance. If it is desired to increase the resistance in ohms in any portion of the range, this can readily be done by cutting away a few turns of the parallel wires. The wall space, or space occupied in width, is usually a very important consideration, and in this the Ferranti rheostat evidently has an advantage, as it only occupies a space of 6in. in width. These regulators were originally designed for use in conjunction with the Ferranti type of switchboard, and are usually placed underneath the switchboard platform, having their spindles extended to a handwheel mounted on the framework close to the controlling switch of the machine. They are, however, quite suitable for use on any other type of switchboard, or can be mounted in the station away from the switchboard near to the machine if required. A number of standard designs have been prepared for carrying currents ranging from 4 to 75 amperes, and resistances varying from 100 to ·5 ohms respectively per single frame. By connecting two single frames together in series, the resistance is, of course,

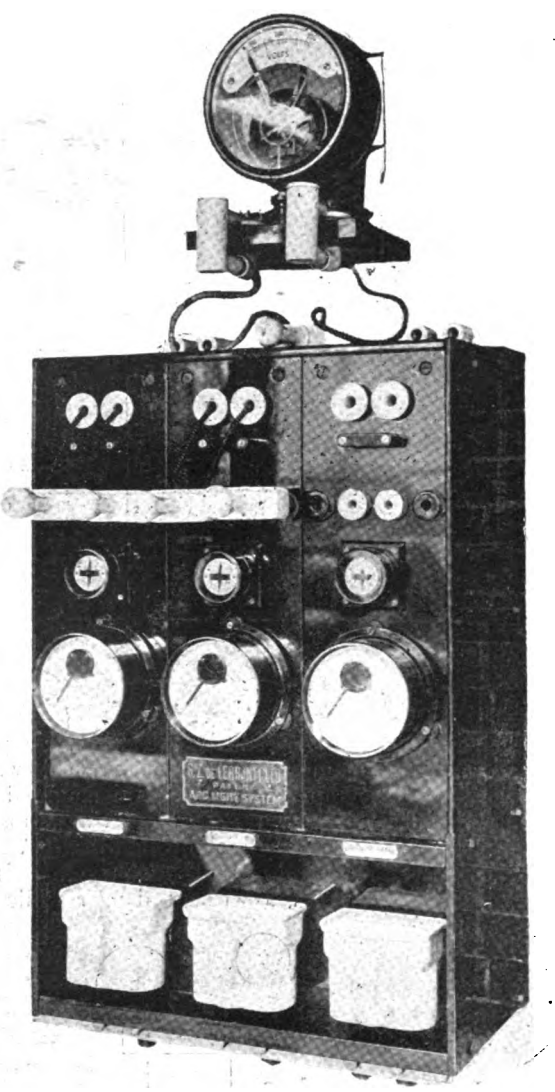

FIG. 13.

doubled, or by connecting two in parallel the set will carry double the current of a single rheostat, and the total resistance of each will be thus halved. Owing to the large number of steps obtained (from 130 to 50) the drop per step is very low, thereby allowing very gradual regulation, although the whole travel of the slider can be covered in about 12 turns of the handwheel. The design of this apparatus is mechanically strong and substantial, and, as will have been gathered from the above, offers many advantages for central-station work.

We may now devote our attention to the switchboard section of this department, describing, in the first place, the Ferranti patent type of high-tension switch gear. For over eight years Messrs. Ferranti have been supplying high-tension switch gear to alternating-current central stations all over the country, and so successfully that they have in many instances replaced switchboards of other types. No less than 650 main high-tension generator and circuit switches have been installed by Messrs. Ferranti. If it were possible to pull off all these switches at working load simultaneously

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a power equivalent to 325,000 kw. would be open-circuited. Fig. 16 represents one of these switch gears as erected at Plymouth for 2,000 volts. Each panel consists of a 'bus-bar fitting and sectional 'bus bar, high-tension ammeter and contacts, high-tension spring-break switch (150 amperes maximum capacity), oil-break fuse with duplicate contacts,

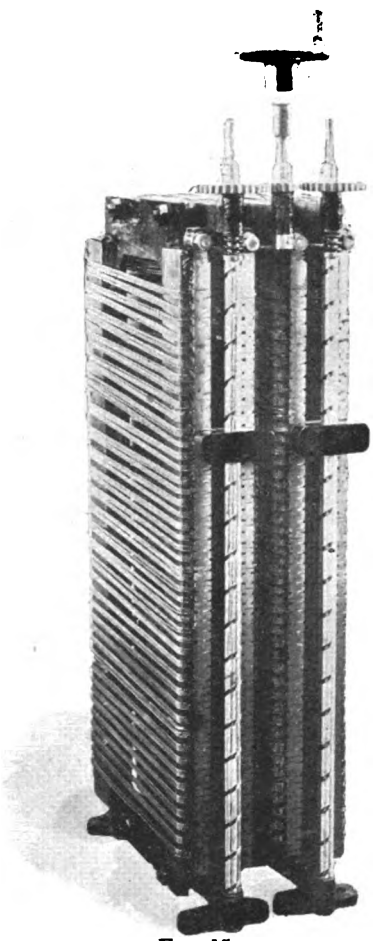

FIG. 15.

cable receiver, outer bar (earthed) and links, complete regulating gear, including low-tension ammeter, field switch, and rheostat. At the top of the board are mounted the synchronisers and high-tension voltmeters, these instruments being protected by small oil-break fuses. All the instruments, fuses, 'bus-bar links, etc, are made so that they may be quickly removed without danger while the

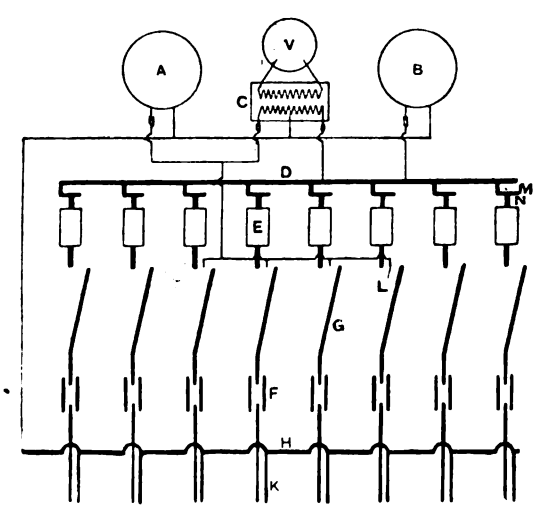

FIG. 17.

board is alive. Special attention is given in the design and construction to produce a gear on which accidental shocks are impossible and chances of fire very remote.

The connections of an eight-panel gear are shown on the diagram (Fig. 17). Even this diagram is unnecessary to understand the connections, for a glance at the actual board will show each connection as clearly as the diagram. The latter feature can be gained only by having a board without a back. The Ferranti gear, having no back, avoids the usual tangle of cables, which not only endangers the life of even an experienced attendant, but also increases the chances of fire. The Ferranti board with each switch, instrument, etc., in a separate compartment, with its 'bus bar of different potential separated by thick slates and wide air-gaps, with the entire absence of cable connections, with its minimum of inflammable material, which is liable to catch fire and damage the gear (or, as sometimes has happened, burn down the station), with its security and simplicity, is claimed to actually save money annually by reducing fire insurance policies. Moreover, the cost of maintenance is found by long experience to be practically nil.

It has sometimes been raised as an objection, that the board being so essentially designed for parallel running of

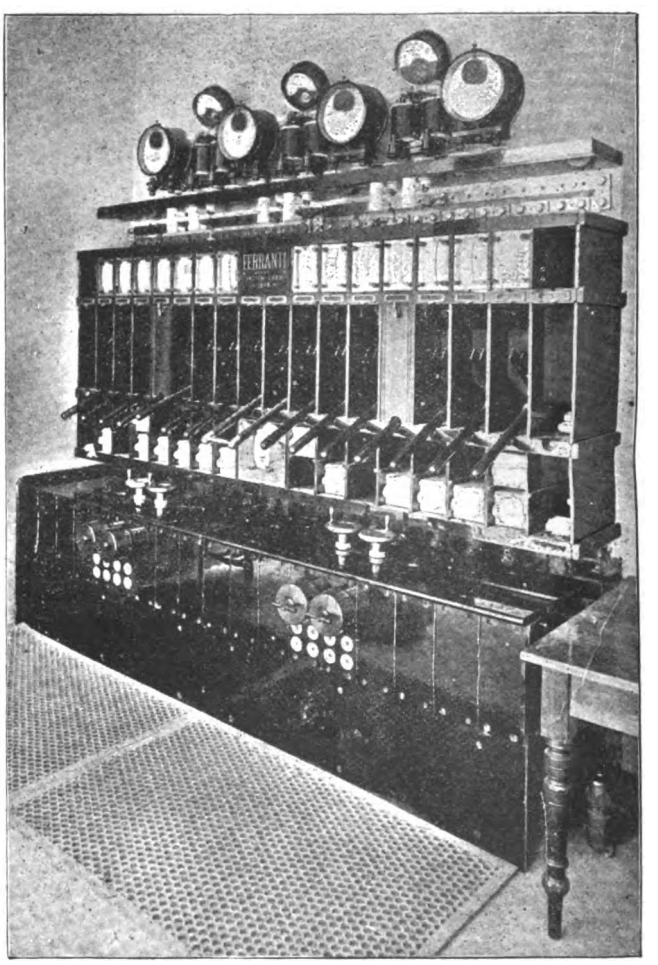

FIG. 16.

alternators, does not lend itself readily for adoption in stations where, owing to faulty machines or supervision, parallel running is a difficulty. To meet this objection, on other boards complicated 'bus bars and plugging arrangements are provided, by which any machine or combination of machines can be connected to any combination of circuits, thus introducing a system which invites errors on the part of the operator, endangering his life, besides damaging the board and disturbing the continuity of supply. So many lives of even experienced hands have been lost on switchboards, that the design of a system giving absolute security is of the utmost importance to high-tension switch gears. But although the Ferranti board is designed for parallel running, there is considerable flexibility about its construction; for instance, each panel is provided at the top (as shown in Fig. 17) with a 'bus-bar fitting, *n*. This fitting is connected to the common inner 'bus bar by a link, *m*, which can be safely removed by means of an insulated handle, thus isolating the panel beneath, or the link can be used for connecting two adjacent panels together independent of the 'bus bar; or for testing purposes a connection can be made between the

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'bus-bar fitting and a tub, artificial load, or other circuit; a jack cord may be used, by which means any machine can be connected to any circuit. When there are a number of machines in one station, the entire switch gear can be divided into any number of sections, each of which can be paralleled together or interconnected at will. Fig. 16 shows a board divided into two independent sections.

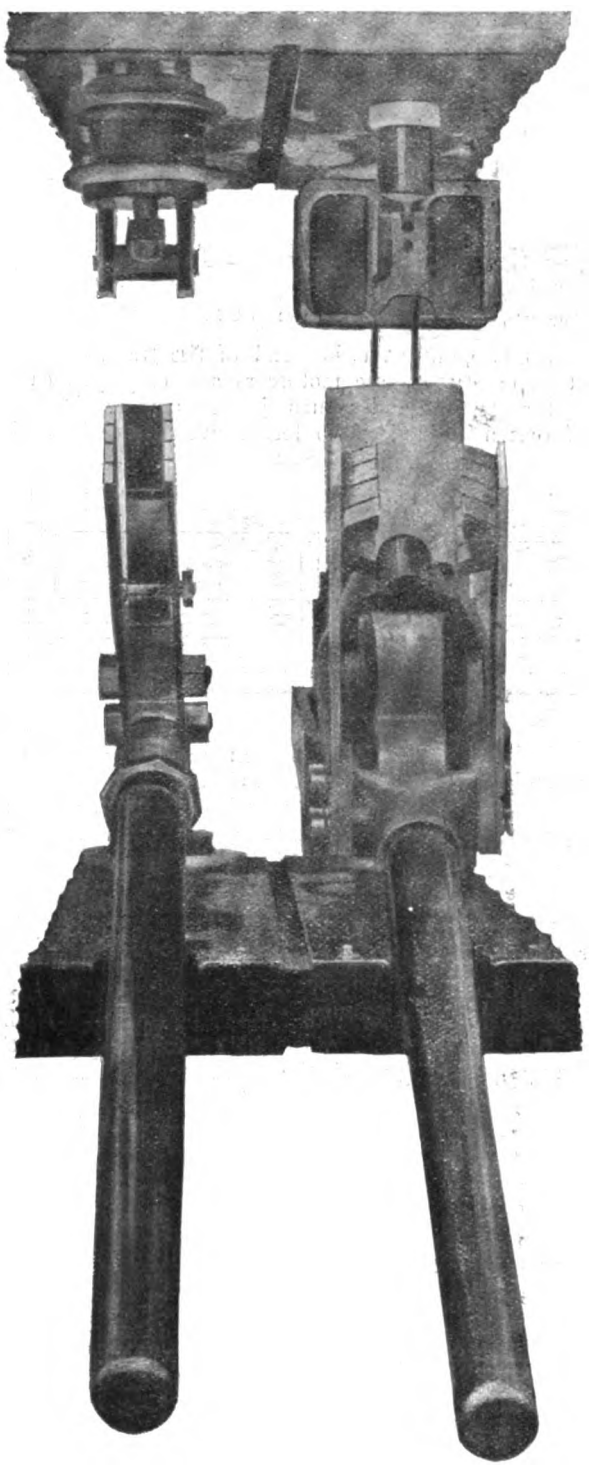

Fig. 18.

The Ferranti switchboard is also claimed to be especially adaptable to multiphase work. In the County of London and Brush Provincial Electric Lighting Company's station at Wandsworth single-phase switching gear was installed which is now being converted into two-phase gear, the only alteration necessary being the addition of a 'bus bar and a few 'bus-bar fittings. No alteration is necessary to the fittings fixed to the slate framework. Two designs of switches are shown on Fig. 18, the one on the left being for a maximum capacity of 150 amperes, and the one on the right for a maximum capacity of 300 amperes, each to fit into a panel 6in. wide. Messrs. Ferranti, Limited, have designs for all sizes of switching gears for single-pole single-phase, two-phase, three-phase, and double-pole single-phase, but a complete description of these various and ingenious appliances would fill a book.

(*To be continued.*)

THE NEW ELECTRICAL TRAIN ON THE METROPOLITAN RAILWAY.

On Monday last the new electric train service between Earl's Court and High-street, Kensington, on the Metropolitan District Railway, was duly inaugurated. The advent of this train as a practical reality has been awaited with considerable interest, the more so because few details of the scheme have been allowed to leak out. It is to be sincerely hoped that its timely appearance is the prelude to the conversion of the whole of the above company's underground system for electric traction, but that, we understand, will largely depend upon the success of the extensive experiment now being made.

By the courtesy of the consulting engineers, Sir John Wolfe Barry and Sir W. H. Preece, we are enabled to give a few details and illustrations relative to the train and generating plant, etc. To deal first of all with the conductors which convey the necessary driving current to the motors on the train, these are of channel-shape cross-section, and weigh 75lb. per yard run. The lead and return conductors are laid outside and, of course, parallel with the metals constituting the permanent way. They are carried in an inverted position by ordinary Post Office pattern porcelain insulators (Fig. 1), which are screwed at

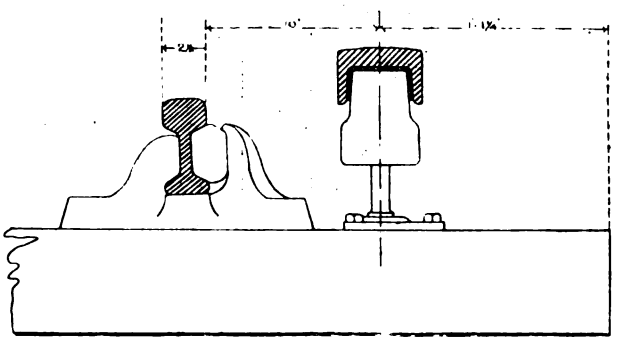

Fig. 1.—Details of Conductor, showing its position relative to track.

intervals into the rail sleepers. A piece of leather is interposed between the insulator and conductor to take up the jarring. These inverted channel-shaped conductors, it should be mentioned, are composed of mild steel, their cross-section being equivalent in conductivity to one square inch of copper. The bonding of the conductors where the joints occur has been most carefully devised, a flexible copper bond of ample cross-section being provided at each joint. These bonds are riveted securely to the channel iron conductors through taper holes in the latter. It has been found that the contact surfaces between these bonds and the channel conductors remain bright and clear even after considerable lapse of time in spite of vibration. At every 100 yards a special anchoring insulator (Fig. 2) is provided to prevent creeping of the conductors. The distance between the lead and return conductors is 6ft. 4in., each conductor being, therefore, situated about 7½in. from the outside of each rail of the 4ft. 8½in. way. There is consequently little danger of an accidental short between the conductors, owing to their distance apart. It was found impossible to place the conductors inside the tracks without disturbing the apparatus of the Station Indicator Company, otherwise this might have been done, and will most likely be arranged when the whole system is converted. At cross-overs and points it has, of course, been necessary to break the continuity of the conductors, leaving in some instances long gaps. Where these gaps occur they are bridged over by means of cables, the conductors being thereby rendered continuous. For further details of these conductors we would refer the reader to Figs. 3 and 4.

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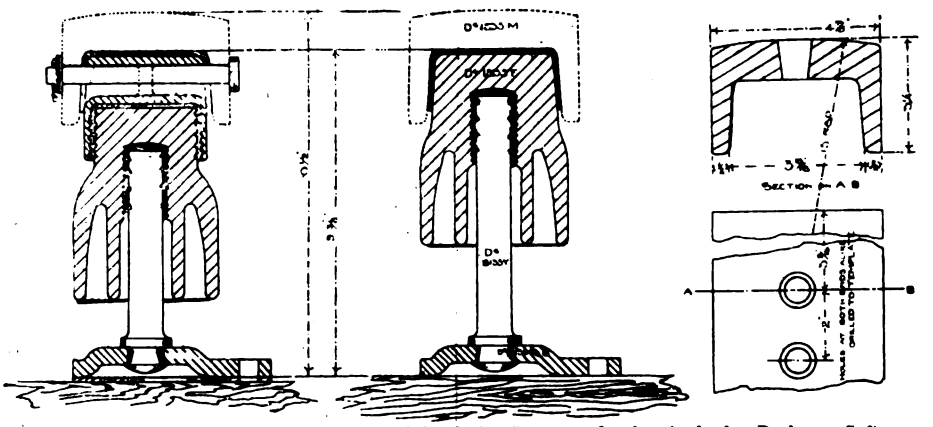
The total length of track equipped amounts to 4,000ft., both up and down roads being provided with conductors. Though fed by separate feeders at the generating station end of the section, the conductors of similar sign constituting the up and down roads are cross connected at intervals, though disconnecting links are provided whereby the one road may be isolated from the other. The gaps in the conductors being in places as much as 225ft., it has been necessary to provide the train with collector shoes on each of the seven cars. These shoes are electrically connected throughout the length of the train by means of special couplings. The positions of these shoes are so selected that one slipper shoe at least on each pole always makes contact with the conductors. Undue sparking is also avoided by the multiplicity of working. The slipper shoes are made to bear on the conductors by means of springs giving about ½in. play to the shoes in a vertical direction, the bearing pressure being adjusted to about 10lb. The train employed consists of six bogie coaches, each 40ft. long, the complete train having a length of 245ft. The motorcars, of which there are two, one at either end of the train, each weigh 54 tons empty. These motorcars are employed each in turn for the out and return journeys respectively, the chief reason for having two locomotive cars, each of which runs light alternatively, being the lack of shunting facilities available over this section of line to be worked. Each of the ordinary passenger cars weighs 18 tons empty, so that the aggregate weight of the train empty amounts to 180 tons. Fig. 5 shows a plan of one of the locomotive cars, from which the interior arrangement of the same will be seen. Each motorcar is equipped with four motors, two to each bogie, on separate axles. The bearing



FIGS. 2, 3, AND 4.—Details of Conductor and Insulating Supports, showing Anchoring Device on Left.

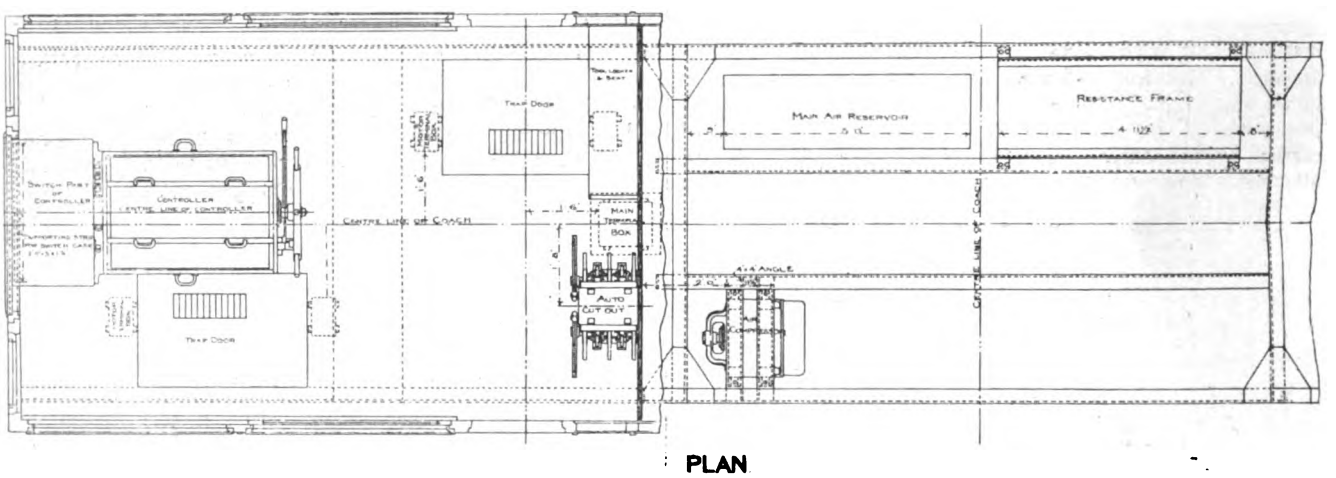


FIG. 5.—Plan of Locomotive, showing Position of Controlling Gear.

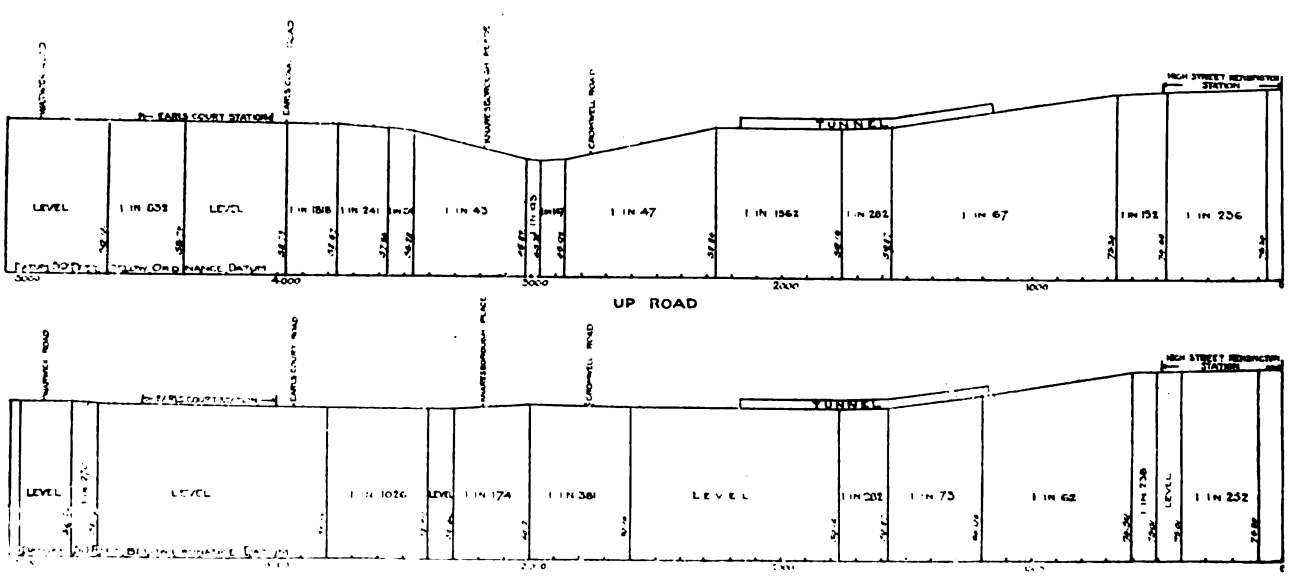


FIG. 6.—Diagram of Gradients.

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wheels are 47in. in diameter, and the armatures of the motors are built up on the respective axles. The motors are of Messrs. Siemens Bros.' powerful enclosed type of railway motor. They possess four poles, and are designed to develop from 110 normal to 200 maximum brake horse-power. Further, they have slot-wound armatures 26in. diameter and with cores 25in. long, and carbon brushes are used. The iron-clad covers provided render the motors quite watertight. These covers are hinged to facilitate inspection of the armatures, etc., while the magnets are carried by the bogie frames, to which they are directly attached. The weight of each bogie, fully equipped, amounts to about 20 tons. The controller is of the Siemens type, and appears to us to be a great advance on its predecessors used on the Waterloo and City line. It carries the series and parallel control further than any American type, as all four motors start in series, and end up with being all in parallel at maximum speed. There are 12 steps in all, four for each of the three groupings of the motors. All the breaking of circuits is done on special contacts, which are easily renewable, and those breaks which are high induction have a specially long and quick break provided. The revolving handle has to be turned three revolutions in passing from the start to maximum speed. The devices for reversing and for cutting out single motors are excellent, and prevent any damage being done by the driver inadvertently.

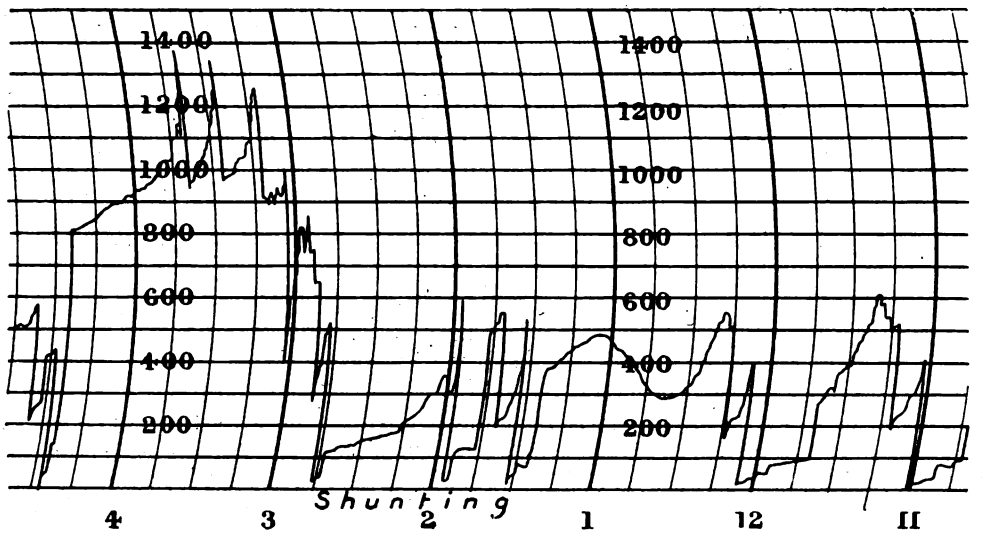

FIG. 7.—Load Diagram.

The starting resistance employed is built up of steel ribbon wound in spirals, with layers of asbestos in between adjacent layers. The train is equipped with a Westing-house brake, the air-compressor in connection with which being driven by an electric motor. The sanding apparatus, which is very efficient, also employs compressed air. An unpleasant vibration is caused by the pump at present in use owing to its high speed; but this objection is to be overcome, we understand, by employing another type of pump.

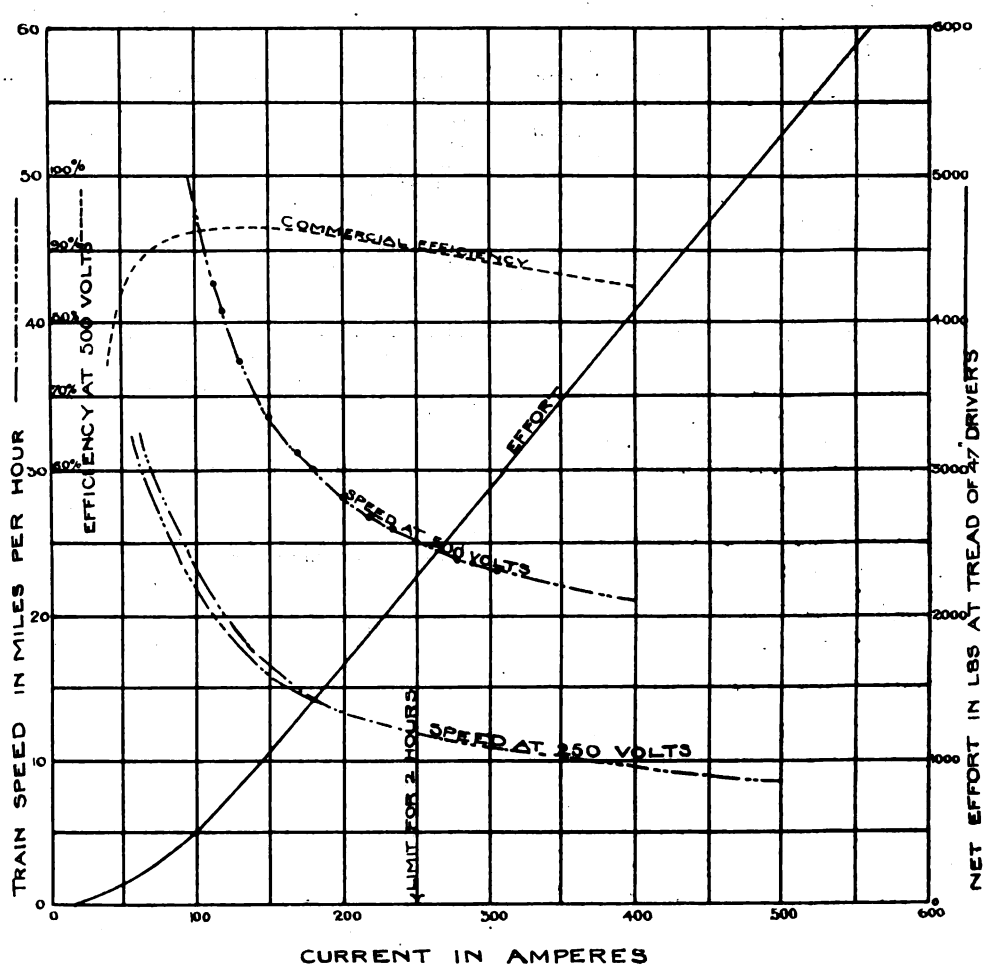

FIG. 8.—Motor Efficiency Curve.

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The locomotive cab, as will be seen from Fig. 5, is commodious, and the arrangement of the various apparatus therein very convenient. Owing to the simplicity of the driving arrangements, it has been found unnecessary to employ specially-trained drivers, the drivers of the ordinary steam-worked trains becoming quickly proficient in the manipulation of the controller, etc. Fig. 6 shows the gradients of the line, while Fig. 7 gives a typical load curve for the out and return journeys. An interesting comparison may be made between these two diagrams, the demand on the generating plant at the various points being easily traceable.

The train—which, it may be mentioned, was constructed by Messrs. Brown, Marshalls, and Co., Limited, of the Britannia Railway Carriage and Wagon Works, Birmingham—is very handsomely furnished, and marks a decided improvement over the ordinary rolling-stock. The train is electrically lighted throughout, the lamps being connected in groups of four in series across the 500-volt circuit, a total failure of the light in any one compartment being avoided by intermingling the lights of different groups in the various compartments. A distinctive feature in the design of the train is undoubtedly the arrangement of the locomotive cars, which are in reality combined locomotive and passenger cars, the room not occupied by the cab being devoted to accommodation for passengers in the shape of a saloon carriage at each end of the train, whereby space is saved, and extra weight distributed over the driving wheels.

The generating plant, which is placed in temporary buildings near Earl's Court, consists of two Babcock-Wilcox boilers, each capable of evaporating 9,000lb. of water per hour at a pressure of 160lb. per square inch. These boilers are equipped with forced-draught apparatus and with superheaters for the steam supply. Two generating sets are fixed, these being Belliss engines of the T E C 4 type, giving normally 300 i.h.p. at 380 revolutions. Their maximum rated load is 360 i.h.p., but much more than this has been taken out. The dynamos are of the two-pole H B type, with armatures 27in. diameter and 40in. long. They are compounded to give 500 volts at no load and 550 volts at the full load of 385 amperes. Here, again, the excellency of design is shown by the fact that 800 amperes have been taken from the machines for a short time, making 1,600 amperes from the station.

In considering the results of tests, it will be well first to refer to the motors. The figures from a test of them are incorporated in the curve (Fig. 8). The motors were specified to give a pull of 4,000lb. with 47in. wheels, and this has been exceeded, as a pull of 6,000lb. is obtained. On a two-hour continuous run without undue heating, the motor, with a current of 250 amperes, gave a pull of 2,300lb. at a speed equal to 25 miles per hour. A further test on the line itself showed that the electric locomotive and carriage combined was much more powerful than the ordinary steam locomotive on the line. This was shown by the fact that a steam locomotive was unable to pull up the grades the electric train loaded up to 220 tons. After this had been proved, steam was shut off, and the electric locomotive started the train with steam locomotive coupled to it, and took the whole up the grade easily. As regards the acceleration obtained, this proves to be nearly 1·25ft. per second per second. Owing to the small amount of generating plant, however, this acceleration cannot be maintained after the motors are in parallel, as the current available is too little. Maximum speeds of 38 to 39 miles per hour have been reached, and great improvements on the scheduled times with steam locomotives are obtained. Quicker travelling and more accommodation is thus ensured by the electric train, in spite of the fact that the experimental equipment is always loaded by the weight of an idle locomotive. These inducements are great, and should be quite sufficient to ensure the complete conversion of the Inner Circle.

Cheltenham.—An order has just been placed by the Corporation with Messrs. Witting Bros., Limited, of 49, Cannon-street, London, E C., for two of their standard over-compounded railway generators, to be coupled direct to Belliss engines. Each of these machines will be of 150 kw., and will supply current to a light railway in the neighbourhood.

THE DUBLIN ELECTRIC LIGHTING BILL.

The Select Committee of the House of Commons presided over by Mr. A. H. Brown, and consisting of Mr. Arthur Moore, Mr. Trevelyan, and Mr. Rutherford, had this Bill under consideration on Wednesday, May 16. The promoters were represented by Mr. Balfour Browne, Q.C., Mr. Gordon, Q.C., Mr. Munroe, and Mr. Fitzgerald Murphy. The petitioners against the Bill were the Dublin Corporation and the Alliance and Consumers' Gas Company. The former were represented by Mr. Pember, Q.C., Mr. Bushe, Q.C., Mr. Macinerney, Q.C., and Mr. F. D. Fitzgerald, Q.C.; and the latter by Mr. Littler, Q.C., Mr. Pembroke Stephens, Q.C., and Mr. Acworth.

In opening the case for the promoters Mr. Balfour Browne said the action of the Dublin Corporation in connection with the electric lighting of the city had been to maintain the monopoly in their own hands, though they would do absolutely nothing to meet the wants of the ratepayers. The tramways company had offered to supply electricity to the Corporation at a reasonable price, but the offer was refused. The result was that the ratepayers had been obliged to take the matter into their own hands, and they came to the House asking for powers which the Corporation possessed, but would not put into operation, and the first directors of the proposed company would be Sir Henry Cochrane, Mr. Vere Ward Brown, Mr. Charles Wisdom Hely, Mr. Joseph Mooney, and others. The gentlemen were themselves consumers of electricity, and had great cause of complaint against the Corporation. They would tell the committee that there would be a very large demand for electricity, and otherwise would make out a very strong case for the Bill. It was a competitive Bill certainly, but there were any number of precedents where Parliament had permitted a company to come in and compete with the local authority. The Corporation had proposed to establish a generating station at Pigeon House Fort, which was some distance outside Dublin, and it had been pointed out to them that the Pigeon House was at such a distance that the cost of carrying the electricity would be prohibitive. Despite this, however, after the Bill was promoted the Corporation applied in hot haste for powers to borrow £250,000 for this purpose. Obviously they were late in doing what they should have done long before, and it was only an effort to compete with the promoters of the Bill. The tramway company had made offers to supply the Corporation with electricity at what was a comparatively cheap price, but the Corporation had not even thought it worth while to acknowledge receipt of communication. The Corporation had got a clause inserted in the tramway company's Bill preventing them from supplying electricity without their consent. The new company expected to be able to supply at an average rate of 4½d. per unit. He hoped to be able to show that this enterprise would pay. The maximum which they proposed to charge was 6d.

Mr. Wm. Murphy, examined by Mr. Munroe, said he was chairman of the Dublin Tramways Company, a shareholder in the syndicate promoting the Bill, and a director of the Cork Electric Tramways. They had desired to obtain a supply of electric lighting for the Corporation, but had not been able to get what they wanted. The charge by the Corporation had been 7d. maximum, subject to a small discount. During last year the Corporation had modified their system of charging, and the maximum was made their standard rate, with a system of discounts, based upon the proportion between the summer and winter consumption of each consumer, and the average charge worked out at something over 6d. In Cork the maximum charge for electricity was 4½d., and the average for public lighting only 2½d., as against 6d. in Dublin. The Dublin Tramways Company had offered on two occasions to take over the Corporation plant and supply to the public at a much lower rate than the Corporation now did, but neither of these offers had been replied to. Recently the Corporation had applied for a loan of £250,000, which was eventually granted. The Corporation had started a scheme to erect a station at Pigeon House Fort, but Prof. Kennedy had pointed out that it would be a very costly site, and, as a matter of fact, parts of the boundaries of Pembroke township and of the county of Dublin lay between the fort and the boundary of the city, from which it was about a mile distant. He believed the company would make a profit, and he anticipated no trouble in raising the capital; in fact, the gentlemen who had supplied £100,000 worth of cables to the tramways company had offered to supply the cables, and invest the amount of their cost in the new company. The tramways company had made two offers to supply the Corporation with electricity, in the last of which they undertook to supply the first million units at 4½d. per unit, the second million at 4d., and all others at 3d., including distribution. As to the supply of electricity in bulk, they offered to provide the first 650,000 units at 2½d., 1,300,000 at 2¼d., and above 2,600,000 at 1¾d.

Cross-examined by Mr. Bushe, Q.C., witness said the Corporation had not sought to charge 7d. during the last 15 months.

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Since then there had been a reduction, and the charge worked out now to an average of about 6d. a unit. He was aware that up to last year the Corporation had been most unfairly dealt with in the matter of their borrowing powers. This Bill was introduced to the public in November, and he did not know that Mr. Hammond had been consulted by the Corporation long before that, and Prof. Kennedy so far back as 1897. Their whole system broke down in 1897. He had seen by the newspapers that a Local Government Board inspector had held an enquiry into the Corporation's application, and that the Local Government Board had sanctioned the loan. The Bill was not a project of the tramways company, but purely a private enterprise in which the tramways company were in no way concerned beyond the fact that he (witness) was chairman of the tramways company and a shareholder in this one. The present tramways company were the sole owners of the generating station, and in that capacity they made their offers to the Corporation, and was a distinct company.

Cross-examined by Mr. Hebworth, he said that three other gentlemen named as directors of the new company were shareholders in the tramway company. They were simply gentlemen who were in the habit of embarking in electrical enterprises. He did not know that the gas company had power to light Dublin with electricity. If they had, they did not exercise it. If the gas company were willing and able to do this it, did not follow that his company would withdraw. The gas company did for some time supply electricity, but they did that without statutory powers to break up the streets to lay cables, and as a matter of fact they carried the wires overhead. They had not done any electric lighting since the Corporation got its order in 1892. The gas company had land which would be convenient for generating stations.

Cross-examined by Mr. Gordon, Q.C., he stated that the company was absolutely independent of any gas company. The Tramway Company, Limited, was a distinct company from any of the two older tramway companies, had a very much larger capital, and was paying a dividend of 6 per cent. Questioned by the committee, he stated that he hoped to be able to supply the electricity for 4½d. per unit. If the Corporation consented to their co-operating with the tramway company, they could give it at about 1d. less.

Mr. CHARLES WISDOM HELY, examined by Mr. Gordon, Q.C., said he was one of the promoters of the Bill. Mr. Brown and Sir Henry Cochrane were large merchants, and he was himself largely engaged in trade. The company wanted to supply a great public want. He with some difficulty got part of the electric supply that he wanted, and on the statement of the Corporation officials he took down his gas brackets, but had to put them back again owing to the failure of the electric light. Although the generating station was close to his place of business, he had not been able to get electricity for his engines, and had to use gas.

Cross-examined by Mr. Stephens, Q.C., he stated that he did not know that the company would come to Parliament for gas-lighting power. What they wanted was electric lighting.

Cross-examined by Mr. Macinerney, Q.C., he said Mr. Brown and he were members of the Rathmines Town Commissioners. He suggested that if Rathmines was included in the Bill he, as a commissioner, could not act upon the syndicate. The Commissioners had, however, their own nearly perfect installation, or otherwise he would have recommended the township to go in with the syndicate. Pembroke and Clontarf were also excluded. Further cross-examined, witness said he did not know what system would be adopted by the company.

Mr. JOHN DOYLE, examined by Mr. F. Murphy, stated he was a director of the Central Hotel Company, Limited, and Todd, Burns, and Co., and had no connection with the promoters, the tramway company, or any of the townships. They had been obliged at large cost to put in an installation at the hotel. They had wished to carry a cable across Dame-lane to their new stock-rooms, but after the tunnel was made the Corporation refused to allow them, although the Corporation could not give them sufficient supply of electricity.

The committee then adjourned.

At the opening of the proceedings on Friday, Mr. PEMBER, Q.C., enquired whether the committee considered it necessary to have a witness from Dublin, who could give evidence concerning the stability, etc., of Pigeon House Fort.

The CHAIRMAN did not think it would be necessary to have any evidence of that nature. The Local Government Board had held an enquiry extending over several days, and sanctioned the loan to the Corporation, and the committee had no intention of going over the same ground.

Mr. GORDON, Q.C., considered it right to say that he intended to call evidence as to the unsuitability of the Pigeon House Fort for the purposes for which it was intended to apply it.

Mr. PEMBER would like, in any case, to know whether it would be necessary to bring over the harbour master to give evidence, but that course might open up a very long enquiry.

The CHAIRMAN: The merits of the Corporation scheme are not before us—good, bad, or indifferent.

Mr. GORDON said that was so, but the merits of the two schemes must arise to some extent in a comparison.

Mr. PEMBER did not, under the circumstances, think it would be necessary to send for the evidence.

Mr. GORDON, in reference to the controversy as to the tramways company supplying the Corporation with electricity, read a letter from the town clerk, which stated that the insuperable objection to that course was that the company were debarred by statute from supplying any electricity save for driving their own cars and lighting their own posts, and that before they could carry out their offer they would need to obtain power from Parliament. As a matter of fact, however, it was only necessary for the Corporation to say that they released the company from their agreement.

Mr. VERE WARD BROWN, examined by Mr. Gordon, Q.C., said he was head of the firm of Brown, Thomas, and Co. In their business house they were obliged to go back to gas, because they could not get a proper electric lighting supply, although they were only 400 yards from the Corporation's lighting station. In 1893 he got an installation, which at first was very fair, but as soon as other customers began to be supplied the quality of the light became very bad, and frequently gave out altogether. So bad and unreliable was the electric light that he had been obliged to provide gas as an alternative. His gas bill had been over £200, which sum would never have been incurred if the Corporation had supplied electricity properly. He was not in any way hostile to the Corporation, but was simply a business man desirous of getting the light. The Corporation had proved their incapacity to deal with the matter even in a small area, and now they were obtaining increased capital and supplying a much wider area, and he anticipated a repetition of the fiasco.

Cross-examined by Mr. Bushe, Q.C.: He was not aware that a general idea had arisen that the power-house for an electric lighting system should be outside the district. The Bill sought powers for the promoters to acquire premises on Sir John Rogerson's quay for their generating station. The tramways company had theirs at Ringsend. This syndicate had nothing whatever to do with the tramways company, excepting so far as they might find it convenient to rely on their power if the new company had a slight breakdown. Not long since the whole of the electric tramways in Dublin were stopped for half a day. If there had been an opportunity of temporarily borrowing power from another station, the public would have been saved much inconvenience. It was only in matters of that kind that the new company would have any connection with the tramway company. It was true that the Corporation had been hampered by want of money, but they had wasted what had been placed at their disposal. They got renewed borrowing powers last August, and he believed that Mr. Hammond was consulted in September, when the cables of the Corporation broke down, and they went to the Local Government Board for more money to put them right. The Corporation, he thought, did not understand anything about electric lighting. He acknowledged that even if directors of electric lighting companies did not understand much about electricity, they yet managed to successfully direct electrical concerns, but doubted whether the Corporation had got the very best engineer to do his best for them. Mr. Hammond might have evolved an excellent scheme, but the point was whether the Corporation had done their share in carrying it out.

Mr. HENRY JURY, examined by Mr. Monroe, said he was proprietor and manager of Jury's Hotel. An effort was made in 1893 to get a supply of electric lighting from the Corporation, but they would only promise to give it at the end of two years. Under these circumstances he had a private installation, which cost about £3,000. It was not in all respects satisfactory, there being vibration and noise, and he would sacrifice his expenditure upon it to get a good supply from a public company. The electric lighting cost him about 4d. per unit.

Cross-examined by Mr. Macinerney, Q.C., he said he was not in any way antagonistic to the Corporation, and would be quite willing to accept a proper supply from them.

Mr. JOSEPH M'CARTHY, examined by Mr. Murphy, said he was formerly a member of the Corporation. He used electricity in part of his business place, and had had to put in gas owing to the failure of the Corporation supply. His place had often been left in complete darkness during business hours. He thought paid directors did their work better than a corporation, and a private company was always able to get labour more cheaply.

Cross-examined by Mr. Macinerney, Q.C., he said he would like to see both the Corporation and the syndicate's electrical schemes in full operation, for he believed the competition would be in the interests of the public.

Mr. GEORGE BEATER, architect, examined by Mr. Monroe, said he had carried out the reconstruction of the premises of Messrs. Arnot and Co., Dublin, and had put in an electric lighting installation at a cost of £3,000, not being able to obtain a supply from the Corporation.

Mr. W. GRAHAM, J.P., examined by Mr. Monroe, said he

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was largely interested in the Dublin shipping trade, and regarded an efficient electric lighting supply as imperative. He thought competition would prove very beneficial.

Cross-examined by Mr. Bushe, he said that Clontarf had been struck out of the Bill, because it had got its own provisional electric lighting order.

Questioned by the Chairman, he stated that there was no electric lighting by the Corporation in the docks.

Mr. SHAW, engineer, of New Kilmainham, examined by Mr. J. Gordon, Q.C., on behalf of the promoters, said that the price of gas in the township was 4s. 6d. He was also an architect, and had to set up an electric installation for a firm at a considerable cost.

Cross-examined by Mr. Acworth, he acknowledged that it was customary to charge more for gas in outlying districts served by a city. He thought New Kilmainham would get electric light equivalent to the gas supply at a price equivalent to 2s. 3d. per thousand in gas.

Mr. HANLEY, of the firm of Hanley and Shanks, of Dublin, examined by Mr. Monroe, said that the Dublin electrical plant was equal to 1,500 h.p., and had 270 subscribers, as against a horse-power of 2,384 in the case of the 70 private plants now established. The Corporation plant was not suitable for the purpose of supplying power. Even if the Corporation went on with their new scheme he believed competition would be beneficial to the consumers, and without it they would have to pay more.

Mr. A. E. PORTE, M.I.E.E., examined by Mr. Murphy, declared that he had an intimate knowledge of the electric lighting of Dublin. His firm did a large business there. Many of his clients had failed to obtain electric supply from the Corporation. There were no motors in Dublin, whereas there were 400 in Cork. He considered that the Cork electric lighting was more successful than that of Dublin, because it was in the hands of a company. In corporations the lighting was in the hands of a committee which came in one year and went out another. General experience was in favour of companies as against corporations.

Cross-examined by Mr. Macinerney, Q.C., witness stated that trade in Dublin would increase if the Corporation gave a supply to suit consumers, but competition should be encouraged. He was not aware that the Corporation were going to supply motors.

Re-examined by Mr. Balfour Browne, the witness said that if the Corporation supplied electricity at a cheap rate the company would be obliged to do so also, and that would be an advantage to the consumer.

Mr. PARSHALL, electrical engineer, examined by Mr. Balfour Browne, Q.C., said he had much experience as to electric traction plant and the supply of electricity. The proposed generating station for the syndicate would supply electricity for lighting or energy at a cheaper rate than the 7d. per unit charged by the Corporation. He himself designed the Cork and other installations. He believed the new company would be able to sell at 4d. or 4½d. for lighting and 2d. for power, and make a profit. The receipts in Dublin ought to be between £40,000 and £50,000 a year. In his opinion the Corporation cables were well laid, but not properly attended to, and thus failed. Competition was a source of cheapness in electric ghting.

Cross-examined by Mr. Bushe, Q.C., the witness said he was never connected with the Corporation, but with the United Tramways Company and with the Southern Tramways Company So far as any offer of the Dublin Tramways Company went, he had nothing to do with it.

Cross-examined by Mr. Pembroke Stephens, Q.C., he stated that the tramway works now existent were not intended to supply electric light, and he had advised an absolutely new set of works to provide light.

Questioned by the Chairman, he said the present mains of the Corporation had broken down, but similar mains, when properly used, would last. The failure was due to over-pressure.

In answer to the committee, he thought the net profit to be made by the new company would be about £20,000 to £21,500.

The committee then adjourned until Monday.

MONDAY.

After a petition on behalf of the Drumcondra Commissioners in favour of the Bill had been handed in, Mr. PEMBER, Q.C., addressed the committee on behalf of the Corporation. He stated that if the proposals in the Bill were sanctioned, such action would be absolutely unprecedented. In his experience he had never known a Bill granted for the supply of electricity in any town in competition with and against the wish of the local authority. Attempts had been made to justify this application out of certain unsatisfactory conditions that had prevailed in the electric lighting of Dublin, but these conditions were easy enough of explanation. But even supposing that the Corporation were unwilling to carry out their obligation, surely that was a matter for the ratepayers themselves to rectify, and did not warrant this intrusion of Mr. Murphy and his friends. It was no fault of the Corporation that Dublin had not had a thorough system of electric lighting years ago. That body had not in the least degree been behindhand as regarded the adoption of electricity for lighting purposes, for only two years after the first London order was granted they themselves obtained a provisional order, under which they erected a generating station in Fleet-street, and proceeded to supply private consumers. The Fleet-street installation now proved inadequate to supply the demand. The same difficulties had arisen in London, where most of the electric lighting companies had been obliged during the last year or two to supplement or altogether replace their generating stations.

Mr. ROBERT HAMMOND, M.I.C.E., examined by Mr. Bushe, Q.C., said he had been engaged for 20 years in electric lighting matters, and had acted as consulting engineer to a large number of public bodies in this country. His first connection with the city of Dublin dated from March of last year, when he was asked to report upon the proposed extensions of the city electric lighting scheme. After some months' study of the question on the spot, he made his report to the Electrical Committee; £254,000 was the amount of his estimate for an efficient scheme, which would cover the whole of Dublin, with 19 distributing centres. The Corporation had made ample provision for the supply of motive power, and it was ridiculous to urge that the ratepayers would only have the advantage of power if the new company came into existence. They would supply light at an average cost of 3¼d. per unit, or 1½d. less than what the promoters of this Bill expected to do. With regard to the offer of the tramway company to supply electricity in bulk at 1⅞d., the Corporation would, of course, have had to undertake all the cost of and loss incurred in distribution. Under their own scheme they would be able to deliver the power at 1½d. He had no doubt as to the ultimate success of the Dublin Corporation's scheme, now that it was thoroughly equipped with capital. He thought it would be very inconvenient if this Bill were passed, and two bodies had power to rip up the roads at their own sweet will. Where a company was competing with a corporation, it could so harass and worry the local body that it could eventually force it to buy them out.

Cross-examined by Mr. Gordon, Q.C., Mr. Hammond said he thought the Corporation would be easily able to supply electricity at the price he had mentioned. Questioned as to whether if, adding on the load of debt and the additional cost of new works they would supply at 4½d., the Corporation had behaved reasonably, when they had no debt, and charged 7d., Mr. Hammond admitted, having regard to the area of supply, that 6d. would have been a more reasonable figure. Counsel closely examined witness with a view to showing that the figures he had arrived at as to the cost of the supply were largely the result of guesswork, but Mr. Hammond explained to the committee at considerable length the data upon which he based his estimate. The laying of a portion of their main from the generating station would be subject to the consent of the Pembroke township, as they would have to pass through that district. There were one or two cases in which he thought the Board of Trade would be justified in dispensing with the consent of a local authority, as when a corporation, for instance, had failed to carry out its electric lighting orders properly. The Corporation of Dublin had, however, given evidence of spending a quarter of a million of money to put their house in order.

Re-examined by Mr. Bushe, witness said his scheme had been prepared and settled before they knew anything about the syndicate which was promoting this Bill. The Dublin Corporation had given him a perfectly free hand to produce the very best scheme.

The Right Hon. JOSEPH MEADE, chairman of the Electric Lighting Committee of the Corporation, examined by Mr. Fitzgerald, Q.C., said that the failure of the local authority to give an adequate electric supply was due to want of money, caused in large part by the large outlay on main drainage. Last year they had to get their borrowing powers extended. The Local Government Board had sanctioned expenditure up to £254,000 for the purpose in question. They advertised for sites for the electric works, and the only one offered was not suitable, and the only suitable one they could get was the Pigeon House, which was really a good one.

Cross-examined by Mr. Gordon, Q.C., the witness stated that at the Local Government enquiry the fact that they had to go through the Pembroke township was mentioned, and the Corporation took its provisional order subject to obtaining that leave. It had been said that the Corporation was a gigantic failure as to electric lighting, but they had, as a matter of fact, paid £15,000 off the sinking fund, and £10,000 out of the interest of the loan, and that £25,000 had been paid out of earnings, and he did not think that that could be said to be a record of gigantic failure.

Mr. RUDDLE, who had charge of the Corporation electric works for some years, examined by Mr. Macinerney, said that at first the electric supply was small, not being in much demand. The station originally cost £37,000, and was intended to supply the central part of Dublin. More applications for

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supply than they could meet were soon afterwards made, and on one occasion the Corporation was summoned for non-supply, but the case was dismissed. They stated that the Corporation had not powers large enough to supply the demand, but intended to get additional powers, and the people were content to wait. Additional powers were obtained, and the supply increased. At first the cables worked well, but after four or five years they had to lay down new cables, which Prof. Kennedy reported as among the best to be obtained. But the breakdown of these cables in Dublin was not singular—similar cables in other places broke down in like manner. The cables were never overloaded. When new cables were laid down, the whole system was brought more up to date. In 1897, £20,000 was borrowed for the purpose. The cables were now in good working order, and all the more important parts of the present working could be utilised in the new system, and that was the intention of the Corporation. In consequence of the delays that took place in laying down the new cables, and from other causes, about 27 persons said they could not wait, and put up plant of their own, but many of these were now anxious to come back to the Corporation for the supply. Now that the new cables had been laid down, and in working order, people appeared to be satisfied with the supply, and had made no complaints recently. The consumption during the last March quarter was larger than in the corresponding quarter of 1899. There was a sliding scale of prices, 7d. down to 5d., and the average last year was 6·10d.

Cross-examined by Mr. Gordon, Q.C., the witness stated that the citizens of Dublin got the benefit of the new cables in December last. At the present time £68,000 of the amount borrowed for the electric lighting remained unpaid out of the £83,000 borrowed. He could not say how many lamps were actually connected with the wires in January last. They might have been lighting 25,000, but he could not give the exact number. Arrangements had been made for lighting 30,000 8-c.p. lamps. The electric light was turned off at two o'clock in the morning. There was no demand for it after 12 o'clock, but if any application was made for a later supply it would be granted. No such application, however, had been made.

Prof. SILVANUS THOMPSON, professor of electrical engineering, examined by Mr. Bushe, Q.C., said the scheme proposed by Mr. Hammond would provide motor power. It was not correct to say that that power would be only provided by the new company's system.

TUESDAY.

Mr. HAMMOND, recalled, said, in answer to Mr. Bushe, Q.C., that while the electric lights in Dublin were now put on about six o'clock in the evening, and put out at two the following morning, with his scheme the lights would be continuous, so that persons could be supplied with it at any time.

Mr. GEORGE PEARSON, the chairman of the Bristol Electric Committee, said the Corporation had a provisional order for supplying the city with electric light, and they had made considerable profit by the working for the benefit of the ratepayers—many thousands of pounds. He believed the Corporation of Dublin must make a profit for the city by electric lighting if they had sufficient working capital, as Bristol had. He saw no reason why Dublin, with the high-tension system, should not be able under that scheme to supply electricity at as great a distance and at as cheap a rate as the Corporation of Bristol did.

Major CARDEW, examined by Mr. Bushe, Q.C., said he approved the selection of a site outside the city of Dublin, where the generating cost could be kept down. In the great majority of cases this was advisable when dealing with the congested area of a large city, especially where there were facilities for doing so. At the same time he would admit that if there was a nearer site, in all respects suitable, it would be better. In the present case he should not approve of such competition as was threatened by the Bill, for it would tend to keep up the cost, and he was aware that the policy of the Board of Trade was opposed to such competition.

Cross-examined by Mr. F. Murphy, Major Cardew said that during the whole time he was at the Board of Trade the interference of a private company with a corporation, when the latter was supplying the electricity, was not regarded with approval. He knew that the Dublin Corporation had not so far given a satisfactory supply, and that some of their customers had been dissatisfied. He had heard that the Dublin Corporation had not worked their undertaking at a profit, but as there was a demand for more than all they could supply, they ought to have worked at a profit. He could not recall a precisely similar case. There was no doubt that if a person within the compulsory area could not after some years obtain a supply, that was a failure, which, he thought, would justify competition being asked for.

Mr. WIGHAM, chairman of the Electric Lighting Committee of the Leeds Corporation, examined by Mr. Macinerney, Q.C., gave evidence as to the success of the Leeds undertaking.

Sir THOMAS PILE, Lord Mayor of Dublin, said, in answer to Mr. Bushe, that the Corporation intended to go on with the order that they had obtained from the Local Government Board, and the money they had borrowed they intended to spend to the advantage of the citizens. They hoped to make large profits, and those profits would go to the diminution of the rates. By means of this electric scheme the Corporation looked forward to developing the industry of the city, and they objected to having another authority in their area with power to put down works where their own were. They had spent an enormous sum recently on their streets. There were at present seven authorities in the city who had power to cut up the streets in pursuit of their industries, and the Corporation did not want another. He was certainly opposed to an electric company coming in and competing with the Corporation, and if such a thing was allowed the citizens might be put to great cost afterwards having to buy them out. Until the Corporation took the matter up, got the necessary order and the money to develop their scheme, they had never heard of a syndicate coming forward to take up the electric lighting of the city.

Cross-examined by Mr. Gordon, Q.C., the Mayor stated that the electric lighting in Dublin had been carried on so far for the advantage of the citizens; he did not regard the working as a failure. Their first consideration was, of course, the interests of the citizens, who were entitled to the best and cheapest supply. He knew that in 1897 it became necessary to lay down new cables. They took steps to do so, but the cables were not laid till 1899. There was a perfect explanation for the delay. The vast majority of the Town Council were opposed to accepting the offer of the tramways company in 1897 because it would not have been to the advantage of the citizens to do so. He did not think there were half the number of 77 persons in Dublin carrying on their own private installations.

WEDNESDAY.

On Wednesday, Mr. GORDON addressed the committee in reply, and said the only real question was that of competition. The views they entertained were that, in the first place, if a corporate body or otherwise was doing the work well, Parliament was unwilling to introduce competition simply on the ground of providing two independent sources of supply. From what had been said by the witnesses, he thought the committee were satisfied that the Corporation had not given a proper supply to the citizens of Dublin, and he thought it would be providing a new principle if Parliament were to refuse to allow another company to come in simply because it would be in competition with the municipal authority. As to the breaking-up of streets, that was done also in connection with gas and water, telegraph and telephone wires, etc., and this was a bad argument against the granting of the powers. The Corporation had been working eight years, and had about 250 customers, while there were over 40,000 electors in the city. They spent £90,000 eight years ago, and had made a loss on it. They were now asking to borrow £250,000 more, and thought they would succeed. At a price of 7d. per unit there was a deficit of £2,000 in round figures. The Corporation had not done their duty. They started with £50,000 as an experiment over a small area. This, perhaps, was in their favour. But if the experiment utterly failed they should not have carried it any further. Alderman Meade was a member of the Electric Lighting Committee, but could not tell them anything as to the borrowing powers. A chairman of a company would, he thought, require to know something as to the borrowing powers of his concern. When, in 1896, their cables started to give out it was their duty to do something rapidly, and not let things go from bad to worse until forced to apply for a loan. He did not think people like this capable of dealing with £250,000. Dublin wanted a cheap supply, and the tramway companies offered, instead of the Corporation's 7d. per unit, to supply at 6d. for private and 4d. for public lighting. After their new station was built, they offered again to supply at 5d. for private and 3d. for public lighting. This letter was not answered. As to the site, the cost of cables from the Pigeon House Fort would be some £10 000 or £12,000 to bring a supply inside the city. Then at the enquiry for sanction to borrow £250,000, the new tramway company offered the Corporation a supply in bulk at the boundary at 2½d., if they took 1,300,000 units 2¼d., and 2,600,000 at 1⅞d. They would distribute it for them at 4½d. for the first 1,000,000 units, after which at 4d. and 3d. What the company wanted was to have a body who would have control of the electric lighting, and who would not be interested in making it subservient to gas lighting, and who would give a cheap and efficient supply to the people of Dublin.

The room was then cleared, and after a short while the counsel and promoters were recalled, when the CHAIRMAN said the preamble of the Bill was proved, but the committee desired to make one suggestion—viz., that the maximum price should be reduced to 5d., not 6d., after three years, and also that there should be a purchasing power.

Mr. MUNROE said this was already in the Bill, or, if not, would be put in.

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IMPERIAL TELEGRAPHIC COMMUNICATION.

An academic discussion of the subject of telegraphic communication took place in the House of Commons on Tuesday last. There was the usual holding up of hands and the crying of "Alack!" and "Alas!"—the labouring of the mountain with the production of the mouse. That was all. The growth—shall we say natural growth?—of submarine telegraphy has given rise to a host of peculiar conditions which the man of to-day raves about as being horrid nuisances. He exercises the same privilege about cables as he does about the narrow, tortuous streets and lanes of mediæval towns. All he says may be true, but that is not to the point, the whole matter involving revolution and confiscation, or in all new work to follow modern requirements, and thus minimise the adverse conditions which prevail. The holder of a brief for either party can make out a very strong case, but then it leads us merely into an *impasse*. The pioneers of cable work—and, mind, all this work has been done within the memory of man — were men of business instincts. They were on the look out for the profitable employment of capital and the directing of as much of the proceeds as they legally could into their own pockets. This class of work is not held to be out of place in the City of London—in fact, it is held that men go into the City to make money. At the outset, the field was unexplored; the wonderful development that would take place in intercommunication unknown; the life, the cost, the maintenance, the working expenses, all to be ascertained. The first question was probability of business in order to have some ground upon which to ask for money in order to provide a cable. Parallel with this question came another: How to promise a return that should bring in the required capital? Is it any wonder that time has shown these pioneers to be shrewd business men, and that they were over-cautious in assuring a good return? That, briefly, is the whole front and offending of the companies. They obtained too favourable subsidies, they charged and do charge too high prices for the work performed, and they cannot guard against breakdowns. They are condemned for not having provided a strategic system, and a host of other things it is needless to mention. We have always attempted to look into this cable question from two opposite and conflicting standpoints. We contend that the work of the business men is to provide for the requirements of business men, and that it is the duty of the Government of the day to provide for the strategic needs of the Empire. These two things may under certain conditions coalesce, under other conditions may compete; but they are as distinct as the poles. Further, not only has the Government to provide for the strategic needs, but it has to foster and assist business requirements. It is the latter duty combined with the former that has hitherto led to subsidies; but we know of no single instance where the Government has actively supported cables that from their point of view are strategic only. From

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the Government's point of view, for example, the proposed Pacific cable is purely strategic. Its treatment of the proposal has been disgraceful; had it been otherwise, the cable would long ere this have been laid and at work. The lack of that cable may, if troubles come to a head in China, be disastrous to us, and then another debate in the House of Commons will show how easy it is to be wise after the event. The proper course to pursue is, time having shown the subsidies and the concessions granted to the cable companies to be greater than the need, to put these things on all-fours with the requirements; and it having been conclusively shown that with the growth of Imperial unity it is important, and may be vitally important, to have self-contained cables—that is, cables wholly within the shores of the Empire—these should have the special attention of the Government, and be laid without unnecessary delay.

COMPETITION.

The decision of the House of Commons Committee on the Dublin Electric Light Company's Bill will come as a rude shock to municipalities. It will serve to remind them that if they do not look after the interests of their inhabitants, they must expect Parliament to do so. We have supported strongly the municipalisation of electric light because it is the duty of the various towns to get their streets well lighted, and because the mains for street-lighting and for private supply are best controlled by one authority. Our support has been justified by the good work done by such corporations as Edinburgh, Glasgow, Manchester, Bristol, etc., not to mention many smaller places where good and cheap electrical energy is distributed. There are exceptions, however, and of this Dublin ranks well up amongst towns which have starved electric lighting undertakings. Thus, while the supply was commenced in 1892, it is not given continuously even at the present time. The supply is only available shortly before sunset and 2 a.m. each day, and for a short time in the mornings in the winter. The stagnation is further shown by the units sold per annum for a series of years. Thus in 1895, 467,844 units were sold; in 1896, 473,547; in 1897, 518,312; and in 1898, 475,686 units. The figures for last year are not to hand, but sufficient has been given to show that the Corporation has proved itself quite unfit to have charge of the supply of a public commodity. We are aware that a scheme is now before them for large works, and that the loans have been granted, but an active competition will end in the survival of the fittest, and at the present time the company has all in its favour. Should the committee's decision be confirmed by Parliament, it will be a warning to municipal traders that they cannot mismanage their monopolies with impunity.

TRAMWAY ACCIDENTS.

The letter published by us last week, and signed by Mr. E. W. Elsley, was, we now learn, intended to be private. The writer did not wish to again open in the Press a vexed point on which a coroner's decision had been given. We regret that the same was inserted, and trust that the writer's motive in communicating with us will not be misunderstood.

INSTITUTION OF ELECTRICAL ENGINEERS.

The Calculation of Distributing Systems of Electric Traction under British Conditions.

BY H M. SAYERS, ASSOCIATE MEMBER.

(Continued from page 701.)

The first alternative to this costly single-station system is the provision of a second generating station (Diagram C), still using low-tension plant and distribution, and retaining T as one station, as the plan indicates that T is fairly well placed for the eastern part of the system. The junction, I, appears to be a good position, consequently the second station is assumed to be at that point. The arrangements east of T will remain unaltered. On the west, the two stations ought to supply power up to equidistant points measured along the tracks. The cross-country conductors, T J, will not be needed, and though useful for enabling one station to assist the other in case of breakdown (a valuable advantage of multiplicity of stations), it will not be further considered here. The equidistant point on the route T D C I is ·1 mile west of D, and on the route T D J I it is 1·68 miles south of D. The western station, I, will then supply all the cars between C and D and two out of the five between D and J; its load will then be 24 cars or 360 amperes, leaving T to provide for 33 cars or 495 amperes. The cost of generating and the most economical current density are taken at the same figures as for the single station. T has to supply westward the current for 14 cars, or 210 amperes, as follows:

60	amperes	for branch	E M,	average distance	1·35	miles.
105	,,	,,	T D	,, ,,	1·17	,,
45	,,	,,	D J	,, ,,	3·20	,,

The two cars on branch F D are taken as before, as supplied *vid* F. At the voltage drop of 15·8 per mile the total watts lost come to 5,500. East of T they are as before, 8,250 unboosted, 720 boosted. I has to supply 360 amperes as follows:

30	amperes	to branch	D J,	average distance	3·3	miles.
45	,,	,,	I J	,, ,,	1·4	,,
30	,,	,,	J K	,, ,,	3·9	,,
15	,,	,,	J L	,, ,,	3·8	,,
90	,,	,,	C D	,, ,,	1·6	,,
30	,,	,,	C P	,, ,,	·8	,,
30	,,	,,	I C B	,, ,,	1·35	,,
45	,,	,,	I B C	,, ,,	·7	,,
45	,,	,,	A B	,, ,,	2·1	,,

The total watts lost come to 10,602. No provision is made in this for boosting, as only a little current is carried beyond the 50-volt drop limit, and under the circumstances that drop is unlikely to be exceeded in actual work. The copper sections, weights, and values needed will be as follows:

Direct Feeders.

Line.	Length, miles.	Amperes, mean.	Section, Cu. sq. in.	Tons, Cu.	Value.
T F	·9	187·5	·531	4·35	£655
F G	1·25	120	·342	3 56	538
T E	·35	203	·579	1·84	278
E D	2 00	98	·277	5 02	758
I B	1·1	75	·213	2·13	323
I C	·9	142	·404	3 30	498
I J	2 8	98	·277	7·01	1,058
C D	1 65	45	·129	1·93	292
	10·95			29·14	£4,400
			Boosted.		
T O	3 8	45	·134	4 63	£699
	14·75				

Total, 33·77 tons; value, £5,099.

The cost of distribution on the trolley side is thus:

Loss in direct feeders, 24·37 kw., worth annually	£411
Loss in boosted feeders, ·72 kw., worth annually	16
Annual charge on boosters	6
Interest on direct feeders, 7 per cent., £4,400	308
Interest on boosted feeders, 7 per cent., £699	49
Total	£796

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This works out per unit delivered to the cars $\frac{£796}{2,340,000}$ =0·81d., or total ·831d., disregarding losses in returns. The track feeder east of T remains as before, and that west of T must tap the rails at D and carry 120 amperes, have a section of ·391 square inch, with a drop of 35·5 volts, needing a booster of 4,260 watts. From I one feeder to J, carrying 43 amperes, section ·140 square inch, drop 42·2 volts, will require a booster for 2,600 watts. No other will be needed, though a small addition to the service and load on the line between A and D would call for a feeder to B or C. The track feeders are then as follows :

Line.	Miles.	Amperes	Section sq. in.	Tons Cu.	Value.	Drop.	Loss, watts.
T E'wards..	2·97	120	·39	10·5	£1,585	41·6	5,000
T W'wards..	2 35	120	·39	8 33	1,253	35·5	4,260
I S E	2 8	43	·14	3·65	536	42·2	1,815
	8·12			22·33	£3,379		11,075

Boosters to a capacity of, say, 18 kw. will be needed, costing £270. The cost of distribution on track side will thus be :

Loss in feeders, 11·075 kw., worth annually	£252
Interest on cables, 7 per cent. on £3,379	236
Charges on boosters, 15 per cent. on £270.....	41
	£529

and the total cost of distribution :

Trolley side.....	£796
Track side	529
	£1,325

equal to ·135d. per unit, or a total of ·885d. The capital cost of the cables will be £8,478, their length 22·87 miles, laid in 13·85 miles of trenching, and the cost of boosters £310. The cost of the cables amounts to £18 per kilowatt full load output, and the efficiency about

$$\frac{427·5}{468} = 91·5 \text{ per cent.}$$

The annual costs of generation and distribution as above qualified will be £8,751, or £1,185 less than with the single station, and this sum is the margin out of which the extra working and capital charges due to the use of a second station have to be met. Unless such extra charges exceed the saving in distribution, the two-station system will be the more economical. A sound knowledge of the local conditions should enable a fair estimate to be made, but it is not susceptible of calculation on general principles. The incidental advantages of the multiple-station system should be carefully considered in each case, and if the calculable operating costs are about equal, those advantages should turn the scale in its favour.

Multiphase Distribution. — Assume one station, at T (Diagram D), generating plant to give three-phase current at

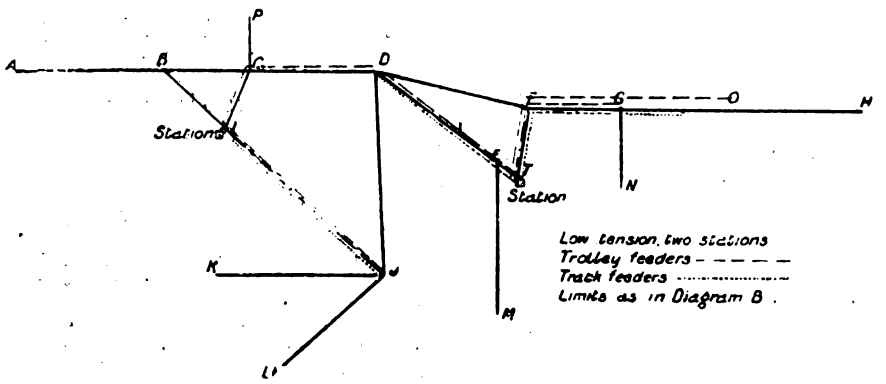

DIAGRAM C

2,500 volts. Using three-wire mains, the current per conductor will be

$$\text{KW.}\frac{1,000}{2,500}\times\sqrt{3} = (\text{KW.}\cdot 23) \text{ amperes.}$$

The cables will be of the three-core twisted or equivalent type, and on this account, as well as the larger amount of insulating material needed, their cost per ton of copper will be higher. The depreciation will also be at a higher rate. First, because the scrap price will be a lower proportion of total value ; and second, because high-tension cables certainly suffer more from faults than those under low tension. Therefore, R is taken at 9 per cent., p at £208, the other values remaining as before,

$$t^2 = \frac{9 \times 58·45 \times 208 \times ·045 \times 9·1}{100} = 448 \text{ and } T = 21·2,$$

the density $\frac{21·2}{·045} = 470 \infty$ per square inch, and the drop per mile 21·2 volts. The loss in any three-wire three-phase conductor will be 3 C × 21·2 per mile, where C is the current as given above for the load transmitted, so that the loss per kilowatt delivered to the cables will be ·69 × 21·2 = 14·62 watts per mile, or 1·46 per cent. per mile. Transformers will be required at G, T, D, J, and B, the output needed being as follows :

From G	12 cars	.....	90 kw.
T	12·5	.....	93·75
D	12·5	.....	93·75
J	8·0	.....	60
B	12·0	.....	90
Total.....	57·0 cars	.....	427·5 kw.

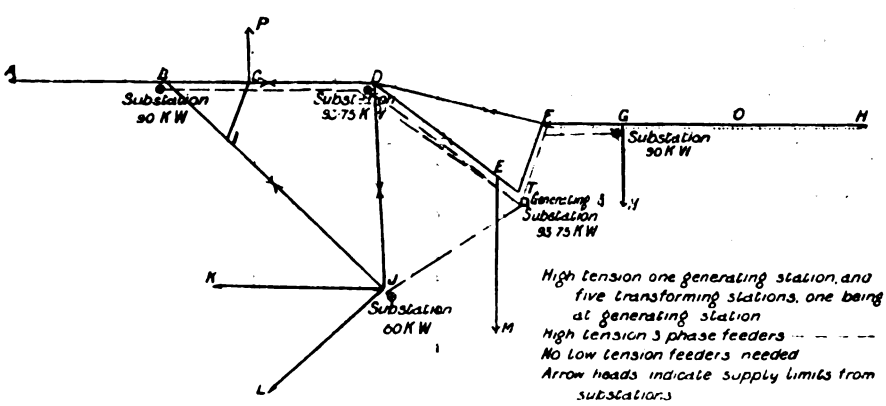

DIAGRAM D.

These loads are allocated on the simple consideration that each transformer should supply half-way to its neighbour in each direction, and represent the energy delivered to the cars. Loss on the low-tension side has to be added to get the gross output, which may be taken at 450 kw. Hence at four of the five stations 100-kw. sets, and at the other a 65-kw. or 70-kw. set would suit. But allowance must be made for spares and for unusual demands due to local pressure or bunching of traffic. Whether it would be better to put down two 100-kw. or three 50-kw. sets at the larger stations should in every case be determined on comparison of the cost of the different sized sets with their switch gear, the probabilities of exceptional traffic,

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and other fairly obvious considerations. It might well happen that the two larger sets would cost little more to instal than the three small ones, and that the extra flexibility would be well worth the cost. Assuming, however, that the three-set plan is adopted, it will be necessary to instal transformers to a total capacity of 705 kw. The high-tension feeders to these sub-stations will be as follows, assuming a full-load efficiency of transformation of 85 per cent., or rather a constant loss during operation at the rate of 15 per cent. of the rated capacity, and 2,500 volts pressure :

Line.	Miles.	Amperes.	Sections. sq. in.	Tons Cu	Value.	Loss in watts.
T G	2·15	3 × 24·2	3 × ·051	2·98	£620	3,307
T D	2·35	3 × 25	3 × ·053	3·27	680	3 736
T J	2·15	3 × 16·1	3 × ·034	1·95	406	2 201
T B	5 25	3 × 24·2	3 × ·051	7·30	1,518	8,080
	11 90			15·50	£3,224	17,324

The loss in the transformers on the above assumption will be 15 per cent. × 470=70·5 kw. With this disposition of sub-stations no track feeders are needed, and secondary trolley feeders can also be dispensed with, as the trolley wires of usual size will not drop more than 10 volts average all over the system, the worst point being H, where the drop will be 32 volts. The trolley wires leading east of G, from T to E, and B to C, will be somewhat heavily loaded, and for reliability of service it might be well to use some auxiliary feeders, or heavier trolley wires on these sections, but this will not be necessary for distribution efficiency. The distribution losses will then be :

In high-tension cables	17·3 kw.
In transformers	70·5 ,,
In trolley wire	8·55 ,,
	96·35 ,,

and the generating plant must be able to give out 524 kw, overall efficiency of the system being thus $\frac{427·5}{524}$ = 81 per cent. nearly. This is a little higher than Mr. Parshall's figures for Dublin. No addition has been made to the cable losses for power factor being less than unity, and it appears probable, on the rather scanty information obtainable in this country, that full justice is done to current practice in the above result. To obtain the annual cost of this distribution, proper charges on the transformers, including attendance, have to be estimated. This again is not easy, for the prices of such plant are not readily obtainable, but for the present purpose market prices are not essential. There is good authority for the statement that for smaller sizes than 200 kw. motor-generators perform better than static transformers and rotary transformers, therefore motor-generators are assumed in the following figures :

Motor-generators to capacity of 705 kw. at £15 per kilowatt with switch gear	£10,575
Four sub-stations and sites at £80 each	320
	£10,895
Interest, depreciation, and repairs, 12½ per cent. on £10,575 and 2½ per cent. on £320	1,329
Attention to each set, say 3s. per week, or £7. 16s. per annum, 15 sets	117
Oil, brushes, and sundries, say £2. 10s. per annum, per set	37
Total per annum	£1,483

The distribution costs then work out as follows :

High-tension conductors, C^2R loss value $\frac{17.324}{58\ 45}$	£295
Interest on cables (cost £3,224)	290
Loss in transformers $\frac{70,500}{58·45}$	1,205
Loss in trolley wire, 8,550 at 48·5 per £1	176
Interest and attention and stores on transformers	1,483
	£3,449

This sum amounts to ·352d. per unit delivered to the cars, making the cost of the power there 1·102d. per unit, or £10,875 annually. This is ·217d. per unit, or £2,124 per annum in excess of the two-station direct supply, and £939 in excess of the one-station direct supply, as will shown by the tabulated results below. Obviously a high-tension station cannot generate at a lower cost per unit than a low-tension station on the same site, but the result of this investigation goes to show that if in the neighbourhood a site exists with such advantages that the cost per unit of the power generated there and delivered to T, or equal point, will be under ·53d., instead of ·75d., there will be an advantage in using the transformer system. In other words, this calculation shows what saving in generation costs is required to justify the use of a transformer system and a high-tension station.

The capital expenditure is not much reduced, as the total for cables and transformers amounts to £14,119, which lies between the costs of cables and boosters in the two low-tension systems discussed. There would be also a considerable saving in cable-laying expenses, due to the lighter cables and smaller number of ways needed. This point and the difference between the capital outlay in the stations are foreign to the present subject, but must, of course, be keenly studied in practical designing. It should, however, be noted that the load factor is of great importance, and that the assumed conditions are rather more favourable to a transforming system than the conditions usually found in practice, for the reason that the losses in transformers are largely independent of the load, and that sufficient transformer capacity must be kept in use to provide for the maximum demands during any given period. The device of dividing into small sets and putting them in as needed cannot be carried far for several reasons. Hence the losses are more nearly those due to the maximum than to the average load over any given period. Cable losses, on the other hand, vary with—and as the square of—the actual load, consequently a poor load factor tells much more against the efficiency of transformers than of cables.

The small proportion of the total losses due to the high-tension transmission indicates the small effect of distance on the overall efficiency, so that the radius within which the advantages of a specially favourable position for a generating station may be utilised is not severely limited. For lines on which multiphase motors and the consequent increased number of overhead wires are practicable, it is apparent that the advantages of this system are very great. Only static step-down transformers being required, the overall efficiency can be kept high, and attendance at sub-station made very trifling. This is hardly a live subject in this country yet, but the economies of distribution on such a system can be worked out on the same lines as here put forward when occasion shall arise and the regulations to be complied with shall be known. The principal figures in the three schemes above worked out are here tabulated for comparison :

—	Low tension		High tension.
	One station	Two stations	One station
Distribution costs, annual ...	£2,510	£1,325	£3,449
Ditto per unit at car	·266d.	·135d.	·352d.
Generation and distribution, annual	£9,936	£8 751	£10 875
Ditto per unit at cars	1·016	885d.	1·102
First cost cables and transformers	£16,593	£8,788	£14,119
Miles of cables	25·64	22·87	11·90
Miles of trenching...	12 025	13 85	9 55

Appendix No. I.

Calculation of Most Economical Current Density.

Rate of ohmic loss.—$C^2 r$ watts, where C=current in amperes and r=resistance in ohms.

Rate of interest and depreciation loss in £ sterling per annum $= \frac{R}{100} p\ m\ a$ + constant. Where R = rate per cent. per annum of interest and depreciation ; p=price in £ per ton of copper in the form of cable, m=tons of copper per mile of conductor of one square inch cross-section ; a = cross-section of conductor in square inches, so that $m\ a$ = tons of copper per mile ; and the constant represents such costs of laying and other expenses as are practically dependent only upon the length of cable laid and independent of its size. To add these losses they must be equated for definite conditions of load and period of use. For this purpose assume the period to be one year ; the load to be steady and lasting for a certain fraction of every day $= \frac{h}{24}$. A certain cost per Board of Trade unit delivered to the conductor $= n$ pence.

Then £1 per annum is the cost of $\frac{240}{n}$ Board of Trade units wasted per annum, and the rate of waste in watts which gives such a loss is $\frac{240,000}{h\ n \times 365}$, or $\frac{657·5}{h\ n}$. Call this w. It is the number of watts which, wasted during all the working hours in a year, will cost £1.

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Then $\frac{R}{100} w p m a$ is the interest cost of the cable expressed as a loss in watts during working hours, and the total rate of cost of distributing the current, C, through the cable is $y = C^2 r + \frac{R}{100} w p m a$.

The resistance of the conductor obviously affects the value of the two quantities making up the total loss in opposite ways, and the problem is to find the value of r which makes y least. Consider a cable of one mile in length. If the resistance of one mile of copper conductor of one square inch cross-section is ·045 w, then $a = \frac{·045}{r}$, and the second item of the total cost $= \frac{R w p m ·045}{100 r}$.

Since this has been equated to a rate of loss in watts, it may be written

$$\frac{C_2^2 r^2}{r} = \frac{t^2}{r}, \text{ where } t = C_2 r,$$

C_2 being such a current as would produce the required loss in watts on traversing the resistance r. We then get

$$y = C^2 r + \frac{t^2}{r}, \text{ whence } \frac{dy}{dr} = C^2 - \frac{t^2}{r^2},$$

and this is a minimum when

$$C^2 = \frac{t^2}{r^2}, \text{ or } r = \frac{t}{C}.$$

This is the Kelvin law, since when this is the case $C_2 = C$, and the two items of cost representing ohmic loss and interest are equal.

The most economical current density therefore is

$$\frac{C}{a} = \frac{t}{·045}, \text{ where } t = \sqrt{\frac{R w p m ·045}{100}},$$

and the most economical rate of voltage drop is t volts per mile.

If the load is not steady but varies in a known way then C^2 = the mean square of the current in respect to time, and C = the square root of that.

In the expression for t^2 $\frac{R p m}{100}$ is the annual cost of one mile of cable of one square inch copper section—*i.e.*, of 9·1 tons copper weight.

Then $\frac{R p m w ·045}{100}$ may be written $\frac{·41 R p w}{100}$ or ·0041 R p w and the most economical current density written

$$\frac{C}{a} = \frac{t}{·045} = \sqrt{\frac{·0041 R p w}{·045}}$$

and a table of such densities for various values of the product R p w can be readily formed.

Appendix No. II.

Examples and Tables of Most Economical Current Density.

Symbols as in Appendix No. 1.

$$\frac{C}{a} = \frac{t}{·045} = \sqrt{\frac{·0041 R p w}{·045}};$$

R = percentage interest charge on cables;

p = cost of one ton of copper in form of cable;

$w = \frac{657·5}{h n}$, where h = equivalent full load hours of use per day,

and n = cost in pence of one Board of Trade unit.

For example, let $\left.\begin{matrix} R = 9 \\ p = £200 \end{matrix}\right\} R p = 1,800$;

$\left.\begin{matrix} h = 12 \\ n = ·8d. \end{matrix}\right\} h n = 9·6$;

$$w = \frac{657·5}{9·6} = 68·49;$$

then $$t^2 = 1,800 \times 68·49 \times ·0041 = 505·4,$$

and $t = 22·5$ = drop in volts per mile $\frac{C}{a} = \frac{22·5}{·045} = 500$ amperes per square inch.

The equality of ohmic and interest losses is readily shown. One mile of cable of one square inch section will cost £200 × 9·1 = £1,820, and the interest on it at 9 per cent. will be £164, while the ohmic loss will be 500 × 22·5 = 1,125 watts, worth also £164 per annum; to the nearest £1 in each case. Tables for varying values of R, p, and w are convenient in the following form, or a table giving values of t and best density for values of the product R p w may be readily made and used.

R p = 1,200.

w	t = drop per mile.	Best density.
40	14	312
50	15·7	362
60	17·2	383
R p = 1,500.		
40	15·7	362
50	17·6	392
60	19·2	427
R p = 1,800.		
40	17·2	383
50	19·2	427
60	21·1	469

(To be continued.)

THE ELECTRIC POWER BILLS.

(Continued from page 708.)

Thursday.

On Thursday, the 17th inst., Mr. C. H. Merz was further examined by Mr. Forbes Lankester, and said the Walker and Wallsend Gas Company had not estimated a load factor of more than 25 per cent., but thought that they might obtain a better, the district being a manufacturing one. There were many kinds of industries there, and they might expect a night load. The gas company would be in a better position than the Tyneside Company, as they could supply the residential districts in Newcastle, Walker, Wallsend, and Willington Quay, which would tend to allow them to supply at a cheaper rate than the Tyneside Company. The preliminary station which the gas company were erecting was of 2,500 kw. capacity. The estimates were based on this first instalment, and on a 25 per cent. load factor they estimated to be able to sell 4,000,000 units per annum, and that the capital expenditure would be £150,000. It had been decided last year that a combined generating station for the Newcastle Supply Company and the Wallsend Gas Company would be necessary, and he reported that it should be of about 10,000 h.p., or 7,500 kw. capacity, and that with a 25 per cent. load factor 13,000,000 units would be generated per annum. The expenditure for the generating station alone would be £250,000. They estimated to be able to generate and hand over the supply in bulk to the two companies at an actual cost of ½d. per unit, this including depreciation. They would be able to generate much more cheaply by combination. They had started negotiations with some of the chemical manufacturers to supply them with electricity. Considerable economies could be effected by increasing the capacity of their station to 5,000 kw.

Examined by Mr. Pember as to the distinctions drawn by Prof. Thompson as to supply in bulk and supply in detail, he said he did not understand them. Supply in bulk to a local authority meant a supply in bulk for redistribution, but he did not understand what a supply in bulk to a manufacturer meant. He should think it applied to a manufacturer requiring from 700 h.p. to 800 h.p. Competition in this class of industry was not comparable with competition in the supply of ordinary commodities, as the capital charges were about half of the total cost of supplying electricity, and to duplicate the capital in mains, etc., was a very serious item. If two generating stations were used to supply one district, the cost would be increased. The prices to be charged by the Wallsend Gas Company compared very favourably with those of the Tyneside Company. They hoped before long to considerably reduce the prices, and ultimately get to a rate of not more than 1d. all round for power.

Examined by Mr. Forbes Lankester, he said if three stations would be required in the Tyneside Company's district, he did not think it would be an advantage to have these owned by one company.

Cross-examined by Mr. Frere, Mr. Merz said there was a large scope for supplying manufacturers in the district. They would probably require about 5,000 e.h.p. in the next few years for supplying manufacturers. The one station which the Tyneside Company proposed at Wallsend would not be sufficient, and he thought there should be two stations to supply the North of the Tyne. The connecting of two or three stations by trunk mains involved a heavy

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capital expenditure, which would absorb all advantage gained, and he thought competition would be bad, and that the manufacturers would eventually suffer, as the prices would not be reduced so quickly as if only the Wallsend Company were supplying.

In answer to the Chairman, he stated that the cost of working 10 h.p. for 40 hours per week for 50 weeks per annum would come out at about £84, or £8 per horse-power per annum.

Questioned by the committee, he stated that for more than 4,000 h.p. at 10,000 volts one should put down at least two cables, while he, as good engineering practice, put down three, one being spare. The economy in cables with one company only supplying was in the distribution cables more than in the mains. If the demand for energy developed during the next few years at the rate at which some people thought it would do, the arguments against competition would not be so strong. It was possible that thousands of horse-power might be required for the electro-chemical works if they came to the Tyne. The horse-power used on the Tyne at the present time cost from £20 to £30, in comparison with the £8 per horse-power with electricity. It would be cheaper to put in a number of smaller machines than 10,000-kw. machines, as the smaller ones were standard sizes, and would cost less per kilowatt. New designs would have to be prepared for the larger sizes, which would increase the cost. He thought the Tyneside Company's calculations rather low. They were bound to supply any applicant in their area. He did not think his company would ever get such a price as would bring the sliding scale into force. The gas capital of the company was absolutely distinct from the electrical capital.

Mr. SUMMERS HUNTER was then called and examined by Mr. Forbes Lankester. He said he was managing director of the North-Eastern Marine Engineering Company, of Wallsend. His company had petitioned in favour of the gas company's Bill in 1899 in order to get as soon as possible a supply of electricity for power purposes. The price they were to pay for power was 4d. for the first hour and 1d. for all subsequent hours. The present company were a good sound concern, and were going about their business in the proper way. He thought this pioneer company should be allowed a fair chance to show what they could do.

Cross-examined by Mr. Frere, he said they would require between 600 h.p. and 700 h.p. His great object was to get a supply as cheaply as possible, but he was satisfied with the agreement with the gas company.

Mr. R. HODGE was then called, and said he was a shipbuilder at Howdon-on-Tyne, and would require about 1,200 h.p. The gas company had offered to take over the whole expenditure of supplying him with dynamos, motors, and wiring. There was no room in the district for a second company, and the duplication of mains and plant would certainly raise the price to manufacturers.

Cross-examined by Mr. Frere, he said the maximum horse-power he would require would be about 500.

Mr. G. B. RICHARDSON, then examined, said he was a director of the firm of Wigham, Richardson, and Co., shipbuilders, etc., and employed nearly 3,000 men. They did not at present use electricity in their works, but were desirous of doing so at once. The indicated horse-power used in their works was about 2,500, and they were making arrangements to take 1,500 e.h.p. He was quite satisfied with the terms offered by the gas company.

In answer to the Chairman, he said he hoped to get the power at an all-round price of 1½d. per unit.

Mr. S. T. HARRISON, chairman of the Wallsend Urban District Council, was then called, and said his Council had petitioned in favour of the Wallsend Gas Company's Bill. He thought the company should have time to carry out their work which they were now doing, and that it would be inadvisable for another company to come in.

Cross-examined by Mr. Frere, he said there was a clause in the Wallsend Company's Act allowing his Council to compete with the company, but this was for their own protection if they were not satisfied with the supply given.

Mr. W. CARR was then examined by Mr. Forbes Lankester, and said he was an electrical engineer in practice at Newcastle-on-Tyne. He was consulting electrical engineer to the Marine Company of Wallsend. He had arranged for this company to be supplied with continuous current for all purposes by the Wallsend Gas Company. He thought the Wallsend Company's system an economical one. The second company would tend to raise the price of energy. If the prices rose too high, the manufacturers would put down their own plant.

Cross-examined by Mr. Frere, he did not think there was room for two companies in the Wallsend area under the existing state of things. Again examined, he said there was too little space for manufactures to develop much in the Wallsend district.

Mr. C. HOPKINSON, called, said he was a member of the Institution of Civil Engineers and of the Institution of Mechanical Engineers, and had given great attention to electrical matters during recent years. The compactness of a district was an economical factor in supply, and the cost of mains was a large item of the expenditure. The area west of Newcastle could not be supplied economically from a station east of the town. In answer to the committee, he said that the introduction of a second company would mean increased cost to the producer, and, therefore, most probably to the consumer.

Re-examined by Mr. Pember, he said the lowest price a general customer would get would be 2d. if his demand were continuous, the lowest to a bulk supply customer about 1·4d., and the lowest to a local authority 1d. In answer to the committee, he said the largest station he had been connected with was the Manchester one, which had between 7,000 h.p. and 8,000 h.p. The charges at Manchester were never less than 1½d. Energy could be produced under 1½d. per unit, and it was supplied for practical purposes at Liverpool for ·9d. per unit.

Mr. C. H. MERZ was then further examined by Mr. Rickards, on behalf of the Newcastle Supply Company. He said their station at Pandon Dene was unsuitable for their extended undertaking, and, therefore, they scheduled the site in the Wallsend district, this being the best for the Supply Company. The site was the property of private owners.

Dr. J. T. MERZ was examined by Mr. Rickards, on behalf of the Newcastle Supply Company, and said he was vice-chairman of the Newcastle-on-Tyne Electric Supply Company. He had had considerable manufacturing experience. The Supply Company was incorporated in 1889, and £125,000 capital had been paid up. The capital had been increased to £300,000. The provisional orders obtained by the two Newcastle companies provided for a supply to the whole of the city and county of Newcastle. The two companies had entered into an agreement to divide up the Newcastle city area between them. They had been negotiating for two years for the Wallsend site, which the promoters of the Tyneside Bill had suddenly scheduled in that Bill. He was satisfied that a good supply would be given in the area they were authorised to supply. They had taken over the Walker provisional order, and agreed to supply the Walker district for 10 years. The Walker Urban District Council would pay the cost of the mains. The transformers and meters would belong to the company, they doing the actual distribution. Their charges were never more than 4½d., as against 6d. on the Newcastle District Company. In combination with the Wallsend Gas Company they would have a capital of from £700,000 to £800,000 for the development of their district, and they did not consider it too much. This was nearly three-quarters of the capital of the Tyneside Company. Their district was only one-quarter of that of the Tyneside Company.

Cross-examined, he stated that a distributing company would require more capital in proportion than a company only giving a supply in bulk.

Examined by Mr. Pember, he stated that there was no connection between the Supply Company and the Thomson-Houston Company. In answer to Colonel Long with respect to the division of profits with consumers after an 8 per cent. dividend had been paid, he thought that if a sliding scale did not come in until after 10 per cent. was paid, it was not of much practical importance. He thought the sliding scale would be very difficult to work.

The committee then adjourned.

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FRIDAY.

On Friday Mr. J. S. WATSON was examined by Mr. Rickards, and said he was the engineer of the Newcastle-on-Tyne Electric Supply Company. They had been supplying current for 10 years, and up to the last two years had only supplied alternating current, when they commenced putting down plant to supply continuous current, and they hoped to supply this current in two months' time. Their charges were, he believed, as low as any in the country. It was absolutely necessary for them to get a site for a station outside Newcastle. The new station would generate electricity on economical lines and on the polyphase system. They would be able to give a polyphase or continuous current according to a manufacturer's requirements. With the new station the cost of generation would be much reduced.

Cross-examined by Mr. Frere, he said they proposed to supply in detail in Walker, Gosforth, and Long Benton. The rates they proposed to charge, and which they had contracted for with consumers, were put in. They had offered them to about 50 power users.

Questioned by the Chairman, Mr. Watson said they had closed contracts at the prices of 4d. and 1d. The Wallsend Company were supplied in bulk, and paid according to the amount they took from the joint station. The cost price would be charged, including interest and depreciation.

In answer to the committee, the only profit they expected to make by the combination of the station would be the reduction in the cost of generation.

Mr. R. HAMMOND was then examined by Mr. Rickards, and said he had been engaged in electric lighting for the past 20 years, and for some years had been a consulting engineer. He had laid down the pioneer works at Eastbourne, Hastings, and Brighton. His experience extended also to the Continent, and had laid down a high-pressure station for Madrid, and a similar one for Leeds. He acted as consulting engineer for about 28 local authorities. He had for many years analysed the Board of Trade returns of electric lighting undertakings' accounts. He then handed in a table showing the analysis of the accounts of local authorities, and another respecting companies. The results showed what some of the largest concerns in the country were working at, but always subject to a very low load factor. Thus at Leeds the load factor was 10 per cent. The cost of production there was 1·29d. per unit. There were at present no undertakings with a 25 per cent. load factor. The tramway works in Leeds had, however, a better load factor than 25, and it was only those works catering for lighting alone which had a very low load factor. It was impossible for lighting companies to get a 25 per cent. load factor. The Gas Company's charges were very reasonable, and in the area of this company electricity could be produced as cheaply as in the area of the Tyneside Company. He took it the main question was as to whether a works of 10,000 kw. would work as economically as one with hundreds of thousands of horse-power. In a paper he had read before the Institution of Electrical Engineers he dwelt very strongly on the advantage of aggregation of output, but this was not alone the only factor in lowering costs. Load factor was a most material element. While in small plants standing charges pressed very heavily, these formed a very small figure where one had a large output. The point at which the economy in supply would not increase was 10,000 kw. He thought the Supply Company could supply as cheaply for electro-chemical and other purposes as the Tyneside Company.

Cross-examined by Mr. Frere, he said steam-turbines were less costly in proportion as they grew larger in size. He had used steam-turbines in places where they were extremely suitable. He doubted whether, with a place like the Tyneside, the larger area gave a better density factor.

Re-examined by Mr. Rickards, he thought it better that a company should work harmoniously with the local authorities, and was against competition. The standard machines were cheaper per horse-power, but often not so efficient as one specially designed.

In answer to the committee, he thought that, with respect to competition, the pressure of possible interference with the powers by the grant of concurrent powers kept the undertaker in order. This policy of not granting concurrent powers had been almost universally adopted outside London. The same principle held on the Continent. He thought a standard rate of dividend and a sliding scale better than competition. He thought that in 20 years electrical distribution on the Tyne would be a very large industry. It would pay firms of the size of Armstrongs and Palmers better to lay down their own plant. He thought the fear of competition would prevent capital coming in for the development of electrical power. The chief source of economy was, he thought, in the size of the machine, and they had reached the limit of size at which they could be made. At Leeds they had nine engines at work, and were advertising for three 1,000-h.p. engines. In this way, by putting in or out an engine, they could run at full economical load, although a lighting load fluctuated very considerably. Through their subdivision of plant at Leeds they had the champion coal bill of the country. He objected to competition because of the waste in duplicating mains and plant, and also the extra cost of breaking up streets. He thought the sliding scale of the Tyneside Company not a workable one.

Prof. W. E. AYRTON was examined, and said he was a professor of electrical engineering at the City and Guilds Central Technical College. He had carefully considered the various Power Bills, and had examined a number of systems of power distribution in Canada, the United States, and on the Continent. The Supply Company's prices compared favourably with those of the Tyneside Company, and also with prices charged in Canada, the United States, and Europe. He would prefer to supply the smaller of the two areas, as offering the better chance of success. The northern portion of the area of the Tyneside Company could not, he thought, be economically supplied from one station. In other countries the use of overhead wires helped considerably to cheapen the supply over large areas. The cost per unit would be increased by ⅛d. if 400 h.p. had to be transmitted from the east of Newcastle to the west, and this would be serious with respect to manufacturers, and would outweigh the advantages of having one 10,000-h.p. instead of two 5,000-h.p. stations. This was shown by the dividends paid by the London companies that a small compact area was better than a large distributed area. He thought competition would result in a higher price to the consumer, because of the extra cost of duplicate mains. The Supply Company could produce 2,000,000 units if they had a load factor of 25 per cent. He agreed with the estimates given by Mr. Merz.

Cross-examined by Mr. Frere, he said he thought 10,000 h.p. the most economical. He thought there was no advantage in the Tyneside Company having the three separate districts in their hands. Taking the distance between them as six miles, it would cost about £18,000 to lay trunk mains between the Wallsend and Whickham stations. For years the stations of the same company in London were not connected. They were now connected because the supplies had grown until they met.

In answer to the committee, Prof. Ayrton thought there was not generally competition allowed between power transmission companies.

Mr. PEMBER then addressed the committee on behalf of the Newcastle Electric Supply Company. He began by stating the position of the Supply Company, and said the share capital was now £300,000, and the borrowing powers amounted to £100,000. They were bound to move their generating station, and would probably end in using the Wallsend station permanently, as it was in an excellent position on the railway and by the river. The site was only contested by the Tyneside Company, and he thought they had a better right to it than the Tyneside Company. A large number of the company's directors were large manufacturers in the district. They were supported by all the local authorities, while none supported the Tyneside Company. He quoted the evidence of Lord Kelvin, Mr. Swinburne, and Mr. Merz, to the effect that the small area was the better to supply in. The evidence showed that no advantage was gained from having the two or three stations in one hand. He then summed up the evidence as to the capital of the joint companies, and as to the bad effects of competition, which, he stated, would be unfair.

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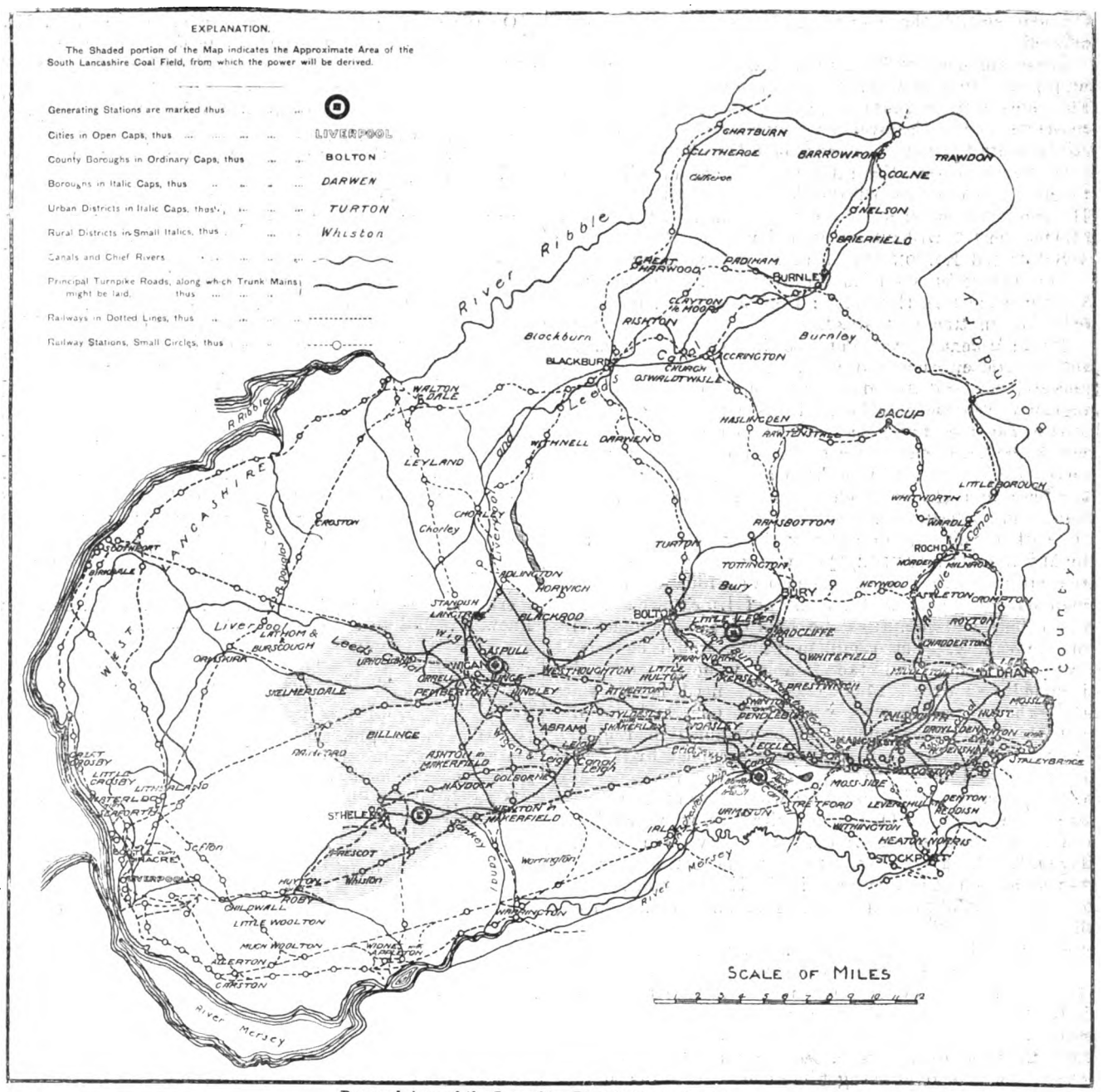
Mr. CLAUDE BAGGALLAY, in reply, dealt with the questions of confining the Tyneside Company to the north of the Tyne, and also the other opposition both north and south of the river.

The proceedings were then adjourned till the Wednesday following.

WEDNESDAY.

Mr. BALFOUR BROWNE said that he wished to raise a point on a decision already given by the committee in order that the same might be reconsidered if possible. The committee had announced that no decision on any one Bill would be given until all the five Bills had been considered. This, he hoped to show, was not necessary, as the Bills were very different in character. The Tyneside Bill and the County of Durham Power Bill had necessarily to be considered together, but the Lancashire Bill opened new points, as would also the South Wales Bill. Now, the points raised by these Bills might seriously affect the County of Durham Bill, on which he would then have no right to intervene. He hoped that after his speech was considered the committee would reverse their decision, and not keep the promoters of the County of Durham Power Company waiting for the verdict on their Bill. Mr. Baggallay in his speech had made comparisons between the County of Durham Bill and the Tyneside Power Bill, and he (Mr. Balfour Browne) would add another feature of difference. He called the first a fair Bill and the second an unfair Bill. The Durham Company proposed to undertake obligations to supply all the districts in their area if called on to do so, and also they took the poor districts as well as the rich. They did not propose to compete with local authorities, as did the Tyneside Company. This Bill was only opposed by two local authorities, who, again, had no *locus standi* except on the wayleave question, which the committee had settled. The Tyneside Company had no objection to their coming in, and hence the County of Durham Power Bill was virtually unopposed. He therefore argued that it would be unfair to ask the proprietors to wait three weeks or a month for the committee's decision on what was an unopposed Bill. The Tyneside Bill, on the other hand, was directed against the local authorities. The promoters of that Bill proposed by private wayleaves to take away the best consumers from the municipalities, which would so spoil the load factor of the districts that the lighting load could not be profitably supplied. This would force the hands of the authorities, and make them come on to the Tyneside Company's mains. He urged that these features made the Tyneside Bill most unfair. As regards the competition on the south side of the Tyne, he argued that no real competition would ensue if both Bills passed, as the Tyneside promoters had already undertaken to supply their own works, and would pick and choose certain other consumers. Mr. Balfour Browne proceeded to quote from the evidence of Sir Andrew Noble and Mr.


EXPLANATION.
The Shaded portion of the Map indicates the Approximate Area of the South Lancashire Coal Field, from which the power will be derived.
Generating Stations are marked thus
Cities in Open Caps, thus LIVERPOOL
County Boroughs in Ordinary Caps, thus BOLTON
Boroughs in Italic Caps, thus DARWEN
Urban Districts in Italic Caps, thus TURTON
Rural Districts in Small Italics, thus Whiston
Canals and Chief Rivers
Principal Turnpike Roads, along which Trunk Mains might be laid, thus
Railways in Dotted Lines, thus
Railway Stations, Small Circles, thus
River Ribble
River Mersey
LANCASHIRE
YORKSHIRE
Blackburn
BLACKBURN
Burnley
BURNLEY
Liverpool
Leeds
SCALE OF MILES

Proposed Area of the Lancashire Electric Power Company.

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A. A. Campbell Swinton to prove that the Tyneside Company would have ample scope if confined to the north bank of the river. Sir A. Noble had expressed himself as doubtful as to whether the proposed competition would be advantageous. As regards the pledge given in the House of Commons by Mr. Ritchie, the County of Durham Power Company had carefully altered the clauses of their Bill to conform with these, while their rivals had not done so at all. As regards the statement that there would be a middleman between the Durham Company and the consumer, he insisted that this term should not be applied in a derogatory sense to an undertaker distributing electricity under parliamentary authority. The so-called middleman's profit was not a second profit, as alleged. The County of Durham Power Company would take the generating profit, and the undertakers distributing the electricity would get the profit on distribution. With the Tyneside Company both profits would go to the company. Again, in the matter of charges, his company treated all alike, and gave reduction to consumers equally. The rival company who wished to compete on the south bank of the Tyne would do so by private wayleaves, with preferential rates, and without any obligation to give a supply to poor districts or isolated consumers. He urged the committee to pass the preamble of the County of Durham Bill without further delay.

Sir JAMES KITSON stated that the committee saw no reason for departing from the resolution they had previously come to. He added: I have to state, on behalf of the committee, that they have arrived at the following opinion: "That the value of electrical energy as a means for the transmission and application of power has been amply demonstrated, and its importance to the industries of this country is admitted. The committee accordingly advise that it is of public advantage to facilitate measures which may ensure a general supply of electrical power to all consumers who may seek to avail themselves of the economy and efficiency offered in the service of these sources of application of power."

The Lancashire Electric Power Bill was then introduced by Mr. WORSLEY-TAYLOR, Q.C., who gave a general description of the powers sought. The area (as illustrated by the map herewith) comprised the whole of Lancashire south of the Ribble, and comprises the bulk of the manufactories of the county. Three million people would be served by the scheme, and the ratable value of the area included was over £14,000,000. He need hardly state that the district was a very good one, and he did not think a better one could be obtained in England. All the valleys in the district were occupied by factories such as would find cheap power of great advantage. The distribution of this cheap power would do much to relieve congested districts. One of his witnesses, who occupied a leading position on the Lancashire County Council, would give evidence as to this, and to the value of this scheme to the county. The pledge given in the House by Mr. Ritchie on their behalf had been kept, and a number of authorities had withdrawn their opposition in consequence. Amongst these was the Corporation of Blackburn, and the letter stating the withdrawal of opposition added that the Electric Lighting Committee might in the future consider the advisability of taking current from the company if they should find it supplied at a cheaper rate than they could generate it. There were 21 authorities in the area who had either got electric light works running or who were constructing them now. These stations would have an aggregate power of 15,000 kw., but the bulk of this was in the Manchester station. There was 5,000 kw. distributed in 19 stations. Again, there were 19 districts owning provisional orders which up to the present had not put them in force, and the remaining 87 authorities had taken no steps whatever towards electrical distribution. The Lancashire Company proposed eventually to build four stations, each one of which would hold more plant than the whole of the stations now running. Mr. Worsley-Taylor proceeded to show that the cost of the plant per kilowatt would work out at only half that of the municipal plants now at work. The company proposed to spend at once £2,000,000, and with their capital of £3,000,000 and borrowing powers as well would have ample capital to spend on the work. He proceeded to refer to the promoters, and showed how well the company would be provided for in matters of finance and electrical experience. The Bill distinctly stated that no monopoly was sought. Mr. Worsley-Taylor concluded his address by criticising the petition against the Bill, pointing out that in no case would any damage arise to the petitioners by the passing of the Bill.

(To be continued.)

MANCHESTER AND LIVERPOOL EXPRESS RAILWAY.

On the continuation of the enquiry into this scheme, Mr. Freeman, Q.C., was heard on behalf of Salford in opposition to the scheme. The Gorton Urban District Council and the Cheshire Lines Railway Company also opposed the Bill. The speech on behalf of the Cheshire Lines Railway Company, who were represented by Mr. LITTLER, Q.C., was very lengthy, and the arguments against the scheme were very powerful. The Great Northern Railway opposed the line, owing to certain land which they required for siding accommodation being taken up by this railway.

Mr. TURNER, general manager of the Midland Railway, stated that the journey would take 47 minutes instead of 20.

Sir DOUGLAS FOX gave evidence as to the Liverpool Overhead Railway, of which he was engineer. He thought there was great risk of derailment if a sleeper on this line settled slightly. The brake power also was not good enough.

On Monday evidence was given in support of the opposition of the Mersey Docks and Harbour Board.

Mr. ROBERT GLADSTONE, chairman of the Dock Board, said they contemplated spending about £5,000,000 on dock improvements. They were not antagonistic to the proposed railway except in so far as it interfered with their Parkhill and Dingle estates, which had been bought for dock purposes. The line passed through both these estates, and would prevent the construction of docks of the character the Board desired to possess.

Mr. W. GLYNN, chairman of the Parliamentary Committee of the Mersey Docks and Harbour Board, Mr. A. G. LYSTER, engineer-in-chief to the Board, and other witnesses, also gave evidence in opposition to the scheme.

Mr. POPE, Q.C., then addressed the committee on behalf of the Board.

On Tuesday the enquiry was resumed, when Mr. BALFOUR BROWNE replied to the opposition, after which the committee deliberated in private.

The CHAIRMAN, in announcing their decision, said it appeared to the committee that the mono-rail system, when fully matured, would make an important contribution to the development of railway traffic at a high speed. In certain important respects, however, the present scheme was seriously incomplete. More particularly the evidence had not satisfied them that a safe method had been thought of to apply effectively brake power to trains running at a high speed. Apart from such considerations, however, the committee were of opinion that the proposed line had not been laid with adequate and reasonable regard to existing interests, bearing in mind that intermediate districts would not participate in the advantages of the railway. The Corporation of Salford seemed to have just grounds of opposition, and the interference with land purchased by the Dock Board for the construction of additional docks had weighed seriously with the committee. In the opinion of the committee, in any scheme to give fresh access to the heart of great cities, the question of underground approach ought to be considered and adopted where practicable. On these grounds the committee were of opinion that the preamble of the Bill was not proved.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the

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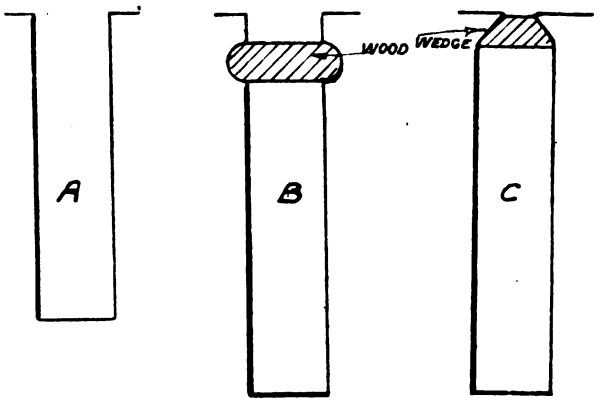
author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

273. Sketch and describe a good form of flexible coupling for use between engine and dynamo.—J. A. SEAGER.

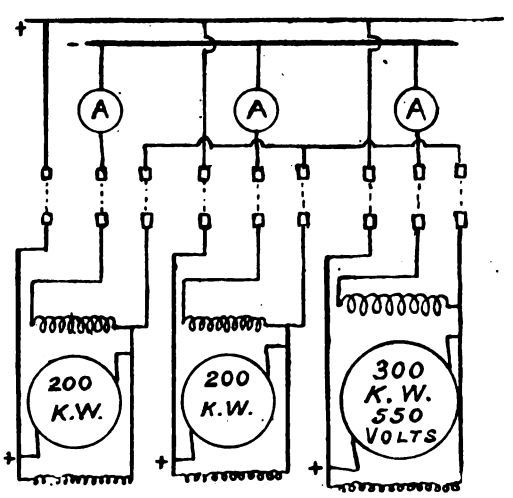
274. In a traction generator it is proposed to do away with binding wires on the armature core, the slot being shaped as shown at B or C, and having insulating wedges driven into them at the top to keep the bars in position. If binding wires were adopted the shape of the slot would be as at A.



With exactly the same armature winding in each case, would there be a greater tendency to sparking with slots shaped as B and C than with A, and if so, why is this so?—Z.

ANSWERS.

Question No. 267.—In a traction station three compound-wound generators are connected as in sketch. What errors could

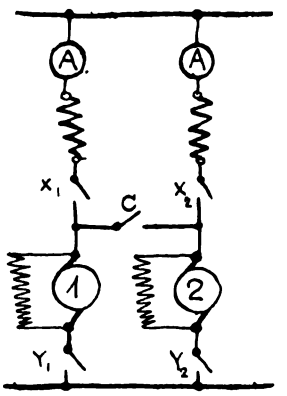


be made in the records by having the ammeters connected as shown?

[The two answers published are considered to be of equal value.—ED. *E. E.*]

Answer to No. 267 (*awarded* 7*s.* 6d.).—The errors that can be made in such a case are fairly large and serious. The ammeters never indicate correctly at all, except when the machines are giving exactly equal currents in the case of similar sized machines, and currents in a certain fixed proportion in the case of machines of different sizes. Consider, for simplicity, two equal machines, 1 and 2, as shown in the diagram, which is equivalent to the diagram of the question. Suppose the two machines are running in parallel, all switches having been closed. The resistance of the lead, C, is, or should be, practically zero, and so also is the resistance of the 'bus bar to which the ampere-meters, A A, are connected. Hence between the terminals of each series winding there is the same volt drop, the voltage at corresponding ends of each having practically the same absolute value. The consequence is that, whatever is happening in the machines, the two ampere-meters will show exactly, or almost exactly, the same current—that is to say, the one machine may be giving much more than its proper load, even driving the other as a motor, but the ampere-meters show no trace of this. Suppose, now, the machines are not equal in size. Then the condition for proper parallel running is that the resistances of the series windings—and armatures also—must be inversely proportional to the current of the machines.

Now, in the case of the three machines given in the question, it may be assumed that they are properly built, and hence in a case where they are all fully loaded, or, rather, where the total load given out is equal to the sum of the three loads—700 kw.—since the volt drop over each series winding is the same, and since the resistances are



as $\frac{1}{2} : \frac{1}{2} : \frac{1}{3}$, the currents in the respective ampere-meters will be as 2 : 2 : 3; apparently then all is going well. But, just as in the case of the two machines, all may be going wrong, and currents may be circulating just as they please amongst the machines themselves. It is evident that the only way to remedy this and find what each machine is doing is to put the ampere-meter in the other side of the machine. A mistake of this sort is easily made in the design of a switchboard, and a case came under the writer's notice a few months ago where the ampere-meters in a fairly large installation were connected up wrongly. At first the attendant noticed nothing, but after a time he discovered that when the machines were, according to the ampere-meters, all doing the same load, the indications of the steam-chest pressure gauge on his Willans engines varied in a remarkable fashion, showing that the load was widely different in nearly every case. A very short consideration led to the discovery of the mistake as it has been described here, and naturally the instruments had to be put into the proper electrical place, which was no easy matter, as it entailed the alteration of many of the switchboard connections.

The main thing to remember is, therefore, that the ampere-meters should be in the opposite side of the circuit from the paralleling wire, else they only serve to deceive the attendant, who, naturally enough, knows no better, and accepts the apparently logical conclusion that "Dynamo Ammeter No. 1" shows what is happening in dynamo No. 1. Only in this case he would be wrong.—T. C.

Answer to No. 267 (*awarded* 7*s.* 6d.).—Assuming that the word "records" means the energy delivered to traction 'bus bars, it will be seen that the sum of the ammeter readings gives the total load on traction 'bus bars, and no

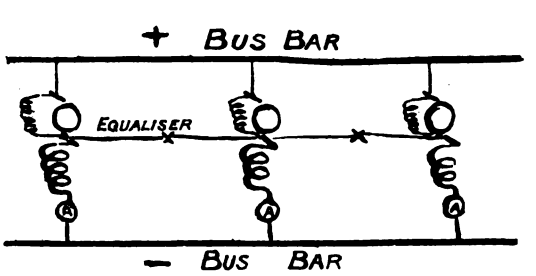


FIG. 1.

appreciable error can be made in estimating the load, because when a machine begins to motor, the motoring current does not pass through the series winding, but along the equalising bar, as it is arranged to have a very much lower resistance than the series winding. There is no doubt but what a small portion of the motoring current will go through the ammeter, on account of the voltage

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drop along the series coil. This amount is insignificant when one remembers that the full current for motoring is only a mere fraction of the full load, and that it can flow along each of the equaliser cables on either side. The annexed sketch will probably make the connections a little clearer (see Fig. 1). With the arrangement as given, the actual load on any machine can never be known, for the current going down the equaliser bars is not recorded on the ammeters. It is certainly a poor way of connecting up traction generators for parallel running with safety.

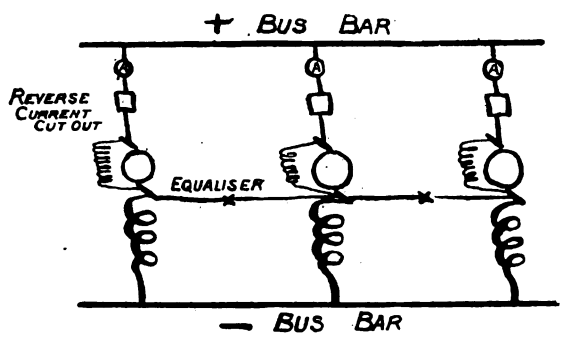

FIG. 2.

One of the best methods is that shown in Fig. 2, where an ammeter and reverse current cut-out are placed on the positive pole, with the equalising switch on the negative. The reverse current cut-out should be set to cut out with a reverse current equal to 10 per cent. of the full-load current, so as to allow margin for variations in governing of the engines.—M. D. A.

Question No. 268.—Discuss the relative advantages of fuses and automatic cut-outs for high-tension work when large powers are being dealt with.

[N.B.—We regret that no correspondent has considered the advantages of automatic cut-outs for any high-tension work in that a path of vaporised metal is not set up. A quicker break of the circuit is also obtained.—ED. *E. E.*]

Answer to No. 268 (*awarded 7s. 6d.*).—For most electrical work fuses are preferable to automatic cut-outs, as the absence of mechanism requires less space for operating; insulation is more easily secured, and the break can be arranged to occur in oil, which prevents excessive disruptive effect, not to mention the greater expense of cut-outs. All these advantages apply to the subject under discussion for main circuit fuses. Where a discriminating device is desired, such as in a generator protector, an automatic cut-out should be used. Automatic cut-outs are used for heavy current work, like traction, more for the greater convenience of replacing a switch lever, instead of a fuse wire, when a temporary short has taken place, or merely an overload. For a permanent short, burning it out by holding the switch up is usually resorted to unless it is a very serious fault. A fuse wire with springs separating break, immersed in high-flash oil and enclosed in a stout porcelain case (Ferranti type), with space and length of break increased proportionately to the current and voltage, should be more reliable and more safely used on a switchboard than an automatic cut-out as usually made.—J. H. C. B.

Answer to No. 268 (*awarded 7s. 6d.*).—Fuses and automatic cut-outs are used in central stations to prevent a short-circuit on the mains damaging the generators. The use of devices to prevent injury to machines is a case of much argument with electrical engineers, some favouring fuses, others automatic cut-outs, whilst some few are in favour of abolishing these appliances altogether. A case occurs to mind where a powerful arc, some hundred horse-power, was set up and maintained under the pavement, and could not be stopped until the supply was shut down, and with most machines this would undoubtedly do great damage, so to prevent this some safety device must be used.

If a safety device is to be used it should be placed in circuit between the 'bus bar and the feeders, not between the machine and 'bus bar, where it is useless. Take the case of fuses between alternators and the 'bus bars. No fuse is needed to protect the alternator, as modern alternators will stand short-circuiting without damaging the alternator. The fuse is needed then to prevent a faulty machine short-circuiting the mains. Suppose an alternator running fully loaded and the generator to be paralleled with it fails, the running machine, besides carrying current for the outside circuit, has to supply current to blow the fuse of the faulty machine, and in so doing will blow its own fuse and shut out the lights. The same applies to direct-current generators; a back current would injure the incoming generator, but a fuse would be useless. What is wanted is an automatic cut-out which will act with a small back current. Fuses are very erratic. Not 1 per cent. of fuses blow through shorts on the mains, and it is not uncommon to find two fuses which have been in circuit some time, one of which will carry twice the current the other will, though originally both were supposed to blow at same current. Some engineers achieve good results by using copper fuses, and allowing small shorts to burn themselves out.

Automatic cut-outs, both zero and excess cut-outs, are unreliable, and from this cause are not much in favour in this country, but Andrews's cut-out, made by Cowan's, is used in many central stations with success. This cut-out has the following advantages: the winding carries its maximum current without undue heating; the apparatus is compact; it operates with a small return current; it is not delicate (to outside influences). The principles which govern the working of the cut-out were clearly explained in Mr. Andrews's paper before the Institution on "Interruptions to Electric Supply." Most cut-outs act at a time when least expected, due to their delicate adjustment, and this sets most engineers against them.—F. M. MOODY.

LEGAL INTELLIGENCE.

CHAMBERLAIN AND HOOKHAM v. THE MAYOR, ETC., OF BRADFORD.

(*Concluded from page 713.*)

Mr. Cripps, in opening the case for the defendants, pointed out that the meter of the defendants measured energy while that of the plaintiffs measured current only, and because under particular circumstances you may get your potential nearly constant, or you may get your E.M.F. so that it varies very little, that does not make the two meters the same, and does not make the one an infringement of the other. That practically was the argument for the defence. The evidence given tended to support this view, and in a subsidiary way that the meter used by the defendants was based upon a combination of Siemens-Deprez, with the substantial addition of a silver commutator and brushes, which it was held went a long way, if not altogether, to make the combination a practical commercial instrument.

Mr. Ferranti, the first witness called, spoke as to his long experience in making meters, and to his having designed a form of meter previous to that patented by Mr. Hookham. He held that an energy meter was entirely distinct from a current meter; that it had a different function to perform, having to take account of pressure and quantity—namely, the energy—instead of taking account only of the quantity of current passing. With regard to the reduction of friction, he held that the method employed by the defendants was quite different to that employed by the plaintiffs. The cross-examination of Mr. Ferranti was postponed because of the indisposition of Mr. Moulton, and **Prof. Ewing** was examined. He also held that the two measuring instruments were totally distinct, and he could not find in Chamberlain and Hookham's specification any directions which would enable a workman to make a meter which could be used with alternating currents, and he held that a workman having the description of a Marcel Deprez would deserve dismissal if he did not make a practical instrument on the lines of the Siemens-Deprez combination.

Prof. Ayrton described, as indeed did other witnesses, various processes of ageing magnets, and discussed the percentage of magnetism ultimately left, without, however, agreeing to any definite figures, that the percentage could vary over fairly wide limits. He showed magnets which had been practically constant, as used in measuring instruments of his made 17 or 18 years ago, and held that they were very good magnets for braking purposes. He held, also, that the defendants had made a very important addition to the previous forms of energy meters, in that by making the friction between the brushes and the commutator small, they thus made a practical instrument.

A good deal of evidence was given in connection with the starting coil of the defendants' meter, the plaintiffs, of course, being desirous of showing that the starting coil was only suitable for a particular voltage, while the defendants' witnesses declared that the starting-coil arrangement would work all right with a considerable variation of voltage, but not an excessive change.

Prof. Silvanus Thompson gave evidence as regarded the saturation of magnets and the use of alternate currents.

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Mr. Bousfield then reviewed the case for the defendants, **Mr. Moulton** replied for the plaintiffs, and judgment was deferred.

A LEEDS ELECTRIC LIGHTING CONTRACT.

In the Queen's Bench Division this week arguments were heard by Justices Darling and Bucknill in the appeal against the decision of the official referee in the case of Ashwell and Nesbit *v.* Stanton. The action was one for £500 alleged to be due on a contract for the installation of electric light in new premises erected at Leeds for Mrs. Stanton, boot manufacturer, who counter claimed for damages for breach of contract. The case had been previously before Justices Wills and Ridley, who had decided that there had been an absolute contract between the parties. After some conversation it was agreed that the decision of the judges as to this point should stand, and that the only question argued should be whether there was any consideration for the promise given by the plaintiffs that the whole of the work should be completed in time to allow of the place being opened for business on Nov. 4, 1897.

Mr. Manisty contended for Mrs. Stanton that the plaintiffs were estopped from saying the promise was a mere naked promise because they knew it would be acted upon, and next that this was a promise made in reference to the performance of the contract. It was a promise making that definite which was indefinite before, and fixing a date for completion.

Mr. Pollock replied at some length on the other side, and quoted authorities in support of his contention that there was no consideration for the promise, and therefore that it was not binding.

Mr. Justice Darling said the facts were that in consequence of the promise Mrs. Stanton did what she would not have done without the promise—viz., she incurred liability for printing, engaging assistants, etc., ready for the opening. Therefore, on the point of consideration, he thought the judgment of the Court must be for the defendant. The appeal would be allowed, and the matter would go back to the official referee to ascertain the damages.

Leave to appeal was given.—*Yorkshire Post.*

COMPANIES' MEETINGS AND REPORTS.

BRITISH ALUMINIUM.

The report, presented at a meeting held yesterday, shows a gross profit of £41,520. After payment of all general expenses, repairs and maintenance, and interest, there remains £14,236 available for distribution. There being still arrears due on the cumulative preference shares, accrued during the time the works were under construction, the payment of the cumulative 7 per cent. dividend on the preference shares up to Oct. 1, 1897, was recommended. The directors also recommended the creation of 10,000 "A" preference shares of £10 each, bearing cumulative interest at 6 per cent., in order to carry through new arrangements for extending their operations, and also to provide for the natural development of the business.

The report was adopted on the proposition of the **Chairman** (Mr. R. W. Wallace, Q.C.), who explained that the proposed purchase of the water rights was practically forced upon the Company, and would give it great advantage in the future.

Lord Kelvin, who seconded, said that the possession of this water power would prove more valuable from day to day, on account of the increasing price of coal, the world's supply of which was becoming more and more limited.

Mr. Robert Heath and Lord Kelvin were re-elected directors and Messrs. Crewdson, Youatt, and Howard were re-elected auditors.

An extraordinary meeting was held afterwards, at which it was proposed to offer 5,000 "A" shares to the present shareholders in proportion to their holdings. The proposition was carried.

A vote of thanks to the chairman closed the meeting, after which a luncheon to the Press took place, at which the usual toasts were proposed and duly honoured.

WEST INDIA AND PANAMA TELEGRAPH.

The accounts for the half-year ended Dec. 31 last show a profit of £1,211, which, with £3,021 interest on investments and £379 brought forward, makes a total of £4,612 to the credit of revenue. The directors recommend the payment of dividends for the preference shares out of the reserve fund; and they also propose that a dividend of 1s. per share be paid on the ordinary shares. The directors have applied for a Government subsidy, as they think that low rates for West Indian telegraphic communications cannot be maintained without the financial assistance of the Government.

REUTER'S TELEGRAM.

According to the report for 1899, just issued, the amount available for distribution, after deducting rebate on unexpired subscriptions and writing off a portion of the expenditure on account of the advertisement branch, amounts to £8,304, including £29 brought forward. The directors have declared a dividend of 4s. per share, equal to 2½ per cent., making a total distribution, tax free, of 5 per cent. for the year. This will absorb £4,995; £3,000 will be added to reserve, leaving a balance of £309 to be carried forward.

CALLENDER'S CABLE AND CONSTRUCTION.

Directors: Henry Drake, Esq. (chairman); D. P. McEuen, Esq.; W. O. Callender, Esq.; Lieut.-Colonel G. A. Elliot; Major W. M. Mackenzie. Managing director: T. O. Callender, Esq. Secretary: Mr. H. L. Manning.

In their report for the year ending Dec. 31, 1899, the directors state that there is a balance at the credit of profit and loss on the year's operations of £41,966. 13s. 1d., to which must be added the balance brought forward from 1898, £6,212. 9s. 6d. From this must be deducted interest on debentures, £4,050; dividend on preference shares, £4,866. 12s. 10d.; interest paid on the new ordinary shares to Dec. 31, 1899, £933. 11s. 5d.; appropriation for depreciation on plant and machinery, £5,000; appropriation for depreciation on office furniture, £107. 5s.—leaving an available balance of £33,221. 13s. 4d.; which it is proposed to deal with in the following manner: by the payment of a dividend to the holders of original ordinary shares, Nos. 1 to 20,000, at the rate of 10 per cent. per annum (clear of income tax), being 10s. per share, whereof 5s. was paid on Nov. 1, 1899 as an interim dividend, leaving 5s. per share to be paid now, £10 000; by the payment of a bonus of 5s. per share, £5,000; by placing to reserve, £10,000; by carrying forward to next year's account, £8,221. 13s. 4d. The total payments to the holders of original ordinary shares will, therefore, be as last year, at the rate of 15 per cent. per annum. The plant and premises have been maintained in a thorough state of efficiency, and the cost of renewals and repairs has been debited against the year's profits, as well as an additional sum of £4,465 for expenses incurred in the removal of machinery and plant from the old factory to the new. This considerable and unusual expense will not occur again. The business transacted in 1899 was very considerably in excess of that of 1898. The past year was, however, marked by a steady and persistent rise in the market value of practically all the materials used at the factory, so that it has been exceedingly difficult to tender forward profitably for contracts. The directors consider the large profit earned under these disadvantageous conditions is eminently satisfactory. So far this year's business compares very favourably with that of 1899. The Company has over 150 contracts in hand, whilst the factory is fully employed, it being indeed necessary to run several departments day and night. The attention of the shareholders is called to the reserve fund, which (with the addition now proposed to be added to it) will stand at £73,881. 18s. 6d. A considerable sum has been spent on new plant and machinery during 1899, and this outlay has enabled the Company to enter into profitable contracts which otherwise must have been declined. Owing to the large increase in the business mentioned above, it is necessary to augment the working capital of the Company, and the directors therefore propose to issue 20,000 new preference shares of £5 each under the powers given to them last year. The directors have pleasure in acknowledging the loyalty and zeal with which all the staff have worked, who have, by their efforts, made the present position of the Company so satisfactory. The retiring director is Major Wm. Mackay Mackenzie, who, being eligible, offers himself for re election. The auditors, Messrs. James Worley and Son, offer themselves for re-election.

Dr. PROFIT AND LOSS ACCOUNT.	£	s.	d.
London office and general expenses	14,442	15	4
Repairs and maintenance of plant and buildings, £3,037. 0s. 7d.; and removal of machinery to new factory, £4,465	7,502	0	7
Samples and experiments	543	15	3
	22 488	11	2
Balance carried down	41,966	13	1
	£64,455	4	3
Interest on debentures	4,050	0	0
Dividend on preference shares	4,866	12	10
Interest on new ordinary shares	933	11	5
Depreciation of plant and machinery, etc.	5,000	0	0
Office furniture	107	5	0
Balance as per balance-sheet	33,221	13	4
	£48,179	2	7

Cr.	£	s.	d.
Profit for the year, after deducting all charges	64,455	4	3
	£64,455	4	3
Balance brought down	41,966	13	1
Balance from 1898	6,212	9	6
	£48,179	2	7

OSWESTRY ELECTRIC LIGHTING AND POWER.

The following is the report of the directors to be presented at the annual meeting: "The directors have pleasure in presenting the audited accounts of the Company for the year 1899, which show continued progress. The gross profit for the year amounts to £318. 8s. 2d., which, with £8. 0s. 1d. brought forward from 1898, makes an available balance of £326. 8s. 3d. Besides providing for depreciation, in accordance with the scheme approved by Board of Trade, the directors have added a further sum of £60 to the reserve fund, which they are charging with the cost of a renewal and extension of battery cells, and have also written off

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£12. 0s. 4d. from the preliminary expenses, a net divisible balance of £254. 7s. 11d. remaining. The directors recommend the declaration of a dividend at the rate of 4 per cent., leaving £20. 9s. 2d. to be carried to next account. The director retiring by rotation is Mr. George Perks, who is eligible and offers himself for re-election. Mr. Josiah Jones having, to the regret of the Board, resigned his office as a director, Mr. Edmund Williams, of Gobowen, has been elected to fill the vacancy. The auditor, Mr. T. H. Crowther, also retires, and is eligible for re-election.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN

Dundee.—The Gas Commissioners invite tenders for the supply of small coal and electricity meters. Tenders by May 31. Details in our advertisement columns.

Vladivostock (Siberia).—The Russian Government invite tenders for the concession of constructing and working electric tramways and light in the town.

St. Pancras.—The Vestry invite tenders for rearranging and additions to bare copper strip conductors. Tenders by June 7. Details in our advertisement columns.

Walthamstow.—The Urban District Council invite tenders for the erection of arc lamps and the supply of incandescent lamps and accessories, etc. Tenders by May 29.

Manchester.—The Tramways Committee invite tenders for the overhead equipment of three routes of tramways. Tenders by June 9. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each. Tenders by June 12. Details in our advertisement columns.

Newcastle-upon-Tyne.—The Corporation invite tenders for switchboards, underground feeders, and pumping apparatus. Tenders by May 25 and June 1. Particulars in our advertisement columns.

Southampton.—The Corporation invite tenders for the supply and erection of one water-tube boiler, with steam and other pipes, and sundry ironwork. Tenders by May 28. Particulars in our advertisement columns.

Grimsby.—The Corporation invite tenders for the supply and delivery of motors for registering current for the equivalent of 25 8-c.p. lights, 25 50-c.p. lights, 25 100-c.p. lights, 25 200 c.p. lights. Tenders by June 1.

Bootle.—The Corporation invite tenders for the supply and laying of underground electric cables, the erection of arc lamps, and the supply of mechanical stokers. Tenders by June 16. Details in our advertisement columns.

Crewe.—The Town Council invite tenders for the wiring of the municipal offices, market hall, and corn exchange, and for supplying lamps and fittings for electrically lighting the same. Tenders by June 11. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the delivery and erection of coal-conveying apparatus and hoppers, also of ash-conveying apparatus, at their electricity works, Valley-road. Tenders by May 31. Details in our advertisement columns.

Partick.—The Corporation invite tenders for the construction, supply, and erection of dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced-draught appliances. Tenders by June 8. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the supply and erection of a switchboard for a pressure of 500 volts, or for alterations to existing switchboard at their electricity works, Valley-road. Tenders by June 7. Details in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for two or three (at the option of the committee) 630 kw. two-phase generators; and one or two (at the option of the committee) sets of surface-condensing plant. Tenders by May 28. Details in our advertisement columns

London.—The Streets Committee of the Corporation of London invite proposals from firms or persons experienced in the manufacture and use of electric motorcars for the hire of an electrically-driven dustcart. Tenders by June 1. Full particulars in our advertisement columns.

London, S.W.—The Fulham Vestry invite tenders for the wiring of their electric lighting works. Specifications, etc., may be obtained at the offices of Mr. F. Hastings Medhurst, B.Sc., M.I.E.E., 13, Victoria-street, S.W., on payment of a deposit of £3. 3s. Tenders by June 4.

Wolverhampton.—The Tramways Committee invite tenders for the construction of tramway track and contingent work in Dudley-road, Cleveland-road, Bilston-street, Piper's-row, and Fiveways, amounting to a route length of about one mile seven furlongs, mainly double track. Tenders by June 26.

Dundee.—The Town Council invite tenders for the overhead equipment of the following routes: (Section 1A) Perth-road (extension) route; (2A) Lochee (extension) route; (3) Blackness-road route; (4) Princes-street and Forfar-road route. Tenders by May 31. Details in our advertisement columns.

Crewe.—The Town Council invite tenders for the supply and laying down of about 25,000 yards of three-core cable for street-lighting extensions, and the supply of upwards of 500 lampholders and reflectors for adapting the existing lamp-posts for electric light. Tenders by May 26. Details in our advertisement columns.

Leeds.—The Lighting Committee invite tenders for two or three (at the option of the committee) 630-kw. two-phase generators, comprising triple-expansion engines and alternators, and one or two (at the option of the committee) sets of surface-condensing plant. Tenders by May 28. Details in our advertisement columns.

Kilmarnock.—Tenders are invited for the supply, erection, and starting of one 60 kw. or (alternatively) one 80-kw. dynamo. Continuous current, 210 volts. Price, with weight, size of shaft, length of journals, and other details fully specified, to be delivered to Messrs. Andrew Barclay, Sons, and Co., Limited, Caledonia Works, by first post on 28th inst.

Heywood.—The Town Council invite tenders for the construction and erection of (1) chimney shaft, 120ft.; (2) electric light station, comprising engine-house, boiler-house, battery-room, offices, and stores. Specifications may be seen and bills of quantities obtained on application to Mr. J. Ainsworth Settle, A.M.I.C.E. Tenders by 28th inst.

Bridgwater.—The Town Council are prepared to receive tenders for the supply and erection of boiler-house plant (boilers, fittings, steam and exhaust pipes, etc.), engine-house plant (steam dynamos, pumps), switchboards, etc., underground mains, lamp-posts, etc., accumulators, meters, and crane. Tenders by June 7. Details in our advertisement columns.

London, S.E.—The South London Electric Supply Corporation, Limited, invite tenders for the complete installation of 3,000 lights on the premises of 500 consumers in any part of the area of the company's supply, and also for the installation of two arc lights on the premises of any consumer in the same area. Tenders by June 2. Details in our advertisement columns.

Brussels.—The Council of St. Jilles, lez-Bruxelles, will receive tenders for the installation and the setting to work of a distribution of electricity upon a part of its district. Conditions of contract, with plan, may be obtained on payment of 3fr., at the office specially dealing with the above, No. 14, Parvis St. Jilles, St. Jilles (Brussels). Tenders should be addressed to the Mayor of St. Jilles, lez-Bruxelles, before 2 p.m. on Sept. 19.

Madrid.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Ambassador at Madrid, stating that tenders are invited by the Spanish Government, to be received not later than July 7, for the concession of an electric tramway from the Puerta de Hierro, Madrid, to Aravaco and Pozuelo. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

London, S.W.—The Asylums Committee of the London County Council invite tenders for (1) the installation of electric lighting and power (except generating plant); (2) the installation of telephones, tell-tale clocks, fire-alarms, and call bells at the Horton Asylum, near Epsom, Surrey. Tenders, endorsed "Tender for Electric Lighting. Horton Asylum," or "Tender for Telephone, &c., Installation, Horton Asylum," by 10 a.m. on June 16. Details will be found in our advertisement columns.

Port-y-waen and Llangynog.—The Cambrian Railways Company invite tenders for the construction of a light railway, about 15 miles long, 4ft. 8½in. gauge, commencing by a junction with the branch of the Cambrian Railways at Port-y-waen, in the county of Salop, and terminating at Llangynog, in the county of Montgomery. Plans can be seen, and copies of specification and quantities obtained, on payment of £1. 1s., at the office of Mr. A. J. Collin, engineer to the Tanat Valley Light Railway Company, Oswald-road, Oswestry. Tenders by June 5.

Sutton Coldfield.—The Corporation invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, etc., pipework, etc., in engine and boiler house, three steam dynamos (vertical enclosed high-speed engines) and motor boosters, storage batteries, main switchboard and connections, eight-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed) and posts, and station lighting. Tenders by June 21. Details in our advertisement columns.

Durban.—The Corporation invite tenders for supply, delivery, and erection of materials under the three following sections: (Part A) comprising the supply, delivery, and erection of the entire overhead equipment for about 16 miles of equivalent single track, including poles, overhead trolley wire, distribution boxes, etc.; (B) comprising the supply, delivery, and erection of 22 double-deck motorcars, complete; (C) comprising the supply and putting into working order of a complete steam and electric generating plant in a power station to be built by the Corporation, including three 250-kw. direct-coupled generators, boilers, condensers, cooling tower, switchboard, etc. Parts A and B will not be separated, but will be let to one contractor. Part C may be let separately. Preference will, however, be given to a contractor who will undertake all three sections, and a separate form of tender for all three sections will be supplied. Specifications, bills of quantities, forms of tender, and lithographic drawings may be obtained on application to Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation, on and after 29th inst. A deposit of £10. 10s. must accompany application for specifications and forms of tender. The deposit will be returned on the receipt of a bona fide tender. Sealed tenders, in duplicate, under separate cover, in specially-provided envelopes, to be delivered to Messrs. Webster, Steel, and Co., by June 29, or to the Town Clerk of Durban by mail delivery on or about July 23. The successful tender will be accepted by cable from Durban.

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RESULTS OF TENDERS.

Barnes.—The Urban District Council have accepted the tender of Messrs. G. Munday and Sons, at £5,719, for erecting an electric generating station.

Walthamstow.—The Corporation have accepted the tender of W. T. Henley's Electric Telegraph Works Company, Limited, at £10,658. 18s. 6d., for cables.

Norwich.—The City Council have accepted the tender of Messrs. G. N. C. Mann and Co., Norwich, at £375, for constructing an electric installation at the technical institute, St. George's street.

London, S.E.—The Bermondsey Vestry have accepted the tender of Messrs. Hughes and Stirling, Bootle, Liverpool, at £2,581, for erection of a chimney shaft on the site of their new electric generating station in Spa-road.

Hill End (Herts).—The Herts County Council have accepted the tender of Messrs. Hayward Tyler and Co., 90, Whitecross-street, E.C., at £254. 13s. 6d., for the provision of electric plant for lighting the isolation hospital at Hill End Lunatic Asylum, near St. Albans, with electric light.

Northumberland County Lunatic Asylum.—Subject to the approval of the Local Government Board, the Visiting Committee of the above asylum have accepted the tender of Messrs. McAulay, Clark, and McLaren, of Glasgow, for the electric lighting of their asylum, to the specification of Mr. A. A. Campbell Swinton. Thirty-one tenders were received.

Kingston-on-Thames.—The Corporation have received the following tenders for putting down the foundations for a new engine and alternator at the electricity supply station:

T. Robinson, 1, Ormsby-terrace, Regent's Park (accepted)	£160	0	0
S. Kavanagh, Surbiton Hill, Surbiton	245	0	0
S. Atkins, Queen Elizabeth-road, Kingston	267	10	0

Raunds (Northants).—The following tenders have been received for electric lighting work at Mr. Coggins's factory, Raunds, Northants:

Electric Wiring Company, Northampton (accepted)	£237	8	4
V. Duckenfield, Northampton	280	17	0
W. Smith, Northampton	307	5	0
Whitfield and Blackburn, Kettering	31'	17	0
Adkins and Co., Northampton	341	10	0
Lea and Warren, Kettering	344	10	6
W. Mansell, Northampton	346	10	0
F. G. Brown, Rushden	370	11	0

London, E.—The Whitechapel District Board of Works have received the following tenders for the first portion of the new electricity supply station, Osborn-street:

H. L. Holloway	£19,500
Kirk and Randall	18,548
Harris and Wardrop	18,200
Perry and Co.	17,589
Holliday and Greenwood	15,889
W. Griffiths (accepted)	15,774
J. O. Richardson	15,555
Martin, Wells, and Co.	15,521
Cheesum and Sons	15,256

Engineer's estimate, £15,890.

Doncaster.—The Corporation have received the following tenders for lighting the Corn Exchange by electricity:

Fisher and Allison, Cleveland-street, Doncaster (accepted)	£135	0	0
Morgan Mordey, and Co., Alpha Works, Eldon-street, Sheffield	118	5	6
McAuley, Clark, and McLaren, 34, St. Anne-street, Glasgow	130	10	6
T. B. and W. Cockayne, Limited, Sheffield	133	10	0
T. A. Ashton, Limited, 36, Norfolk-street, Sheffield	139	15	0
Keighley Electrical Engineering Company, 5 Printing Office-street, Doncaster	148	13	0
Linnley and Postlethwaite, 16, Hall-gate, Doncaster	156	2	6
National Electric Wiring Company, Limited, 16, Guildhall-street, Lincoln	160	0	0

BUSINESS NOTES.

TRACTION.

Swansea.—The Corporation have decided to apply for light railway powers.

Dumbarton.—The proposal to establish tramways for Dumbarton has been allowed to lapse.

Bootle.—The Corporation are pushing on with their appeal to the Board of Trade with regard to the tramways.

Kinver.—The work of completing the electric tramway is being pushed forward. No date has yet been fixed for the opening.

Kingston.—Application will be made by the Corporation in the next session of Parliament for tramway powers in regard to the borough.

Dover.—The returns of the Corporation electric tramways for the year show a profit of £3,155, a considerable increase on the preceding 12 months.

Linthwaite.—Colonel Yorke, R.E., has inspected and approved the second portion of the tramway laid on the Manchester-road by the Urban District Council.

Sunderland.—The Town Council have decided that in future drivers and conductors shall work 10 hours per day, or 60 per week, instead of 14 hours per day as heretofore.

Cardiff.—The Town Council have passed a resolution in favour of a separate station for the tramways, and the appointment of an electric traction engineer, with a salary commencing at £500.

Halifax.—A successful trial trip took place on the new route on the 23rd inst. The terminus is at present at Stump Cross, but the Corporation have applied for powers to continue the line to Northowram.

Grimsby.—A resolution was passed at a meeting of ratepayers on Monday night protesting against the tramway company's Bill now before Parliament and the agreement which had been entered into between the company and the Corporation.

Rawtenstall.—The Tramways Committee of the Haslingden Corporation, along with their town clerk, recently attended before the Electric Light Committee, and the question of the tramways between Rawtenstall and Haslingden was discussed.

British Motor Traction Co.—This Company has been registered with a capital of £100 in £1 shares, the object being to carry on the business of tramway constructors and proprietors, steam, oil, electrical, and other motor manufacturers, cycle makers, etc.

Greenock.—At a recent special meeting of the Police Board the terms of the agreement for leasing the tramways within the burgh of Greenock with the Greenock and Port-Glasgow Tramway Company were discussed. Another meeting is to be held on the 29th inst.

Farnworth.—Colonel Yorke visited Farnworth and Kearsley on the 18th to inspect the tramways. We understand that the inspector did not find the rails as badly worn as he anticipated, and he left the impression that he would recommend the granting of a certificate for the use of the lines for another seven or ten years.

Newcastle.—The first portion of the new tramways was opened to traffic on the 20th inst. A single line on Northumberland-street, extending upwards from Prudhoe-street, has been completed, and connected, by means of points, to the old one above and below it. The second line will be commenced immediately. It is expected that Northumberland-street will be completed in time for the visit of the Prince of Wales next month.

Swadlincote.—Mr. A. H. Timms has presented plans on behalf of a proposed company for a light railway to run between Burton and Woodville and passing through the district. The Highways Committee have reported that they are unable to recommend the Council to consider the same, the name of the company on whose behalf the plans are presented not being known, and the committee consider it undesirable for the Council to express any opinion on such a matter without more information.

Bath.—The City Council having approved of the proposed scheme of electric tramways for Bath and the district, the adjourned meeting of the Bath Rural District Council was held last week to take the matter into further discussion, the Rural Council being one of the bodies affected, controlling as they do roads which will be traversed. A resolution was passed to the effect that the promoters be required to supply a service of omnibuses or other means for locomotion on routes now served by 'buses where the tramways are not to be laid in the event of the present service being discontinued.

Aberdeen.—An inspection of the electric car system, buildings, poles, etc., was held recently under the auspices of the Tramways Committee of the Town Council. Reference was made to a proposal to have the electric car system introduced on the Union-street route. It was considered that centre poles would not be suitable for that thoroughfare on account of the amount of vehicular and other traffic, but there would be little trouble, it was said, in having the overhead wires suspended from side poles or from rosettes attached to the houses on either side of the street. At the next meeting of the Council a proposal will be brought forward to have Union-street thus adapted for the electric tramway system.

Bolton.—Colonel Yorke inspected the new tracks on the Horwich, Daubhill, and Farnworth routes on the 18th inst. Mr. Ellis, M.I.E.E., general manager of the tramways, Mr. H. England, traffic manager, Mr. Brown, borough surveyor's department, Mr. T. Riley, of the town clerk's office, and other officials, attended. The car selected for the purpose was one of the new cars of the Liverpool type, with extended covers over the platform, which will protect the motormen and conductors at the end of the cars. We learn that the running and everything passed off satisfactorily, and the route was opened on the following day with a 40-minute service, the fares being 5d. each way between Bolton and Horwich. Colonel Yorke also paid visits to the Daubhill and Hulton section and to the Farnworth route.

Stalybridge.—The Town Council have adopted the report and recommendations of the Stalybridge, Hyde, Mossley, and Dukinfield Electric Traction and Lighting Joint Committee. An expenditure of about a quarter of a million sterling is involved in the scheme. The capital is to be contributed by each of the four Corporations in equal shares. The tramway and the equipments thereto are to be laid and provided by the Joint Committee throughout the whole of the tramway system. The Joint Committee will also maintain the tramway track on all the county roads for the space required by the Tramways Act, 1870, but each Corporation is to maintain the tramway track on all other roads within their respective districts. Otherwise the whole of the undertaking and the working thereof, including the installation and distribution

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of the electrical energy (both for lighting and power) will be under the control of the Joint Committee.

Birmingham.—The Lord Mayor of Birmingham and the Public Works Committee, to the number of about 20, have visited Liverpool in order to examine the working of the system of electric tramways which has been adopted by the Corporation. The members of the deputation were conveyed over some of the principal routes on which the overhead trolley system is now in operation, and they also visited the stations where the electrical power is generated. During an interval in the tour of inspection, the deputation were entertained to luncheon by the Lord Mayor at the Adelphi Hotel. The Public Works Committee made an inspection of the Bristol-road electric tramway route on the 23rd inst., with a view to seeing how far it will be practicable to adopt any of the Liverpool methods in connection with the overhead system.

Light Railways.—We understand that Messrs. Greenwood and Batley's Kingston, Surbiton, and district light railway scheme has been postponed indefinitely.—The Rishton District Council have been approached with regard to a scheme for light railways, and they have decided to reply that they could not give a definite answer, as they were already in negotiation with the Blackburn Corporation for electric tramways.—At a recent enquiry held by Sir Courtenay Boyle for the purpose of hearing objections to the Lastingham and Rosedale light railway scheme, the chairman said the objections which had been put before him would be considered.—The Light Railway Commissioners have granted an order for the construction of the Brackenhill light railway.—A clause has been agreed upon which will be inserted in the light railway order for the protection of the interests of the Hendon Council. The agreement with the Metropolitan Tramways and Omnibus Company with regard to the lighting of the route will be sealed by the company at their next meeting.

Isle of Man Tramways Co.—Messrs. Turquand, Youngs, and Co., chartered accountants, have now issued their report on the financial position of the Isle of Man Tramways Company, and, says the *Financial Times*, it is of a remarkable character. They are of opinion that since the year 1894 dividends have been paid otherwise than out of profits amounting to £15,646. They specify various items debited to capital which should properly be charged to revenue account, and items credited to revenue account which are transferred to credit of purchase account. Absence of title to shares value £2,000 in Snaefell Mountain Railway is mentioned. Strong criticisms are made on the inefficient manner in which the accounts were kept. On the separate undertaking of the Laxey-Ramsey section the outstanding liabilities are placed at £48,000, and the net revenue account shows a loss of £434 in 1898 and £402 in 1899. Assuming that an additional capital of £48,000 is raised for the Laxey-Ramsey section, the accounts based on the revenue of the year 1899 show a deficiency of £920 but it is pointed out that the line was only opened for six months in 1899.

Glasgow.—At a meeting of the Corporation on Monday, a minute of the Tramways Committee was confirmed containing a draft agreement between the Glasgow Tramways Committee and the Paisley Corporation as to a lease of the tramways from the eastern boundary of Paisley to Paisley Cross. The committee stated that the Paisley representatives expressed themselves as generally satisfied therewith, and the committee undertook to give the memorandum further consideration. With reference to the extension in the Renfrew and Govan-road, it was recommended that, in the event of power to construct a tramway line on the Govan and Renfrew-road, sought by the Glasgow and District Tramways Bill, not being granted, the Corporation should agree to construct within five years from their obtaining parliamentary powers an extension of their system in that road so far as in the county of Lanark, the terms and conditions to be the same as those contained in the Corporation Tramways, etc., Act, 1899, with reference to the extensions of line in the county thereby authorised. It was remitted to the Parliamentary Bills Committee to take the necessary action for giving effect to the finding of the Corporation.

Ayr.—The Town Council have adopted a report of the sub-committee appointed to consider the merits of gas traction compared with electric traction. The report contained the following recommendation: "After visiting and inspecting the various tramway systems in Blackpool, Dover, and Liverpool with regard to the relative merits of gas and electric traction, we now beg to report that we consider the overhead trolley system of electric traction to be the best, and unanimously recommend its adoption for the proposed Ayr tramways. The length of the proposed tramway lines in Ayr and Prestwick is as follows: single line, 2 miles 3 furlongs 3·20 chains; double lines, 6 furlongs 3·10 chains; ditto at passing places, 2 furlongs 8 chains—total length of route, 3 miles 6 furlongs 4·30 chains, which is equal to 4 miles 7 furlongs 5·40 chains of single tramway track. The gauge of the lines would be 4ft. 8½in., and the gradients and curves present no difficulties whatever. For an efficient car service (allowing a proper proportion of reserve cars) 12 cars, each carrying 57 passengers, would be required, with the addition of a motor track cleaner, a most necessary adjunct in the operation of the line. The tramway line can be constructed and opened for traffic in from 12 to 15 months. The estimated probable cost for the complete installation of tramways on the electric overhead trolley system and relative works and plant, would be as follows: permanent-way construction, £31,000; overhead construction and electrical equipment, including cars, £13,200; car shed, etc., £3,800; buildings of power station, generating plant, etc., £9,000—total estimated cost, £57,000." The committee have been empowered to appoint an engineer, to prepare plans and specifications, and to receive tenders for the construction of the track.

LIGHTING AND GENERAL.

Chester.—Electric light extensions estimated to cost £490 are proposed.

Rawtenstall.—It is proposed to erect a dust destructor at the central depôt, at a cost of £1,000.

St. Martin's-in-the-Fields.—The parish was for the first time lighted by electricity on Wednesday.

Wolverhampton.—The cost of electric lighting at the town hall during the past quarter amounted to about £86.

Mile End.—The Vestry have approved the draft order granted to them for the supply of electricity in the parish.

Chesterfield.—An enquiry has been held into the Council's application to borrow £25,000 for electric lighting.

Hendon.—The electric lighting scheme is still under the consideration of the committee of the Urban District Council.

Norwich.—The Norwich Electric Tramways Company are being urged to run halfpenny trams at certain times during the day.

Middleton.—Mr. R. H. Bicknell has held an enquiry into the Corporation's application for a loan of £20,000 for electric lighting.

Wellingborough.—The Board of Trade have approved of the provisional order for the supply of electric light at Wellingborough.

Personal.—Messrs. Johnson and Phillip's Electric Cable Works inform us that Mr. T. M. Harvey left their employ on the 19th inst.

Plymouth.—The electric lighting accounts for the last six months show a revenue of £3,278. The working expenses were £3,167.

Dartmouth.—A provisional order is being applied for by the Urban Electric Supply Company, Limited, for the electric lighting of the borough.

Keighley.—Mr. W. A. Ducat held an enquiry on Wednesday into an application by the Corporation to borrow £45,000 for works of electric lighting.

Sevenoaks.—A sub-committee, consisting of Messrs. Ince, Marriott, and Rudge, has been reappointed in reference to the question of electric lighting.

Berwick.—An amended agreement with the electric lighting company and also the agreement with the Telephone Company have been sealed by the Council.

Edinburgh.—The City Council have decided to reduce the public lighting from £14 to £13 per lamp, and to increase the charge per unit for electric energy by ¼d.

Norfolk.—The Council have granted the application of the National Telephone Company for leave to erect poles on the main road between Carrington Villas, Cromer, and Overstrand.

Lincoln.—About £40,000 has already been borrowed for electric lighting. Recently Mr. F. H. Tulloch held an enquiry into the Council's application to borrow a further £6,000 for extensions.

Western Telegraph Co.—The directors have declared an interim dividend of 3s. per share, being at the rate of 6 per cent. per annum, payable 22nd prox., for the quarter ended March 31.

Harrogate.—We understand that the electric lighting engine made by Messrs. J. and H. McLaren is completed and ready for erection at the works. The electrical engineer's salary has been increased.

Clydebank.—The Commissioners have appointed a deputation to approach Messrs. John Brown and Co., Limited, for an electric installation from the shipyard for the public halls and other buildings.

London Address.—Messrs. Browett, Lindley, and Co. (1899), Limited, engineers, Sandon Engine Works, Patricroft, near Manchester, have opened offices at 6, Old Queen-street, Westminster, S.W.

Barnet.—A letter from the North Metropolitan Power Distribution Company, offering to supply electricity for lighting the workhouse, has been referred to the Special Lighting Committee of the Guardians.

Accrington.—The total cost of the electric light and refuse destructor scheme will be about £45,000; £18,000 has already been borrowed, and an enquiry into an application for a loan of £26,250 was held recently.

Outing.—The Glasgow Corporation electricity department will make their first annual excursion and sports to Ayr on Friday, June 8, 1900. Sports, refreshments, and dancing comprise the alluring programme.

Worcester.—At the last meeting of the City Council it was suggested that the Electricity Committee should take into consideration the advisability of raising the price of electricity on account of the increase in the price of coal.

Aberdeen.—The Water Committee of the Town Council have agreed in the case of electric connections with houses or other premises in the city to allow the earth-wire to go into the water-mains, the charge to be made being at the rate of 5s. per annum for each connection.

Surbiton.—The District Council are about to canvass the district in order to see what amount of support the electric lighting scheme would receive from the inhabitants. Negotiations for Mr. Butler's land, which it is proposed to acquire for a site for station, have resulted in a preliminary agreement.

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Heaton Norris.—The Urban District Council have appointed a deputation to wait upon the Electrical Committee of the Manchester Corporation with respect to the laying of electrical cables in the streets now proposed to be repaved, etc.

Birkenhead.—The Klein Engineering Company, Limited, Manchester, have received an order from the Corporation to erect at their Craven-street generating station one of their patent counter-current jet condensers with cooling-tower, for engines of 1,000 h.p.

Sale of Works.—We are informed that Messrs. Clayton and Co., Union Works, Huddersfield, have purchased the whole of the business of the Penistone Electrical Company, of Huddersfield and Penistone. Mr. G. Richardson represents the firm in London.

Yeadon.—The Council have decided to ask the Board of Trade to extend the time of the electric lighting provisional order they obtained in 1894, and also to write the Leeds City Council asking if that authority would supply electricity in bulk to Yeadon in conjunction with the proposed tramway scheme.

International Electric Traction and Power Syndicate, Limited.—This Company has been registered with a capital of £25,000 in £10 shares, the object being to carry on the business of rolling-stock and vehicle manufacturers, electrical, mechanical, chemical, and hydraulic engineers, suppliers of electricity, etc.

Teddington.—The Board of Trade have informed the Council, with reference to their objections to the application of the Twickenham and Teddington Electric Lighting Company for a provisional order, that the Board had decided to grant the order, but had restricted the area of supply to the urban district of Twickenham.

"English Illustrated Magazine."—The June number, just out in a refreshingly summer garb, is particularly good. The "Beaufoy Romances" are continued; also "The Adventures of Archibald P. Batts, Millionaire." Exquisite gems of landscape illustrate the haunts of the rail, and "A History of the Penny" is worth keeping.

Hebburn.—The District Council have agreed to a report by the Electricity Committee stating that Councillor Smailes has been appointed chairman. The report of Messrs. Handcock and Dykes, of Westminster, electrical engineers, advising the Council to become undertakers to supply electrical energy under the Electric Lighting Acts has been adopted.

Inverness.—Electric lighting, it appears, is steadily and rapidly increasing. The installation in a number of large private and public buildings are already completed, and we learn that Messrs. P. C. Middleton and Co., Limited, who have carried out most of the installations in the town, have a large number of contracts in hand in Inverness and the North, including the Great Western Hotel in Oban.

London Gazette.—A second and final dividend of 9½d. in the pound has been declared in the estate of S. G. Trehearne and A. H. Crump, trading as Trehearne, Son, and Crump, 155, Fenchurch-street, E.C., payable on Wednesday, May 30, between 10 and 1, or on any subsequent Wednesday between the same hours, at the offices of Messrs. Pratt, Norton, and Co., 9, Old Jewry-chambers, E.C.

Ingleton Water Power Co.—This Company has been registered, with a capital of £7,000 in £1 shares, to acquire the business carried on by the Ingleton Carbide Company at Ingleton Mill, to adopt an agreement with P. Middleditch, and to carry on the business of calcium carbide manufacturers and merchants, and any other business which may be conveniently carried on in connection with water, steam, or electric power.

Newcastle West.—At the last meeting of the Guardians, the Chairman said a resolution was passed before by the District Council on behalf of the Shannon Electric Company, but it appeared they desired that one should also be presented from the Board of Guardians, and there would be no opposition to an enterprise which would be of such vast benefit to the entire district within the area of its scope. This was agreed to.

Glasgow.—The Committee on Electricity are negotiating with the Glasgow and South-Western Railway Company to give a supply for St. Enoch Station and other premises belonging to the company. Their annual requirements are estimated at 660,000 units. The terms upon which it is proposed to supply Partick Police Commissioners, until the new works which the Commissioners propose to erect have been completed, have not yet been settled.

Eastern Extension, Australasia, and China Telegraph Co.—This Company is about to offer the unissued balance of 50,000 ordinary shares to shareholders who were on the register on the 16th inst. at £3 per share premium, or £13 apiece. The funds are required in connection with the new Cape-Australian cable, and they will readily be forthcoming, as the shares are quoted at about £16. The *pro rata* allotment really means a bonus of about 10*s.* per share.

Bridgwater.—The following petition has been presented to the Corporation in regard to electric lighting: "We, the undersigned, burgesses and householders of the borough of Bridgwater, recognising the desirability of retaining the power of providing electricity in the hands of the ratepayers, desire the Town Council to proceed with the scheme they have adopted, and not to allow the opposition which has been raised to deprive the town of the provisional order."

Ilkeston.—Mr. H. F. Tulloch has held an enquiry into the application of the Corporation for power to borrow £18,271 for purposes of electric lighting. The Town Clerk (Mr. Wright Lissett) said the estimated cost of the generating station was £28,452, and this was to be divided equally between the tramways and electric lighting schemes. This showed £14,226 to come out of the loan applied for that day, the balance of £4,045 being for the laying of the mains, wires, etc.

Croydon.—The Board of Trade have informed the Rural District Council that, in their opinion, Clause 16 of the schedule to the Electric Lighting Clauses Act, 1899, and the provisions of the Gasworks Clauses Act, 1847, incorporated with the Electric Lighting Acts, fully provided for the requirements of the District Council as to the reinstating of roads disturbed by electric companies, and that there was no need for any special clause to be inserted in the Wallington provisional order.

Shrewsbury.—The alterations and additions to the station sanctioned by the Council have been completed, and the work of placing the additional plant is also nearly finished. The electric light will be used in the pumping station at Coleham, and a main laid at an estimated cost of £160. The increase in units sold for the quarter ended March 31, 1900, over the corresponding quarter in 1899 is 82 per cent., and the number of lamps connected to that date is equal to 8,953 of 8 c.p.

Electric Launch.—The steamer "Maid of Athens" is to be succeeded, according to the *Yorkshire Post*, on the lake at Roundhay Park, Leeds, by an electric launch, costing about £600. It will be 53ft. long, with 8ft. beam, will be fitted with a saloon deck, and be capable of carrying 45 passengers. The order has been given to Messrs. W. S. Sargent and Co., electric and steam launch builders, Kew Bridge, Chiswick, and the vessel is to be plying for hire on the lake before the August Bank Holiday.

Meldrum Bros.—The firm of Meldrum Bros., of Manchester—whose specialities, the Meldrum furnace, the "Koker" stoker, and the Simplex destructor, have such a wide reputation—are converting their business into a limited liability company. Ordinary stock will be taken by the vendors, and £50,000 5½ per cent. preference shares are being issued to the public. The object of the issue, we understand, is to provide additional and extensive works to meet the great demand for the firm's productions.

Cefn Mawr.—At a meeting of ratepayers last week an enquiry was proffered as to whether the Parish Council had any intention of introducing the electric light. If the Parish Council would not do it immediately, it was said a private company would take the matter up. The Chairman remarked that if the ratepayers could bring forward a scheme which would satisfy the Council as a reasonable body of men, they would only be too pleased to consider it. No resolution was arrived at in reference to the question.

Babcock and Wilcox, Limited.—This Company has been registered with a capital of £630,000 in £1 shares, the object being to adopt and carry into effect an agreement expressed to be made between a company having a similar title (in liquidation) and J. H. Rosenthal and A. T. Simpson of the one part and the present Company of the other part for the acquisition by purchase or otherwise, as a going concern, of the business hitherto carried on by the said old company, and to develop and extend the same, etc.

Whitechapel.—The District Board of Works have received a letter from the Board of Trade, forwarding copies of the electric lighting provisional orders relating to Limehouse, Mile End Old Town, and St. George-in-the-East, in the form in which the Board of Trade have issued them, and intimating that it is proposed to insert in the Bill to confirm the orders a clause providing for the treatment of the three undertakings as one, with that authorised by the Whitechapel district electric lighting order, on the establishment of the new borough of Stepney.

Portsmouth.—Mr. E. A. Sandford Fawcett has held an enquiry into the application of the Corporation for sanction to borrow £9,775 for purposes of electric lighting. It was explained that the loan was wanted for laying mains and alterations. The demand for the electric light was steadily increasing, and during the past year they had added 14,000 8-c.p. lamps. This was 150 lamps less than what they had put up the previous year, but the number of applicants had been much larger. The profits were sufficient to pay the interest on the sum, and to leave a considerable balance.

Kilmarnock.—Mr. Bryson, Leith, has been appointed engineer in connection with the electric lighting scheme, and his plans and specifications are now being considered. With regard to the suitability of the proposed site at Riverbank, Riccarton, he thinks that this site would involve an increased cost of about £2,000 for copper wire as compared with a more central site, but the buildings already in existence could be very easily altered to suit the electric station, and it was a question whether they should sink the money in new buildings on another site or in copper wire on the streets.

Kingston-on-Thames.—The Town Council have authorised application to the Local Government Board for their sanction to the borrowing of £15,000 for further extensions in regard to the electric light works as under: extension of boiler-house—new shaft and requisite main flues, coal bays in yard with connecting tramway, intake pipe and well, £6,550; two boilers complete with chain grate stokers, steam, exhaust, feed, and other piping, and steam-traps, £3,750; condensing plant—economiser, two pumps, feed-water filter, tanks and connections, foundations, £4,250; contingencies, £450.

British Electric Plant Co.—This is a purely Scottish company which has been formed with a capital of £100,000 in 10,000 shares of £10 each; £75,000 (of which the directors subscribe for one-third) in 7,500 shares of £10 each are just being issued. The Company proposes to establish and carry on works in Scotland for the manufacture of electrical engineering plant of all descriptions, but principally dynamos, motors, transformers, rotary converters, and accessories connected therewith. It will also undertake an elec-

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tricity bulk supply business worked in conjunction with its own electric lighting and power plant.

Redcar.—Mr. Eldridge, electrical consulting engineer for the Tees Union Shipping Company, has advised the Urban District Council that the charge to consumers should not exceed 4½d. per unit, which would be cheaper than gas at 3s. 6d. per 1,000 cubic feet, the present price of gas at Redcar. He further recommends that in conjunction with the illumination of the town by electricity, tramways should be laid down along the Esplanade and some of the streets, so that in summer, when not much lighting was required, the power could be utilised for the tramcars, which he considered could be made very remunerative.

Appointments Vacant.—The Corporation of Brighton require a tramway engineer for their proposed undertaking.—The Water and Lighting Committee of Shrewsbury are prepared to receive applications for the post of assistant electrical engineer.—Messrs. Johnson and Phillips's Electric Cable Works, Old Charlton, Kent, require a draughtsman and a shop foreman. Particulars of the above, and other vacancies referring to improver, etc., will be found in our advertisement columns. The Corporation of Glasgow invite applications for the post of cashier and book-keeper in connection with their telephone exchange system.

Stirling.—One dozen 25 ampere meters and 600 yards service cable and three spare storage cells are to be obtained. The Council have drawn the attention of intending users of electric light to the necessity of giving early notice, in order that the staff may be able to execute the orders in rotation. They also bring under the notice of the public the arrangement entered into between the Commissioners and the National Wiring Company, whereby consumers have the privilege of introducing the light into their premises without any outlay for fittings and connections for the small extra charge on the lighting bill of 1d. per unit.

Shoreditch.—The Lighting Committee having reported at the last meeting of the Vestry that they had considered plans prepared by the surveyor, with an estimate of the cost, for erecting new buildings and adapting portions of the existing buildings at the lighting station in Coronet-street and Hoxton-square for stores and work-shops, also for an iron roof over boilers in the destructor house and louvre ventilators in the main roof, recommended that the plans and estimate, amounting to £7,500, be adopted, and that they be instructed to have quantities prepared and to obtain tenders by advertisement for carrying out the work. The report was adopted.

Beckenham.—The Urban District Council have adopted a report of the Electric Lighting Committee stating that Mr. Lenden has been appointed chairman, and Mr. Blake deputy-chairman for the ensuing year. The Council have confirmed the proposals for free wiring suggested at a meeting between the Council's officers and a representative of the British Insulated Wire Company, Limited. The Council propose to advertise for tenders on a specification to be drawn by the engineers of the Council and submitted to the British Insulated Wire Company, Limited. Wood casing will not be objected to. Proposals for several transformer stations have also been submitted.

Deptford.—At a meeting of the New Cross and Deptford Electric Light Users' Association last week it was stated that the London Electric Supply Corporation, Limited, had stated, in reply to a letter from the hon. secretary, that they were willing to give a rebate of 15 per cent. off all the accounts due at Christmas, but declined to allow anything off the accounts due at Lady Day. A resolution was passed that, in view of the fact that the inconvenience and loss sustained were even greater in the quarter ended Lady Day than in the previous quarter, the accounts be not paid unless a rebatement of 15 per cent. be allowed on the Lady Day quarter as well as on the Christmas quarter.

Southampton.—The estimate of income and expenditure for the year ending March 31, 1901, of the Electricity Committee is—income, £18 233; expenditure, £17,277. It appears that last year there was an excess of income of £1,321 over the amount estimated to be received from private lighting. There was an increase from meter rents, trams, etc., and the total excess of income over the amount estimated was £1 637. There was a deficit on the year's working of £293, owing to the rise in the price of coal, otherwise there would have been a surplus of about £400 For the current year the estimates showed an estimated surplus of income over expenditure of £956. During the period the works have been in existence £6 233 of the capital has been repaid.

Stock Exchange.—Application has been made to the Stock Exchange Committee to appoint a special settling day in and grant a quotation to Edison and Swan United Electric Light Company, Limited, provisional certificates for £100,000 5 per cent. second debenture stock. The committee has appointed May 30 a special settling day for British Electric Traction Company, Limited, further issue of £150,000 5 per cent. perpetual debenture stock, and ordered the undermentioned securities to be quoted in the official list: Blackpool and Fleetwood Tramroad Company, further issue of 3,000 shares of £10 each fully paid, Nos. 12,001 to 15 000; British Electric Traction Company, Limited, further issue of £150,000 5 per cent. perpetual debenture stock.

Aldershot.—The District Council have adopted the following recommendations: "(1) That invitations be issued to responsible firms to tender for laying down an electric light installation sufficient for the wiring of 6,000 lamps. (2) The area to be included in the scheme to embrace the following—from the electric light station along Victoria-road to High-street, also Station-road to the railway station; from the electric light station along Grosvenor-road, Union-street, Wellington-street, and High-street to Station-road; Upper Elms-road, Lansdowne-road, and Cargate-avenue. (3) That it be a condition that the Council do not bind themselves to accept any plan, and that the scheme must pass the Local Government Board. (4) That the site of the proposed works be at the Parish Clerk's Land at the rear of Laburnum-cottages.

Dalkeith.—A report is being prepared for the Burgh Commissioners on the offer made by Messrs. Crompton and Co., Limited, with regard to the electric lighting of the town, in which Messrs. Crompton and Co. propose that the company shall be bound within a given time, after the obtaining of statutory powers from the Board of Trade, to establish an electric lighting installation, fitted with the most modern appliances, and completely equipped, keeping and supplying the number of lines to be agreed upon. The maximum prices charged by the company for the supply of electrical energy in the town are to be 7d. per unit for the first hour (equivalent to gas at 4s. per 1,000 cubic feet), and 4d. per unit (equivalent to gas at 2s. 8d. per 1,000 cubic feet) for any current required beyond the first hour on the demand meter system. The price to be charged for electrical energy for power purposes and for cooking and heating is to be at 3d. per Board of Trade unit. The price to be charged for electrical energy for public lighting is to be at 3d. per Board of Trade unit (equivalent to gas at 2s. per 1,000 cubic feet). The local authorities shall have the right to acquire the undertakings after 8, 15, 22, 29, or 42 years.

Parliament.—In the House of Lords the following Bills were read a third time during last week and passed: Glasgow and South-Western Railway, Rawmarsh Urban District Council (Tramways), Stockport Corporation Tramways, Aston Manor Tramways. The following Bills were read a second time: Lee Conservancy, Hamilton, Motherwell, and Wishaw Tramways. In the House of Commons the following Bills were read a third time: Baker-street and Waterloo Railway, City of London (Various Powers), and Liverpool Corporation. The following Bills were considered and ordered for third reading: South-Eastern Metropolitan Tramways and Bray Urban District Council. The London United Tramways Bill, as amended, was further considered, and an amending clause was inserted at the instance of Mr. Lough, providing for and regulating the maintenance of a cheap morning and evening tram service for artisans, mechanics, and daily labourers Petitions against the Bradford Corporation Bill have been deposited in the Private Bill Office of the House of Lords on behalf of the Cleckheaton Urban District Council and the West Riding County Council. A Select Committee of the House of Commons, presided over by Mr. A. H. Brown, last week considered the Bill promoted by the City of London Electric Lighting Company to empower the company to apply to the purposes of their undertaking various reserve funds, and to take lands in Southwark for the erection and extension of a generating station. The measure was opposed by the Corporation. The committee found the preamble of the Bill proved, but limited the application of the reserve funds in question to capital purposes, not allowing them to be applied to dividend. The committee refused a clause proposed on behalf of the Corporation restricting the company's charges to those authorised in the case of the Charing Cross Company; but inserted a proviso giving purchasing powers to the Corporation in respect of mains, etc., outside its jurisdiction, but necessary to the supply of electric light in the City of London. The Bill of the Huddersfield Corporation, proposing to carry out an extensive system of tramways outside the borough, which has been recommitted for the committee to consider the expediency of reinserting those portions of the scheme which the committee had previously struck out, has passed Mr. Jeffreys's Select Committee on the ground of public health, as it would relieve congested areas. The Cork Electric Tramways Bill has been sent by the Examiner for a second reading in the Lower Chamber. A requisition on behalf of the Tyne Improvement Commissioners for leave to withdraw their opposition to the Newcastle-on-Tyne Electric Supply Bill has been deposited in the Private Bill Office of the House of Commons. The Glasgow District Tramways Bill was on Tuesday discussed in committee. The Chairman, after the committee had deliberated in private, intimated that they had decided that tramway No. 7 must come out of the Bill. As regards the other tramways, they must postpone their decision until they heard what the agreements were between the parties. It was impossible for them to give a final decision until they had these agreements before them in their ultimate form. The Rawmarsh Urban District Council Tramways Bill has been ordered to be reported to the House of Commons for second reading. Colonel Cotton-Jodrell's committee on Thursday last week considered the clauses of the Bill of the South-Eastern Metropolitan Tramways Company, of which they passed the preamble on the previous day. The Bill empowers the company to substitute electric traction for horse traction on their line running from Greenwich to Catford, the system used to be either the surface-contact or the conduit. The Lewisham District Board asked the committee to restrict the company to the use of the conduit system, and the London County Council sought to insert a clause by which the company should be obliged to obtain the Council's consent before adopting any particular system. The committee decided not to restrict the tramway company, as asked by the Lewisham Board, to the conduit system, and also rejected the proposals of the London County Council. The Halifax Tramway Extensions Bill has been approved by the Parlimentary Committee.

London County Council.—At Tuesday's meeting the Council decided to serve notice on the South London Tramways Company and the London, Deptford, and Greenwich Tramways Company for the purchase of 2¼ miles and 4¾ miles of the respective undertakings. The Highways Committee's reported that the Council was now, under powers conferred by recent Acts of Parliament, carry-

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ing on widenings of York-road, Battersea Park-road, and Wandsworth-road, in which there were single lines of tramways which would shortly become purchasable by the Council under the Tramways Act, 1870. Having regard to the fact that the existing single lines in these thoroughfares would so soon become purchasable, it was desirable that the Council should obtain power to reconstruct them as double lines. The cost of the paving works was in each case included in the estimate for the street widening, so that provision would have to be made only for the reconstruction of the tramways. The length of the York-road section was 7 furlongs 110 yards; that in Battersea Park-road, 198 yards; and Wandsworth-road, 1 furlong 13 yards. The estimated cost of reconstructing them for an underground system of electrical traction was—in the case of Battersea Park-road, £3,200; York-road, £28,000; and Wandsworth-road, £4,000. The Highways Committee, having had the matter of the light railways under consideration, reported having come to the conclusion that the decision of the Light Railway Commissioners regarding the Wandsworth and Kingston-road light railway order should not be appealed against, especially in view of the fact that the Council's Improvements Bill as amended did not contain powers for the Council to carry out the necessary street widenings, and they recommended the Council to that effect. The same committee also submitted a report referring to the probability of the London County Tramways (Electrical Power) Bill (which is to authorise the Council to reconstruct for electrical traction any tramways within the county of London which have been or shall be acquired by the Council) becoming law this session In view of this contingency they had in preparation the specification and form of contract for the supply of the rails, fishplates, etc., which will be required in connection with the reconstruction of the tramways between Westminster Bridge and Tooting, and those between Blackfriars Bridge-road and the Kennington terminus of the cable tramways. Upon the advice of Dr. Kennedy, and also of Sir David Dale, and with the approval of the General Purposes Committee, they recommended that as regards contracts for the supply of the rails, fishplates, etc., required in connection with the reconstruction by the Council of existing, and the construction of new, tramways, the operation of the Council's standing order No. 212 be suspended so far as to permit of the omission of the usual clauses relative to hours and wages, and the insertion of a special clause as follows: "All wages to workmen for work executed under this contract must be paid at the rates arranged between the employers and workmen in the rail trade in that part of the country where the order is placed. The Council reserves power to cancel this contract so far as relates to any part of the articles specified therein not totally or partially manufactured at any time on one week's notice, should it be proved to the satisfaction of the Council, after hearing both parties, that lower rates than the standard rates of the district have been, or are being, paid in the execution of this contract." Sanction was also given to works referred in a notice given by the City of London Electric Lighting Company of intention to lay mains across and along Sumner-street, along Park-street (crossing Southwark Bridge-road), and along portions of Bankside and Bankend. The sanction is subject to various conditions—*i.e.*, it is not to apply to any works, pipes, or wires other than such as are the property of the company, and to be used exclusively for its purposes under the Southwark Electric Lighting Order, 1891.

Birmingham Electric Supply.—The Electric Supply Committee of the City Council have reported that the formal completion of the purchase of the electric supply undertaking was effected on Jan. 1. Immediately on their appointment in November last, the committee applied themselves to obtaining as full a knowledge as possible of the undertaking. Accompanied by the engineer, they made a careful inspection of the works. The districts at present lighted may be divided into three distinct areas—viz., the central part of the city (which was the original area under the provisional order of 1889), the area of Edgbaston, and the Jewellers' quarter, these two districts having been added to the area of supply under the provisional order of 1894. A large proportion of the streets in these districts are now provided with mains, and there are in all 36 miles of distributing mains from which the supply is available. The station in the central area is situated on a freehold site in Dale End, where are also the administrative offices. This station is equipped with 12 steam dynamos and 10 boilers. The station in the Jewellers' quarter is situated in Water-street, on a freehold site with canal frontage. There are at present at work there seven steam dynamos and seven boilers. This station is being extended, and there are four further boilers and two steam dynamos on order. There is a connection between this station and Dale End, and the plant is so arranged as to supplement the supply in the central area when required. The Edgbaston district is supplied by transforming a high-tension current taken direct from Water-street or Dale End to a depôt in Parker-street, Monument-road. A small portion of the property here is freehold, and the remainder is held on a long lease on favourable terms. At this station there is a large battery of accumulators which are charged during the day hours, with a view of assisting the supply during the evening demand, and carrying on the lighting when the output is small. The works are equal to the present demand, with a fair margin for extension; but it is clear that if any important developments are to be made outside the area at present supplied, the works will have to be very largely extended. This subject will shortly engage the consideration of the committee. The financial year of the company ended on Dec. 31 last, and the auditors' statements for that year showed a gross profit of £23,489. 10s. 9d., an increase of £5,962. 11s. 1d. over the gross profit for 1898. If the undertaking had been in the hands of the Corporation, the profit would have been sufficient to pay the interest and sinking fund on the loan of £500,000, and to leave a margin of profit of about £3,000. The company had set aside annually a certain sum to form a reserve fund. The committee, after careful consideration, have decided to continue this fund. The amount to its credit on Jan. 1 last was £25,856. 8s. The general reserve and balance of profit and loss account of the late company have been credited to the capital account. During the year 1899 the total units sold amounted to 2,252,692, against 1,722,327 units sold in the previous year, being an increase of 30·8 per cent. The lamp and motor additions on the various circuits, reduced to a 16 c.p. factor, amounted to 12,694, bringing the total number of lamps to the end of the year to 62,705, against 50,011 in 1898, being an increase of 25·3 per cent. The gross revenue during 1899 amounted to £43,245. 18s. 9d., against a gross revenue of £33,462. 18s. 11d. in 1898, being an increase of 29·2 per cent. The committee decided, as the financial year of the Corporation ends on March 31, that the accounts should be made up to that date, so that, as with other departments, a clear 12 months could be commenced from April 1. The audited statements for the three months are now submitted. They show a balance, after providing for interest accrued on the £500,000 loan, of £2,707. 4s. The three months in question form one of the two best quarters of the year. This being so, and seeing also that some of the charges incurred during the quarter are exceptional, the figures must not be taken as any basis of calculation as to the future. The committee have decided to apply the balance of £2,707. 4s. towards meeting the cost, estimated at £6,200, of relaying certain of the older mains in the centre of the city. In common with similar undertakings in all parts of the country, the committee have experienced some difficulty in connection with the supply of fuel for the department, and have found it necessary, in order to secure a supply for the current 12 months, to pay a considerably higher price than last year. There has been a general increase in the demand for current throughout the districts covered by the department's system, in many instances the increase being due to the enlargement of existing installations. The supply has been steady, and appears generally to be efficient. The department have undertaken considerable extensions of works at the Water-street station, which will enable them to cope with the increased demand during the ensuing winter. The report was adopted without discussion by the City Council on Tuesday.—*Birmingham Daily Post.*

PROVISIONAL PATENTS, 1900.

MAY 14.

8866. **Improvements in electric signalling apparatus.** Philip Arthur Newton, 6, Bream's-buildings, Chancery-lane, London. (Henry Guy Carleton, United States.) (Complete specification.)

8880. **Improvements relating to means for recording the number and duration of telephonic communications.** Heinrich Eichwede, 18, Buckingham-street, Strand, London. (Complete specification.)

8894. **Improvements in electric smelting furnaces.** Hugo Koller, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 15.

8901. **A method of applying auxiliary electric drive to gas and other motors as used on cycles and motor vehicles.** Marcus James Astle and Charles Henry Guest, Ockbrook, Derbyshire.

8945. **Improvements in or relating to electric motors, particularly applicable for propelling boats.** Alfred Julius Boult, 111, Hatton-garden, London. (Tracy Barbour Hatch, United States.) (Complete specification.)

8968. **Improved means for protecting electric conductors.** Mervyn Joseph Puis O'Gorman, 24, Southampton-buildings, Chancery-lane, London.

MAY 16.

9033. **Improvements in strap coils for electrical machines.** John Purington Mallett, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 17, 1899, being date of application in United States.)

9058. **Improvements in electric brakes.** Frank Clarence Newell, 322, High Holborn, London.

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9060. **Improvements in electromagnetic brake shoe.** Frank Clarence Newell, 322, High Holborn, London.

9061. **Improvements in automatic regulator for electric brake.** Frank Clarence Newell, 322, High Holborn, London.

9084. **Improvements in electric arc lamps.** Alfred George Stockwell, 47, Lincoln's-inn-fields, London.

MAY 17.

9133. **An improved process for manufacturing thin homogeneous plates, more particularly applicable for use in electrical condensers.** Luigi Lombardi, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 30, 1899, being date of application in Italy.) (Complete specification.)

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9110. Improvements in contact pieces for transmitting the current from the fixed base to the revolving or swinging top of electric searchlight projector. Matthew Paul, 121, West George-street, Glasgow. (James Paul, India.) (Complete specification.)

9140. Improvements in or relating to telephone systems and installations. H. Degenhardt, 111, Hatton-garden, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on June 9.

1899.

10199. Joint-boxes for electrical installations and connections therefor. Wilkinson.

10153. Method of controlling mechanisms by means of Hertzian waves. Wilson, Evans, and Godsal.

10863. Switches for alternating electric currents. Hopkinson.

12781. Electrical switches particularly suitable for high-voltage connections. Holt and Atherley.

13257. Underground conduits for electric tramways. Smith.

14632. Collectors for electrically-propelled vehicles. Choné.

14704. Electrodes for electric arc lamps. Bremer.

14997. Switches for electric circuits. Wright and Aalborg. (Date applied for under International Convention, Jan. 30, 1899.)

14998. Fuse blocks for electric circuits. Davis. (Date applied for under International Convention, March 23, 1899.)

15002. Electric arc lamps. Barton and Jandus Arc Lamp and Electric Company, Limited.

15066. Systems of electrical distribution. Lamme. (Date applied for under International Convention, Jan. 30, 1899.)

16210. Manufacture of thin tubes or sheets of copper or other metal by electro-deposition. Cowper-Coles.

16215. Electrolytic baths. Walker, Wilkins, Lones, and Lones.

16980. Rheostats and means for operating the same. De Kandó.

24956. Rotary field measuring apparatus for uniformly loaded rotary phase-current systems. Siemens Bros. and Co., Limited. (Siemens und Halske, Actien-Gesellschaft.)

1900.

837. Incandescence electric lamps. Lake. (Shearman.)

840. Incandescence electric lamps. Lake. (Shearman.)

3050. Electric meters. Feeny. (Allgemeine Elektricitäts-Gesellschaft.)

4303. Electric incandescent lamps. Feesenden. (Date applied for under International Convention, Aug. 7, 1899.)

4369. Couplings for electrical connections. Rawlings and Rawlings.

4607. Electrical gas lighters. Von Arnswaldt.

5032. Electrical cut-out devices specially adapted for preventing excessive flow of electric current. Malignani.

5216. Manufacture of filaments for electric incandescent lamps. Boult. (Blondel.)

5394. Method of insulating electrical conductors. Zappert. (Schaefer.)

5443. Magnetic work holders for metal-working machines. Walker.

5866. Regulation of dynamo-electric machines. The British Thomson-Houston Company, Limited. (Steinmetz.)

6028. Brush-holders for dynamo-electric machines. Mix.

6335. Methods of and apparatus for electrically separating the relatively volatile liquid component from the component of relatively fixed substances of composite fluids. Cooley.

7098. Multipolar electric machines. Short.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Birmingham Tramways Co.	May 19	4,610	4,184	+ 426	82,170	77,756
Blackburn Corp'rat'n	—	—	—	—	—	—
Blackpool Corporatn.	,, 17	270	221	+ 49	2,462	1,945
Blackpool-Fleetwood	,, 19	526	324	+ 202	5,110	5,047
Bradford City Trame	,, 20	453	335	+ 118	3,143*a*	2,399
Bristol Tramways Co.	,, 19	2,763	2 863	- 100	—	—
City & South London	,, 20	1,339	1,079	+ 260	24,963	21.321
Dover Tramways	,, 19	173	160	+ 13	3,194	3,046
Dublin U.T., elec. cars	,, 18	3,247	1,064	+2,183	—	—
Dublin S.D. Electric	,, 18	759	744	+ 15	—	—
Halifax Corporation	,, 13	634	431	+ 203	3,931	2,657
Hull Corporat'n E.S.	,, 12	1,150	—	—	6,408*a*	—
Liverpool Corporat'n	,, 12*b*	7,106	6,613	+ 493	131,467	114 889
Liverpool Overhead	,, 20	1,476	1,395	+ 81	28,228	27,023
Sheffield Corporation	,, 20	2,204	—	—	—	—
South Staffordshire	,, 18	650	596	+ 54	12 928	12,316

a Since April 1. *b* Partly electrical.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 6½
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	¾-1
—— 6 per cent. Cum. Pref., 1-50,000	1	..	15/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	—	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼ xd
Brush Electrical Engineering, Ordinary	2	—	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	—	108-113
—— 5½ per cent. 2nd Debenture Stock	100	—	103-106
Callender's Cable, Debentures	100	—	113-116
—— Ordinary	5	—	14½-15½
—— 5 per cent. Pref.	5	—	5¾-6
Crompton and Co.	3	..	3¾ 4
—— 5 per cent. Debentures	—	—	100-103
Edison and Swan United, Ordinary	3	—	2-2¼
—— 5 per cent. Debentures	5	..	2¼-2½
—— 4 per cent. Deb. Stock, Red.	100	—	98-95
Electric Construction	2	—	2-2¼
—— 7 per cent. Cumulative Pref.	2	—	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	103-106
W. T. Henley's Telegraph Works, Ordinary	5	—	12½-14½
—— 6½ per cent. Preference	5	..	5¾-5¾
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	..	100-103
Telegraph Construction and Maintenance	12	—	34-38
—— 5 per cent. Bonds	100	—	102-105
Telegraph Manufacturing, Ordinary	5	—	11½-12½
—— 5 per cent. Cum. Pref.	5	—	5¾-6
Willans and Robinson, Ordinary, 1-30,000	5	..	11½-12½
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	7-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106 xd
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-⅞
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	7-7½
Charing Cross and Strand	5	..	8½-9½
—— 4½ per cent. Cum. Pref.	5	—	5¾-6
Chelsea Electricity Supply	5	—	6¾-7½
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	..	10-11
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9½-10½
—— 6 per cent. Cum. Pref.	10	—	12-13
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	109-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4¾-5
—— 4½ per cent. First Mort. Deb.	100	..	100-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	3	..	1¾-2
—— 6 per cent. Pref.	5	..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-103
Metropolitan, Ordinary	10	..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1-1⅛ xd
—— £5 Shares	5	..	7-7¼ xd
—— £4½ Shares, New	4½	..	6⅞-6⅞ xd
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	..	6¾-7
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	$ 00	..	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$ 00	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	8½-9½
Westminster, Ordinary	5	..	14½ 15½
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-Shares	5	..	4¾-5¼
—— ,, ,, deferred	5	..	5-5¼
City and South London, Consolidated Ordinary	100	..	61-64
—— Ordinary	10	—	5½-6½
—— 4 per cent. Debenture Stock	100	—	123 128 xd
—— 5 per cent. Pref. Stock '91	100	—	140-145
—— ,, ,, '96	100	—	182-187
Liverpool Overhead, 5 per cent. Pref.	—	—	12½-12¾
Waterloo and City, Ordinary	100	..	100-103
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17½-18½
Brisbane Tramway	100	..	103-104
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10½-10¾
British Electric Traction, Ordinary, 1-30,000	10	..	15½-16½
—— 60,001-75,000	10	..	15½-16½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	—	12¾-13
—— 5 per cent. Perpetual Debenture Stock	100	..	124-127
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	104-107
Isle of Man Electric Power, 1-95,000	1	..	½-5/16
—— 6 per cent. Preference, 100,001-170,000	1	..	⅜-7/16
Kidderminster and District Lighting and Traction, Pref.	10	..	9½-10
New General Traction, Ordinary	5	—	3¾-4
—— 6 per cent. Cum. Pref.	5	..	4¾-5¼ xd
North Staffordshire Trams	6	..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— Preference	10	..	10¾-11¾
Potteries Electric Traction, Ordinary, 28,667-40,000	10	—	11¾-12¾
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10½
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	⅛-¼
National Telephone, Ordinary	5	..	4¾-5¼
—— 6 per cent. Cum. First Pref.	10	—	13-15
—— 6 per cent. Cum. Second Pref.	10	—	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	—	96 99
Oriental Telephone and Electric Company	1	—	15/16-1 1/16

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NOTES.

Photographic Exhibition.—During the month of June there is to be held at 66, Russell-square, W.C., an exhibition of photographs taken by Dr. P. H. Emerson. These should prove very interesting, and should well repay a visit to these rooms.

French Automobiles.—We gather that official assurance has now been given to the Automobile Club of France that the first international challenge contest for the motor-car cup presented by Mr. Gordon Bennett will be allowed to be run this year, as arranged before the interference of certain local authorities seemed likely to prevent the race.

London Telephones.—With respect to the proposed London County Council telephone service, we notice that at the last meeting of the Council, in view of the Government's decision to establish a telephone service in London, Mr. Benn obtained leave to withdraw the proposals of the Highways Committee in regard to a municipal telephone service.

Physical Society.—At the meeting to be held next Friday (June 8), at 5 p.m., papers will be given "On the Magnetic Properties of Iron and Aluminium Alloys, Part II.," by Dr. S. W. Richardson; a "Note on Crystallisation Produced in Solid Metal by Pressure," by Mr. W. Campbell; and "On the Viscosity of Mixtures of Liquids and of Solutions," by Dr. C. H. Lees.

The Rontgen Society.—The next ordinary general meeting of the Rontgen Society is to be held at St. Bartholomew's Hospital on June 7 next. At this meeting Dr. Lewis Jones, by whose invitation the meeting is held at the hospital, will show an influence machine of American design; Mr. James Wimshurst, F.R.S., will give a short statement of his work in the design and the perfecting of the several forms of his influence machine; and Dr. Rémy, of Paris, will show a new localising apparatus.

Association Amicale des Ingenieurs Electriciens.—In connection with the above society a number of meetings have been arranged for the Paris Exhibition, which meetings will be held towards the end of each month. These meetings will take the place of a regular congress. In connection with the same the monthly *déjeuner* has been organised, the first of which took place on May 29. These lunches will be held in the Brasserie Bachelier, situated near the Palais d'Electricité.

Society of Model Engineers.—A branch of the Society of Model Engineers has, we are informed, now been successfully formed in Liverpool, and all persons who wish to become members should communicate with the hon. secretary, Mr. F. T. Stewart, 14, Adelaide-road, Kensington, Liverpool, from whom full particulars may be obtained. The next meeting of this branch of the society is to be held at the Balfour Institute, Liverpool, on June 12, at 7.45 p.m., when a number of models will be exhibited.

Newcastle Tramways. — The conversion of the Newcastle tramways is proceeding at a good rate, and we notice that at a meeting of the New Tramways Committee of the Corporation held on Friday last it was decided that Jesmond-road and Osborne-road should be opened at once for the laying down of the new electric lines. Tenders were also received for the erection of new car sheds, but the consideration of this matter was allowed to stand over until the next meeting of the committee.

North-East Coast Institution of Engineers and Shipbuilders.—We have received a list of the newly-appointed officers of this institution. The session 1900 to 1901 will be the seventh, and the president for this period is Mr. Henry Whitby, J.P., of West Hartlepool. There is a long list of councillors, and amongst them are several notable names. The secretary of the institution is Mr. J. Duckett, of Newcastle-on-Tyne. The chairman of the graduate section for the coming session is Mr. W. J. A. London.

The Electro-Harmonic.—The annual meeting of this society was held on Tuesday last. We learn that during the past season 36 new members were admitted and 25 resigned. The roll of the society at present includes 278 names, while 20 proposals for membership for next season have been received. The concerts of the society have been arranged to be held at St. James's Hall Restaurant during next season. There was also a suggestion to change the evenings for the meetings from Friday to Wednesday brought forward.

Institution of Electrical Engineers.—The list of the committee of the Irish (Dublin) section of the Institution will during the year 1900-1 remain the same as when the section was first formed, this happening so lately as to render a re-election superfluous. The names of the committee will, therefore, be Prof. G. F. Fitzgerald, F.R.S. (chairman), Colonel C. F. C. Beresford (vice-chairman), Prof. W. F. Barrett, F.R.S., Messrs. C. A. Burge, C. P. C. Cummins, F. Gill, R. Humphries, M. C. Olsson, G. F. Pilditch, A. E. Porte, M. Ruddle, and P. S. Sheardown.

Heat Insulators.—A method of testing the comparative efficiency of heat insulators was recently described in the *Proceedings* of the Royal Society, the authors being Messrs. C. J. Lamb and W. G. Wilson, and the following results were given: air (no baffle plates), 0·000200 conductivity; pine sawdust, 0 000242; pine shaving, 0·000162; brown paper (crumpled up), 0 000167; hair felt (broken up), 0·000145; hair felt in two sheets, ½in. thick each, 0·000106; dry asbestos, 0 000297; charcoal, 0 000150; sand, 0 000740; rice husks, 0·000150; kapok (a heat insulator), 0·000144; kapok (loose), 0·000122; and silicate cotton, 0 000151.

Indian Water Power.—Our contemporary, *Indian Engineering*, commenting on the electric lighting of Simla, says that with water power as near and as extensive as is to be found about Simla, the advent of electricity, at a price to oust kerosene oil, is only a matter of time. Nothing will be finally settled in this last connection until the report of Mr. Meares, electrical expert, who has been called in by the Municipality, is submitted. It will be remembered that the electric light installation is due to Mr. Meares, who erected the turbines and carried out the details at the power-generating station, which form the most successful feature of the scheme.

A New Arc Lamp.—The *Elektrotechnische Rundschau* calls attention to a form of arc lamp recently patented, in which it is sought to avoid the disadvantage, common to all arc lamps hitherto used, of having to periodically renew the carbons. It seems that the new lamp consists of a vacuum bulb, in the interior of which, in place of the customary carbon-rods regulated in their feed by means of complicated mechanism, are two L-shaped aluminium arms pointed with platinum. These arms are regulated by a simple pendulum arrangement. The lamp casts no shadow, and there is said to be practically no wear of the incandesced portions. The inventor proposes to employ the lamp in a horizontal position.

Municipal Steamboats. — With respect to the stoppage this season of the river pleasure steamers plying up river from London, a suggestion is being put forward by the Rivers Committee of the London County Council that the Council should take over the steamers and piers

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and establish an efficient steamboat service. There is, amongst other suggestions on the matter in the daily Press, one which is said to find favour in the eyes of certain of the members of the London County Council. This is a scheme for electric launches to carry about 100 passengers each, and to have twin screws instead of paddles for a means of propulsion. The matter will, however, be given due consideration by the Council.

Cattle-Feeding by Electricity.—The effects of the war are very far reaching, and every day we hear of some or other form of labour being affected by it. Thus in the *Daily Mail* there recently appeared a statement to the effect that the war having taken away so many farm hands, much difficulty is experienced in feeding cattle. Consequently they are to be fed by electricity, and at several of the leading agricultural shows this season an electrical feeder is to be shown, which, by means of an alarum clock, will supply animals with food at any hour required. The services of an attendant are entirely dispensed with. This would appear to be a very convenient arrangement, but by the time the apparatus has been manufactured the farm hands will probably have returned to the farms and have resumed their duties with regard to cattle-feeding.

A Cylindrical Slide Rule.—Prof. Robert H. Smith has devised a cylindrical slide rule which is not too cumbersome to be portable. The length of the rule is 9½in. and its diameter only ⅞in. By means of a spiral on the cylinder a length of over 4ft. is obtained for the logarithmic scale, which enables considerably more accuracy to be obtained than is the case with the ordinary Gravet rule. There are four indicators on the outer cylinder, which is so designed that any part of the scale can be readily seen. We understand that these instruments are being made by Messrs. A. and J. Smith, of Aberdeen, and that they can be highly recommended where accuracy of working and a portable slide rule are required. Of course, in some respects they are not so handy as the Gravet for engineering calculations where extreme accuracy is rendered necessary in consequence of the high safety factors adopted, but they are very valuable in other ways.

The Institution Visit to Paris.—The secretary of the Institution of Electrical Engineers has now issued a circular respecting the extraordinary general meeting in Paris, which will commence on Thursday, Aug. 16. This allows two clear days before the opening of the international congress. The joint meeting between our Institution and the American Institute of Electrical Engineers has been arranged for this date. It is hoped that ladies will take part in the visit, and add as much to the enjoyment of the meeting as they did to the meeting in Switzerland last year. Arrangements have been made with Messrs. T. Cook and Son for the journey, and also for the hotel accommodation. The advisability of having rooms reserved from an early date is pointed out in the circular. Those members who wish to attend the international electrical congress will have to pay 20 francs to the French committee, and this subscription can be forwarded through Mr. McMillan.

Paris Congresses.—The fourth Congress of Applied Chemistry, which is to be held in Paris from July 23 to 28, will include 10 sections, of which the tenth—to be devoted to electro-chemistry—will be of great interest to electricians in general. The Organisation Committee consists of the president (Mr. H. Moissan) and five members. The provisional programme of this section of the congress deals with voltaic piles, dynamos, and accumulators; materials and general processes of electroplating; production and employment of ozone; the production of chlorine and soda; chlorates of potassium and sodium; perchlorates, dioxides, and disulphates; the electrolytic production of metals, such as copper, nickel, chromium, lead, etc.; aluminium and its alloys; the use of aluminium and its employment as a conductor; electric furnaces; metallic carbides; calcium carbide and its preparation; the production of acetylene; bleaching; the disinfection of sewer water and the treatment of sugar syrup.

Marine Engineers' Certificates.—A deputation of marine engineers and members of Parliament representing various seaport towns on Friday last proposed to the President of the Board of Trade new regulations for applicants for marine engineers' certificates, including the extension of the time of apprenticeship, and the refusal of sea service as an equivalent of workshop service. Mr. W. Allan, M.P., expressed the opinion that five years' apprenticeship in the workshop was necessary. Mr. Ritchie, in answer to the deputation, said he recognised that there was a general feeling among many of the big firms that three years' apprenticeship—the period laid down by the Board of Trade regulations—was not enough; but there was a large body of shipowners who strongly objected to an extension. He suggested that an intermediate course should be taken—namely, that four years should be fixed as the period of apprenticeship, with a view to seeing how the alteration worked. He thought this would go a long way towards meeting the desire of the deputation.

The Patent Law.—We are pleased to note that the Board of Trade have appointed a committee to enquire into the working of the Patent Acts, and have to congratulate the Board on the selection they have made of the members of this committee. These members are as follows: The Right Hon. Sir Edward Fry (chairman), the Right Hon. Sir Richard Webster, Bart., G.C.M.G. (Master of the Rolls), the Right Hon. Sir Edward Carson, Q.C., M.P. (Solicitor-General), Sir Wm. H. Houldsworth, Bart., M.P., Mr. F. J. S. Hopwood, C.B., C.M.G., Mr. S. E. Spring Rice, C.B., Mr. J. Fletcher Moulton, Q.C., M.P., Colonel Thomas W. Harding, Mr. Edward Carpmael, and Mr. Herbert Hughes. Mr. A. Paget, barrister-at-law, is to be secretary to the committee. With so many experts in patent matters on the committee some conclusions to a practical nature should be arrived at which will, if adopted, render our Patent Office more useful than it is at present. We trust, however, that no attempt will be made to introduce the American and German system of enquiry into the validity of a patent before it is granted. The malpractices which have followed this system in the United States are quite sufficient to condemn it.

Speed of Electric Waves.—The following is an abstract of a paper read by Mr. C. Gutton before the Société International Electrique. The abstract, which appears in *Science Abstracts* for May, reads as follows: "A linear Hertz oscillator is placed in the focal line of a parabolic mirror facing a similar mirror provided with a resonator. From the latter two parallel wires proceed to a Branly coherer, which is also connected to the oscillator by another pair of wires; the latter are longer than the first pair, and their length can be varied. The distance between the focal lines of the mirror is 5·4m. The wires from the oscillator are crossed, and their length is adjusted so that no effect is produced on the Branly tube. The mirrors are now brought 4m. nearer each other, and the velocities in air and along the wire are compared by finding what length has to be added to the pair of wires proceeding from the resonator to the tube in order to compensate for the shortening of the distance traversed in air. It is found that no effect is produced on the Branly tube when the increase of length is 4m. Thus the velocities in air

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and along wires are equal. The method can be used for comparing the velocity in air with that in a given dielectric by introducing a plate of the latter between the mirrors."

Optician's Electromagnet. — We notice in the *Electrical World* an illustration of an electromagnet to be used for removing particles of iron from the eye, which is manufactured by a Mr. E. B. Meyrowitz, of New York. The apparatus is a most substantial one, as the magnet and stand weigh no less than 600lb. The electromagnet consists of a bar with conical ends, the middle of the bar being wound with magnetising coils. It is stated that experiments on the tractive force of the magnet have shown that with a piece of wood ½in. thick interposed, a weight of 11½oz. will be supported; with ⅝in. of wood, a weight of 6oz., and a weight of 3½oz. through ⅜in. of wood. Unfortunately, all these experiments were evidently made with a substantial piece of iron to be attracted, but we can quite believe that sufficient tractive force would be obtained on an iron filing to cause it to disengage itself from the skin of the eye. The electromagnet is mounted on one end of a balance lever, so arranged that it can be readily brought to any spot near the stand.

Geneva Tramways.—The arrangement entered into between the Geneva municipal authority and the local tramway company is of interest, in view of the fact that the energy for driving the trams is to be supplied by the municipal authority. Under the agreement, the energy will be supplied to the tramway company at a cost of 1·2d. per kilowatt per hour. This price will hold good until 1,800,000 units have been taken per year. After that consumption the price is to be reduced to ·9d. The town of Geneva is not obliged to supply more than the kilowatt-hours mentioned above, but in the event of it refusing to do so, the tramway company will have the right to erect its own generating station. The authorities also reserve the right of connecting other consumers on to the network of the tramway company, and in that case an electricity meter at the point of connection will be used to determine how much energy has been diverted from the tramway system. This energy will, of course, be deducted from the total quantity supplied to the tramway company when making out accounts. This last clause seems to us to be open to objections, as by it the municipal authority can overload the tramway company's mains to such an extent as to cause damage or to interfere with the working of the tramways.

Manchester Telephones.—We notice that Alderman J. W. Southern has resigned the chairmanship of the Telephone Committee of the Manchester Corporation, on the ground that he did not agree with the action the Corporation was taking with respect to the telephone service of the district. In a letter to the Lord Mayor, sending in his resignation, Mr. Alderman Southern states that in his opinion the telephone service should be in the hands of the municipal authority, while the interurban communication should be given by the Post Office. He adds that it had been decided by the committee to purchase, if possible, on reasonable terms the Manchester exchange of the National Telephone Company, and also recompense the Mutual Telephone Company for any injustice done to them. He considers that the proposed steps will entirely deprive the ratepayers of the advantages of competition, and also will tend to prevent them having a cheaper and more efficient telephone service than at present. Mr. Southern is also chairman of a committee which was appointed in London recently by the Municipal Associations' Corporation to report on the practicability of municipal telephones. He thus testifies in a practical way his deprecation of any business relations between municipalities and the present company.

St. Marylebone Electric Lighting.—The lighting of the parish of St. Marylebone has for some time past been a subject for considerable agitation in that part of London. We now notice that Mr. J. Fletcher Little has written to the local Press stating that the statement of the President of the Board of Trade to the deputation on Jan. 17, that consumers had a right of action against the company for breaches of contract to supply electricity, was not supported by the legal advisers of the Department. On this ground he forwarded him the opinion of Mr. Mattinson, Q.C., showing that he was wrong; in reply to which the Board stated that whilst Mr. Mattinson's opinion did not dispose of the matter, there was no doubt room for difference of opinion. The Board also declined "to introduce legislation into the matter." The result was that whilst the Board of Trade was introducing legislation to confirm the provisional order granted to a second company in Marylebone against the wishes of the Vestry, it declined to introduce legislation to clear up the difficulty lying in the way of the consumer recovering damages from either company on its breaking its contract to supply electricity. This Mr. Fletcher Little thinks is singular conduct, whether viewed as affecting the consumer's rights when he suffered from failure of supply, or the desirableness of having the law clear.

High-Speed Traction.—Mr. J. Wetmore in an article appearing in *Electricity* of New York refers to the contract recently made for the equipment of an electrical railway between Detroit and Toledo, over which a speed of 60 miles per hour is to be maintained, according to the schedule. He proceeds to refer to difficulties which he predicts will be found in connection with such high speeds by electric traction. We think that a number of his points will not be found to hold in practice, but in other cases he certainly does give valuable hints as to the most likely solution of certain difficulties. Amongst these is the question of maintaining a good connection between the train and the fixed conductor. For high speeds obviously the third rail is preferable in this respect, as the overhead wire cannot be kept absolutely taut. When the third rail is laid for carrying the current, it will be well to fix the collecting shoe on to the trucks themselves, and not on to the car bodies. The spring on the collector itself will then only have to give the required flexibility to cope with small irregularities of the third rail. Mr. Wetmore also refers to the advisability of having rolling contacts to collect the current, and the desirability of this having a flat contact, which would give more advantages than the wheel now in use, giving only a point contact. He himself devised some such arrangement some years ago, which, however, at the time failed to meet commercial requirements.

A Substitute for Rubber.—In the *Scientific American* for May 19 we find a description of a new substitute for rubber. It is stated that an Italian resident in Mexico made experiments with a shrub known as "Yule," which grows abundantly in that country. Within the bark of this plant a large amount of gummy matter is found, and on finely dividing the wood and macerating it with a hydro-carbon solvent, such as naphtha, oil of turpentine, etc., the gum is softened and extracted from the wood, and, still holding a portion of the hydro-carbon, remains a sticky mass which fulfils all the conditions of crude rubber. It can be vulcanised, and needs no freeing from mechanical impurities. The shrub yields 40 per cent. of its own weight in gum, and may be treated whether in a green or dry state, great economy in time and labour being obtained thereby. In preparing the composition for the market, the

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plants are pounded with hammers and then placed in a hermetically sealed reservoir with the solvent, and kept thus for about 12 hours. When thoroughly soaked it is taken from the receiver, and the pulp produced placed in canvas bags, which are placed in an hydraulic press. The gum which comes out falls into tubes, and is conducted to large receivers containing reels to beat and stir the gum and to dry out part of the solvent. The advantages claimed for this new composition over rubber are: (1) a saving in the cost of reproducing the plant; (2) saving in the cost of exportation; (3) saving in material used in the purifying establishments; (4) saving in fuel; (5) in machinery; (6) saving in time.

South Metropolitan Gas Company.—The Bill of the above company has passed the committee, and has introduced several new features into the system of gas supply in the country. The first object of the promoters was to give effect to the recommendations of the committee which sat last year to consider the question of gas supply generally. The next object was to give the public the advantage of cheaper gas by freeing the company from the financial and other burdens of the artificial enrichment necessary in the gas. The first two objects of the Bill have been secured *in toto*. The rest of the Bill was devoted to the abolition of gas testing in favour of a system of ascertaining the illuminating power of the actual gas supplied, and of instituting on this a standard price under which a sliding scale was to follow. This last object has not been wholly secured, as it involves exceedingly radical changes in the supervision of gas supply, and it might happen that while the quality of the gas is reduced, the reduction of price provided by the clauses in the Bill might not be equivalent to the inconvenience caused to consumers. The company are, however, to be allowed to reduce their standard of illumination, coming down to a 15-candle standard from July 1, 1901, and to a 14-candle standard within four years later. The new standard price for the 14-c.p. gas is to be 3*s.* 1d. per 1,000. The South Metropolitan Company are to be congratulated on the success of their Bill, but more particularly that the committee recognise them as a business undertaking in which the convenience of the public is regularly considered.

Electric Traction in Berlin.—With reference to the question of adopting electric traction on the Berlin local and suburban railways, Mr. Schubert, in a contribution to the *Zeitschrift des Vereins deutscher Eisenbahn-Verwaltungen*, advocates the greatest possible distribution of traffic. In working with locomotives, this distribution, as against concentration, is impracticable both on technical and financial grounds. But if electric traction were introduced, Mr. Schubert thinks that 180 trains could be dispatched in each direction per hour, as compared with 12 under the present conditions of working, and instead of a three-minute service one of 30 seconds would be possible. In place of the nearly empty trains of eight to ten carriages, with accommodation for 1,450 passengers, which run during the periods of minimum traffic, a single car affording accommodation for 75 passengers might be dispatched. Electric traction would further render the present railways capable of dealing with a daily average of 253,000 passengers, while their present capacity in passengers carried amounts to only 143,000 per diem. As regards conversion, this, he considers, might be easily accomplished. For the whole of the local and suburban lines 300 cars would be necessary, while the total cost of the equipment of the lines for electric traction is estimated by Mr. Schubert at £450,000. But it is open to question, concludes the article, whether it would not be advisable under the existing condition of things to entirely separate the local traffic from that of the suburban circular railway, and for the present introduce electric traction on to the inner lines only.

Heating Surface in Boilers.—The fact that a boiler can have too much heating surface was brought up in the discussion on Major Crompton's paper during the past session of the Institution of Electrical Engineers, and an interesting illustration of this well-known fact, cited recently by Dr. Coleman Sellers in a lecture before the Franklin Institute, will be found in *Cassier's Magazine* for June. When the first large engines and boilers for the waterworks of the city of Philadelphia were installed some years ago, it was found, upon testing, that the boilers were insufficient for their purpose. Mr. Oliver Evans, who had designed the engines, had specified the length of the grate bars and the width of the furnace to be used, as also the length of the boilers, which were of the plain cylinder type; but the wise men of the city government believed that they could do better by making the boilers much longer than he had suggested, and they were so constructed. Upon their failure to do the work, Mr. Evans was sent for in haste to correct the difficulty. His message to those in charge, enforced by his presence afterwards, was that they must cut off 10ft. from the length of each boiler. This seemed a strange proceeding, but he soon explained to them that the extra length which they had added to his prescribed dimensions was acting as a condenser to reconvert steam into water, inasmuch as the heat of the furnace could not extend the whole length of the boilers as they had been built. Upon cutting the boilers down to their proper size they proved sufficient for their work, and continued to operate as long as this primitive water plant was in existence.

Hub Motors.—We had occasion some months back to refer to a hub type of motor which was being constructed in the United States, and now understand that a Hub Motor Transit Company has been incorporated in Chicago to run vehicles equipped with these motors. Omnibuses and lighter vehicles with accumulators are to be supplied to the company in question, who will ply them for hire on the public streets. Our contemporary, the *Western Electrician*, gives an illustration of one of these hub motors complete with the wheel. In the omnibus size the external diameter of the hub is 16in., while the wheel will be 40in. in diameter. Roller bearings will be used throughout in this motor in order to reduce the friction of the moving parts, which is essential, as both the armature and magnets revolve. The internal gearing arranged in these motors is neat, and gives a reduction of about 1 to 4. The diameter of the pneumatic tyre used on the omnibus wheels will be 6in., and the wheel complete with its 6-h.p. motor will weigh about 500lb. The accumulators on the omnibuses will consist of 80 cells, which weigh 4,000lb. A number of different types of accumulators are to be experimented with. The three speeds of these motors will be three six, and twelve miles per hour. The control will not be in the usual way, by keeping the accumulators in series and grouping up the motors into series and parallel combinations. Instead of this the motors will be always kept in parallel, and the accumulators will be grouped in various series-parallel arrangements. The charging station is to be placed in the middle of Chicago, and it is stated that the omnibuses are to be on the streets within 90 days of the 12th ult.

Soldiers' Home of Rest.—In connection with the building trades' gift to the nation, which is to consist of a home of rest for discharged soldiers at Bisley, an electrical section has been formed to take in hand the electric lighting of the home, which will have accommodation for 100

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discharged soldiers. A most influential committee has been formed to make arrangements for this installation, and, we presume, also to find the money for carrying out the electric lighting. This committee is as follows: Messrs. M. Byng, A. Collins, H. Edmunds, R. K. Gray, R. Wallis-Jones, A. B. W. Kennedy, F.R.S., J. E. Kingsbury, W. L. Madgen, E. Manville, Sir W. H. Preece, K.C.B., F.R.S., and Mr. R. P. Sellon, with Prof. J. Perry, F.R.S. (president, Institution Electrical Engineers) as chairman, and Messrs. Alabaster and Gatehouse as hon. treasurers, and Mr. W. G. McMillan (secretary, Institution Electrical Engineers) as hon. secretary. Mr. Adrian Collins has given his assistance by drawing up the specifications for the generating plant, wiring, and fittings, and for any arrangements that may be found to be desirable for the supply of electric power in the laundry, workshops, or elsewhere. As soon as this specification is ready, the committee hopes to appeal to the electrical trades for gifts, either in money or in kind, to enable them to equip the homes satisfactorily, and they are hopeful that the contributions will not only suffice for this purpose, but will provide a substantial surplus that may be handed over to the Princess Christian's Fund for the maintenance of the homes. Already, even before any general appeal has been put forward to the electrical trade, very satisfactory progress has been made.

The Thomson Magnetic Blow-Out.—A legal action has just been fought in the United States Circuit Court in New York as to the validity of the Thomson magnetic blow-out patent, dated April, 1899. The suit was brought on two patents, one of which was for a magnetic field in an electric switch to dissipate the arc formed by breaking the circuit, and the other for a shield of insulating material to control the place of formation of the arc. Judge Wheeler held that the first-mentioned patent had been declared invalid by a previous decision, and confined attention to the second patent, which he sustained. Referring to a claim of invalidity owing to priority of invention, he said that only one of the citations used an insulating device as a guard, but that the safety device of this patent did not appear to be any arc-dispelling device of a circuit breaker for constant use, but to be a device for suppressing the formation of an arc under the occasional and extraordinary circumstances of electrical storms, to guard against danger from lightning. In the opinion of the Court it had not any combination with a circuit breaker and a magnetic field for dispelling an arc formed by continual breaking of the circuit in the operation of powerful electric machines; and the addition of an insulating shield to the prior combination of the magnet with a circuit breaker seems to be new and highly useful, and patentable whether the combination of the magnet with still prior machines was patentable or not. These claims were for this addition of the shield to the combination of a magnet with a circuit breaker, thus forming a new and useful combination, which was patentable as such. The Court concluded that in this view of the invention the infringement of them by the defendant appeared to be made out. Notice was given of appeal against the decision.

Electric Distribution in France.—We are pleased to note that the Compagnie Electrique de la Loire has obtained such a large demand for light and power that it has been compelled to reorganise its generating station, and to order some new generating units of large capacity. These new machines will be mounted on a plot of land acquired for the purpose, which has sufficient area to accommodate eventually some 100,000 h.p. of machinery. At present only one new steam dynamo is on order, which will have an output of 1,500 kw. The dynamo is being supplied by the Oerlikon Company, while the firm of Dujardin, of Lille, are making the engine. This engine is to be triple expansion, with two low-pressure cylinders and four cranks placed at angles of 90deg. The valve gearing will be of the Corliss type, and every precaution is being taken to ensure economy in working. The most economical load of the engine is to be 1,200 h.p., but it will continue to give economical results at considerably higher loads than this. The cost of the engine at Lille is £5,400. The alternator supplied by the Oerlikon Company will be of the three-phase type, with fixed armature and revolving field, and is designed to give a frequency of 50 at a speed of 85 revolutions per minute. The current will be generated either at 5,500 volts, or at a pressure of half that, according to the choice of the company. The cost of the alternator with exciter, delivered at St. Etienne, is to be £3,280. The arrangement of the new station will provide for each steam-engine being independently supplied by four boilers. It is said by our contemporary, the *Bulletin des Usines Electriques*, that the Compagnie Electrique de la Loire now distribute power at a price which is much cheaper to the user than steam-engines for all sizes up to 10 h.p. In fact, the supply is rapidly replacing all small gas-engines and steam-engines in the district.

Imperial Telegraphs.—On Monday last Sir E. Sassoon read a paper at the Society of Arts on the subject of Imperial telegraphic communication. In the paper he gave a history of the British cable companies, and stated that they had been helped to a very large extent by Government subsidies. In spite of this, however, the rates to the East were almost prohibitory, and he urged that a great reduction should be made. Some reduction had been made, but this was not nearly sufficient to make the cables useful to the ordinary commercial man. He thought the Government should in this respect, as in gas, electric light, and other undertakings, have the right to object to exorbitant charges. The impending realisation of the Pacific cable had, he thought, shown the companies that to some extent the time for trifling had passed, and they were going to lay a Cape-to-Australia cable, and to charge reduced rates. From the reductions in the rate per word made at various times an increased revenue had always resulted, and consequently it would pay the companies to make a rate at which an ordinary person could make use of the cables. Sir Henry Fowler also pointed out that although private enterprise had its advantages, he did not know whether they could say that the result had been advantageous in this case, and he thought it would be admitted that this was a matter which could not be left any longer in private hands. If commercial interests only were involved, the matter might be left to the higgling of the market. But the question was a matter for the Empire, and it was essential that they should endeavour to bring their Colonial fellow-subjects into the closest communication with England. It was worth while to spend public money to effect this, and such a great empire, with colonies in every part of the world, ought to have its own communications under its own control. Other speakers following also voiced this opinion, it being mentioned that the rate to Bombay was 4s. per word, while that to Australia was exactly the same, the message having to pass through Bombay, which is about half way, in order to reach its destination. A very different opinion was given on the same date at the Royal Institution, when a paper was read by Lieut. Bellairs on "The Routes of Submarine Cables." He thought that in laying lines to assist commerce, all that was wanted for other purposes was obtained.

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MESSRS. FERRANTI'S HOLLINWOOD WORKS.

(Concluded from page 731.)

Of equal interest with the Ferranti high-tension switch gear, though perhaps not so well known, is the standard continuous-current lighting and traction switching gear manufactured by the firm. We saw several very fine examples of the latter type of switching gear in various stages of erection at the time of our visit to the Hollinwood works. The standardisation of central-station continuous-current switching gears as required to-day is rendered somewhat difficult owing to the many differences in arrangements required for the control of various types of machines, circuits, balancers, batteries, and boosters, this variance being brought about by the special requirements of the district to be covered by the supply and differences in details of connections, etc., set forth by consulting engineers in their specifications. But Messrs. S. Z. de Ferranti, Limited, have successfully adopted a standard design of continuous-current switching gear after having carefully balanced the varying conditions involved. The gear is designed for employment in connection with lighting and traction schemes where the supply is distributed at pressures varying from 400 to 600 volts. The principal features and merits of the design will be best exemplified by a description of the gear, the general construction of which is similar to, and, in fact, based upon the Ferranti standard type of high-tension switching gear already described, which has obtained such marked success. The base consists of a number of heavy slate panels fixed in a horizontal position and grouted into the station wall. Between these main slates, and sliding into grooves in them, are arranged a number of division slates about ½in. thick, dividing the whole base into a number of distinct compartments. By this means the usual steel framework is avoided, the valuable space usually necessary at the back of the switchboard and between it and the wall being, moreover, saved, thus allowing more room in the front. The switches, instruments,

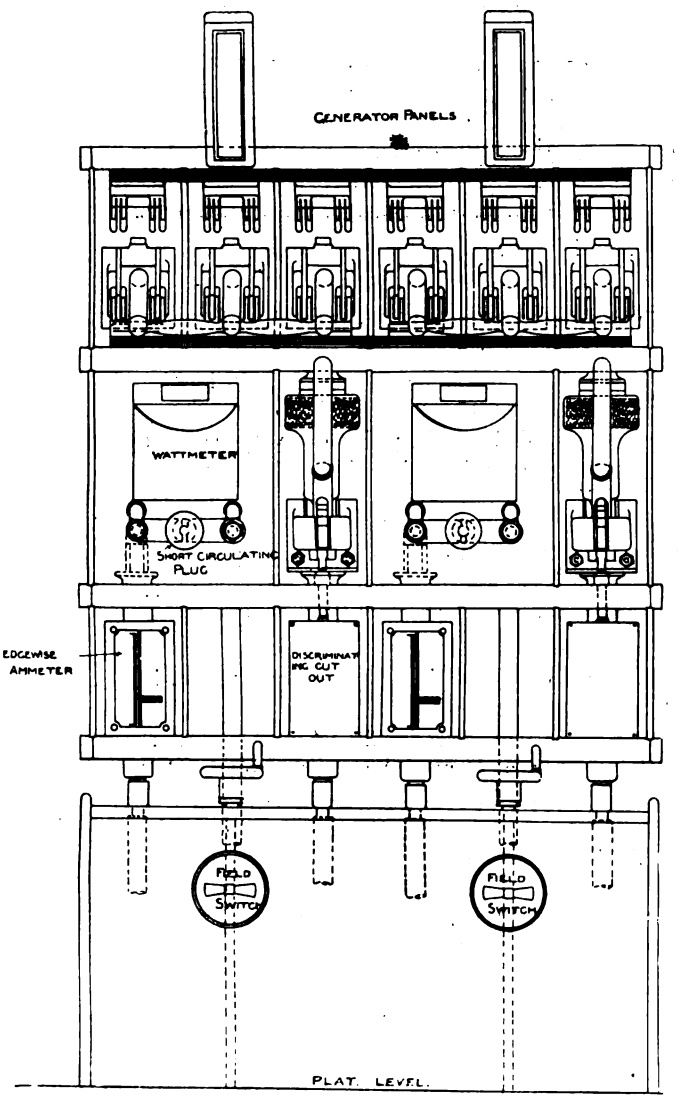

FIG. 19.

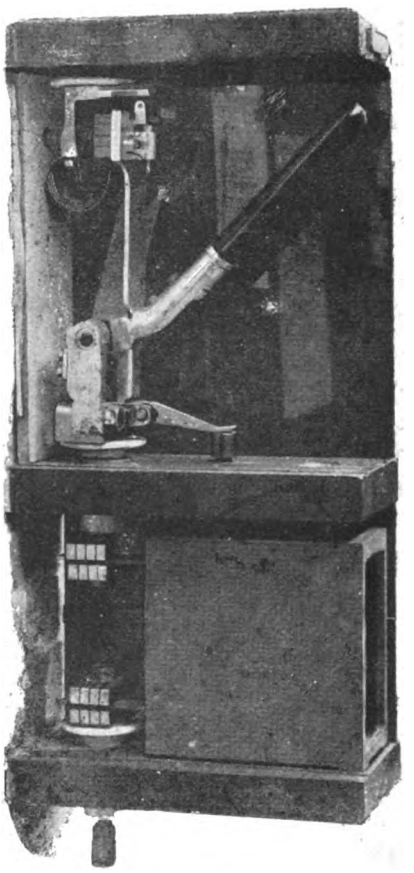

FIG. 20.

'bus bars, and other appliances are mounted in such a way that each appliance and each conductor of different potential is separated by some insulating material, each switch being mounted in an entirely separate compartment.

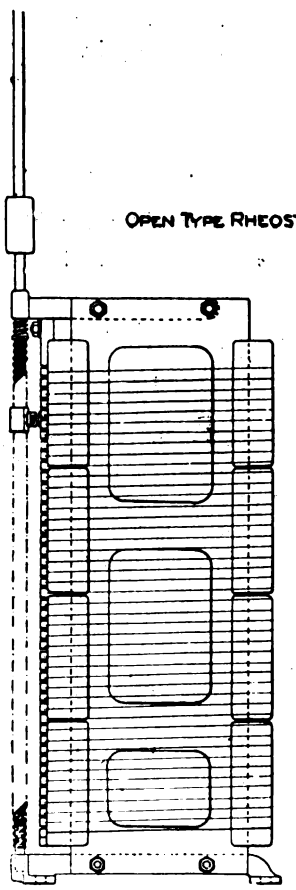

FIG. 21.

Where it is required to control compound-wound

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machines which have to answer the double purpose of generating energy for traction as well as lighting, panels,

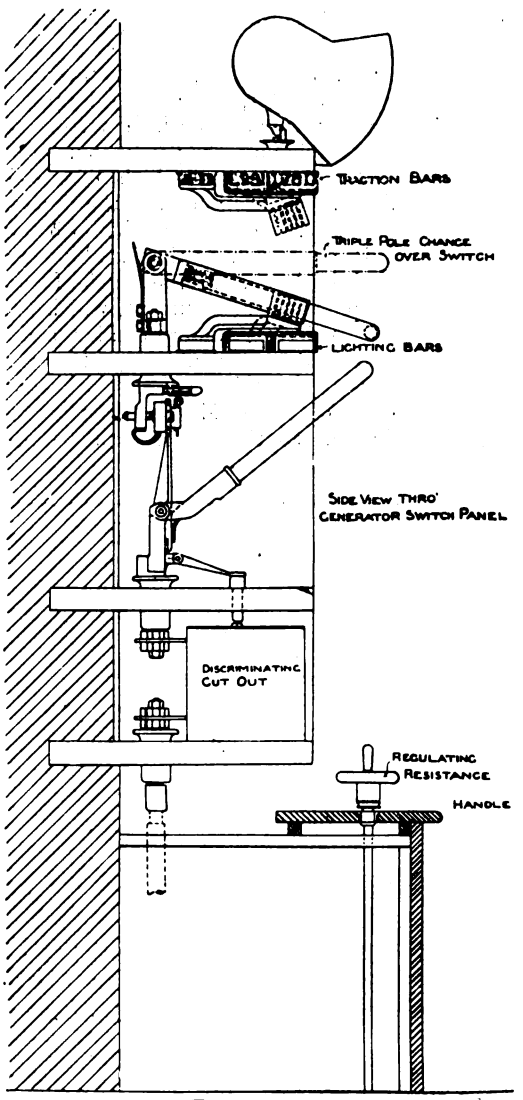

FIG. 22.

as shown in Fig. 19, are used. Referring to this illustration, it will be seen that the voltmeters are mounted

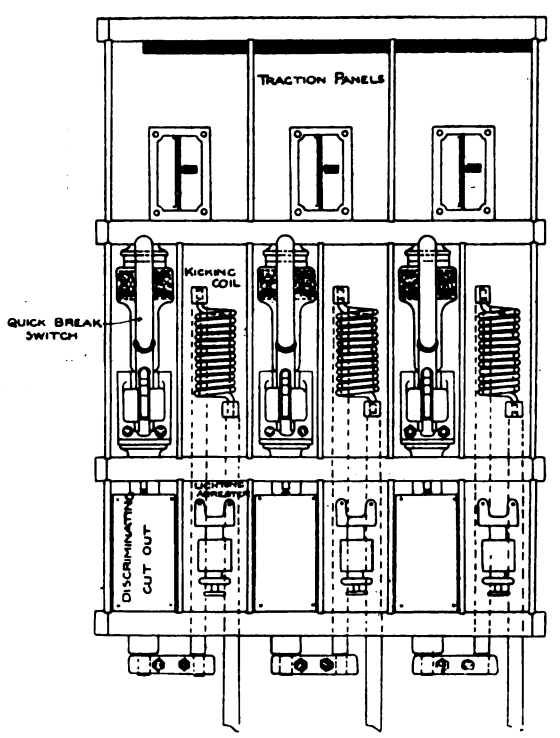

FIG. 23.

on the top slate, each being of the edgewise type, with a large open scale, and indicating the 'bus bar and incoming machine potentials respectively. These instruments are hooked on to their contacts, and hence may be quickly and safely detached from the board without removing any nuts, bolts, or cable connections. In some cases, to save the necessity of a voltmeter for each machine, a voltmeter contact is provided in the switch panel, by which means a common voltmeter may be connected to any incoming machine. The 'bus bars are made up of thin copper strip of high conductivity, firmly clamped together and arranged in recesses under the voltmeters. There are two sets of three bars—positive, equaliser, and negative—as shown in Fig. 19, for the traction and lighting systems respectively. Chopper type change-over switches with massive contacts are arranged on the same panels, by which the machines may be connected to either system. It is possible to couple the positive and equaliser change-over switches by one handle, leaving the negative switch to be operated independently. This negative switch may then be used for paralleling the incoming machine after closing

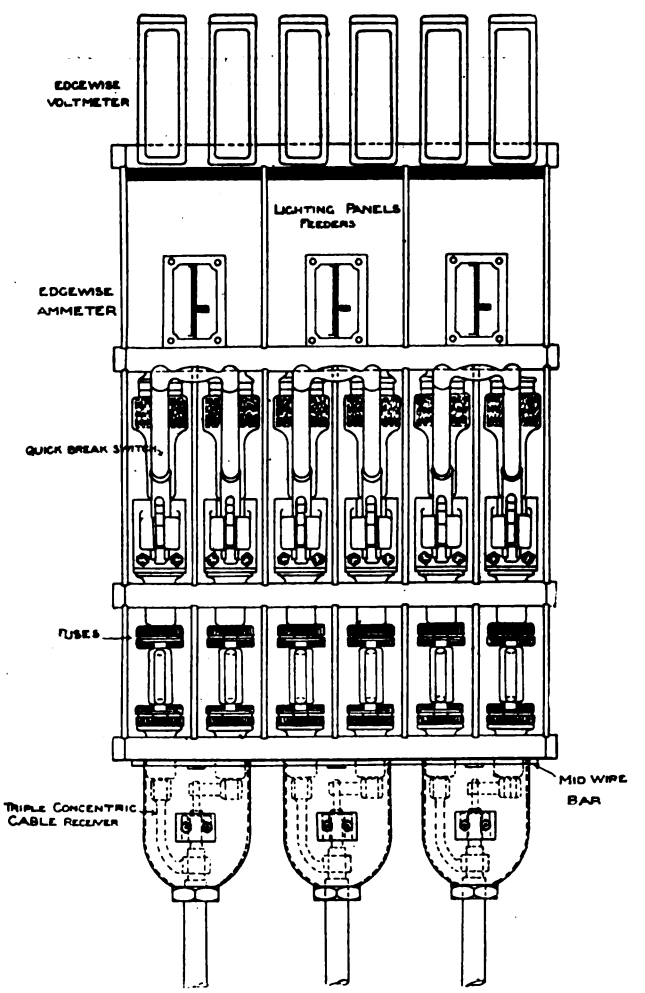

FIG. 24.

the circuit breaker, which will open the circuit again if there is any fault on the machine. The circuit breaker is placed in a vertical line with the negative change-over switch, with which it is connected in series. It consists of a quick carbon break switch and an automatic attachment, as shown in Fig. 20, with the switch "On." The switch blade, it will be seen, swivels from the fulcrum at the bottom of the panel, contact being made at the top by a flat surface on the blade pressing against a set of laminated copper plates. The release spring for the switch is fixed behind these contact plates. The blade is held up against the compression of this release spring by a trigger at the bottom, whereby the power tending to throw the switch out is utilised in improving the electrical contact. There are no jaws for the blade to slide into, and, therefore, no mechanical friction to be overcome, a feature whereby the mechanical resistance is minimised and the switch rendered perfectly free to open immediately the release trigger is raised, either by the automatic attachment in the panel beneath or by a downward pull on the handle. The action of the switch is further characterised by its

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reliability, while another advantage claimed is that it enables the circuit to be opened and closed by operating the one handle, as described above. The automatic attachment fixed in the panel below the switch is arranged to lift the trigger, and thus throw off the switch on reversal of current or excess overload. This automatic device can at any time be removed without interfering with the switch. It may be replaced by a fuse or another automatic attachment, the alteration being easily effected without the use of any special tools. The lugs projecting from the back of the attachment engage into a set of laminated contacts, making all necessary contact, and also forming the necessary means for holding down the appliance and fixing it in position. A recording wattmeter, provided with a short-circuiting plug, is mounted in a separate panel by the side of the quick-break switch. The generator main current is indicated by an edgewise ammeter, which plugs, like the automatic device, into laminated contacts. Both instruments are arranged so that they may be quickly removed from the board if necessary.

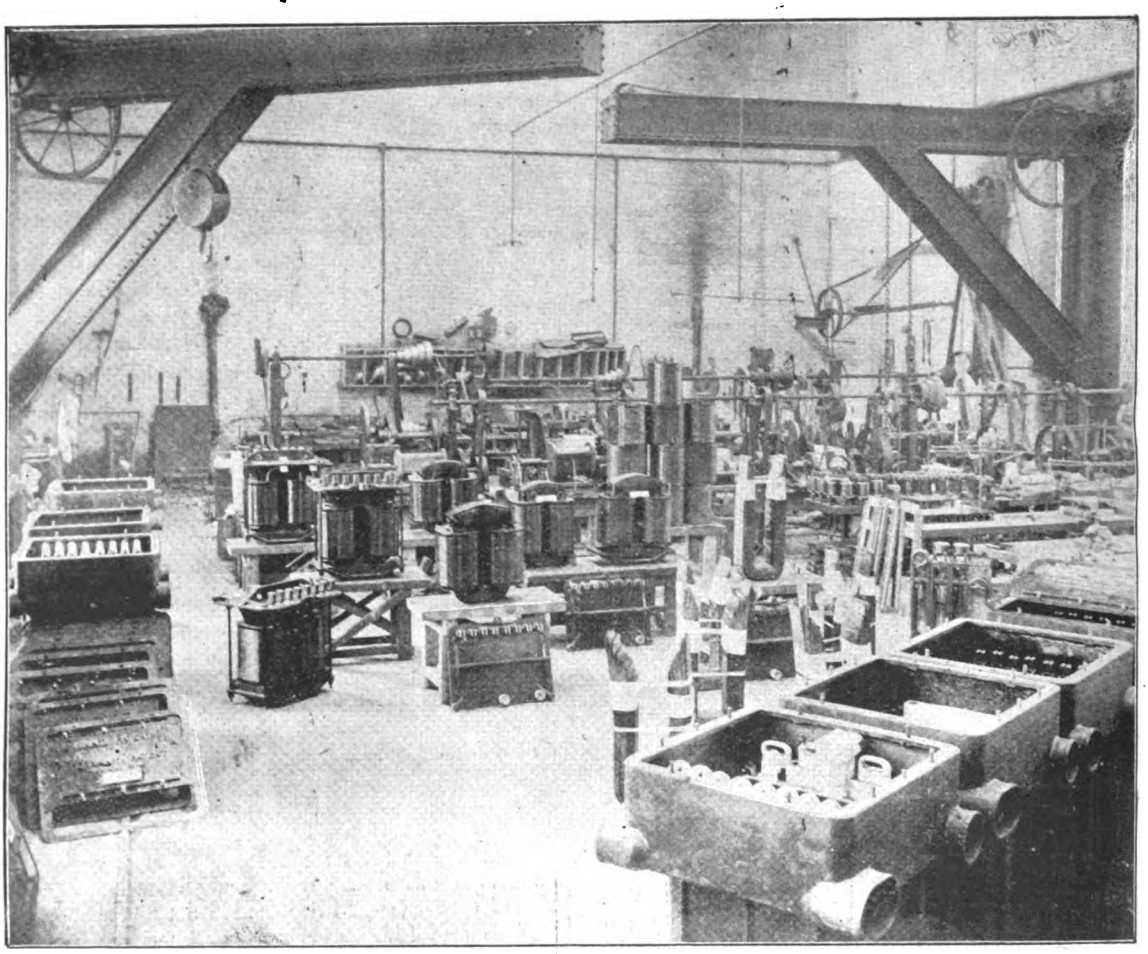

FIG. 25.

The regulating resistance, combined with a sliding switch for controlling the field current of the dynamo, is of the special open type previously described. It is usual to fix these rheostats in a cellar under the switchboard platform when the latter is only 2ft. or 3ft. above the station floor, but where the platform is situated on a gallery the rheostats are suspended under the gallery, or supported on girders grouted into the wall. But in any case they are connected by a straight spindle direct to a handwheel mounted on a slate base, in a direct line with the remainder of the dynamo controlling gear.

We have already given several illustrations of these rheostats, but venture to give yet another (Fig. 21), which should assist the reader in understanding the constructional details of this compact form of resistance. An exciter field switch, sometimes required in series with the shunt field winding, may be placed on the slate base near the rheostat handwheel. Fig. 22 shows a complete side view through the panel, from which the method of fixing the main slates in the wall is at once apparent. A ½in. back slate, usually white enamelled, is fixed on the surface of the wall in between the main slates. The traction feeder panels, three of which are shown in Fig. 23, each consist of positive or line 'bus bar, ammeter, and circuit breaker with an automatic device or fuse similar to those used on the dynamo panel. In addition, there is provided a kicking coil and lightning arrester, these several appliances being in separate compartments and entirely surrounded by slate-work. It is preferable on these panels to use fuses in place of the automatic devices, in which case the auxiliary switch, described in connection with the dynamo panel, is rendered unnecessary, since if there should be any fault on the line, it will be developed by the fuse blowing as soon as the circuit switch is closed. Moreover, the fuse will permit of a sudden temporary rise in current, which is common to traction circuits, whereas, under similar conditions, the magnetic automatic device would open the circuit immediately. Considering that the use of fuses or magnetic devices is such an open question, Messrs. Ferranti have wisely designed their gear so that either can be used without disturbing the construction of the parts fixed on the slates. The negative return feeders, not shown in the illustrations, are usually fixed on a centre panel connecting through an ammeter to the negative 'bus bar. When necessary, special provision is made for connecting a negative booster in this circuit, in such a manner that the booster may be put in or out of circuit at will. In some cases it is found desirable to connect boosters on to the outlying positive feeders, particularly where there is a considerable potential drop due to long mains. For this purpose a change-over booster switch is fixed in a separate panel. Three panels of the Ferranti standard lighting feeder type are shown in Fig. 24. Each of these is designed for a three-wire feeder. As in the case of the dynamo panels, the voltmeters are placed on the top slate. The edgewise ammeter is fixed in a similar position to that on the traction feeder panel, and in other respects the panels are somewhat similar in construction, but the switches and fuses are double-pole, while kicking coil and lightning arresters are not so essential. The special cable receiver is shown receiving a triple-

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concentric cable, the intermediate conductor connecting to the case of the receiver and from thence by a link to the mid-wire bar, running longitudinally along the underside of the bottom slate. Suitable provisions may be made here, as on the traction feeder panel, for

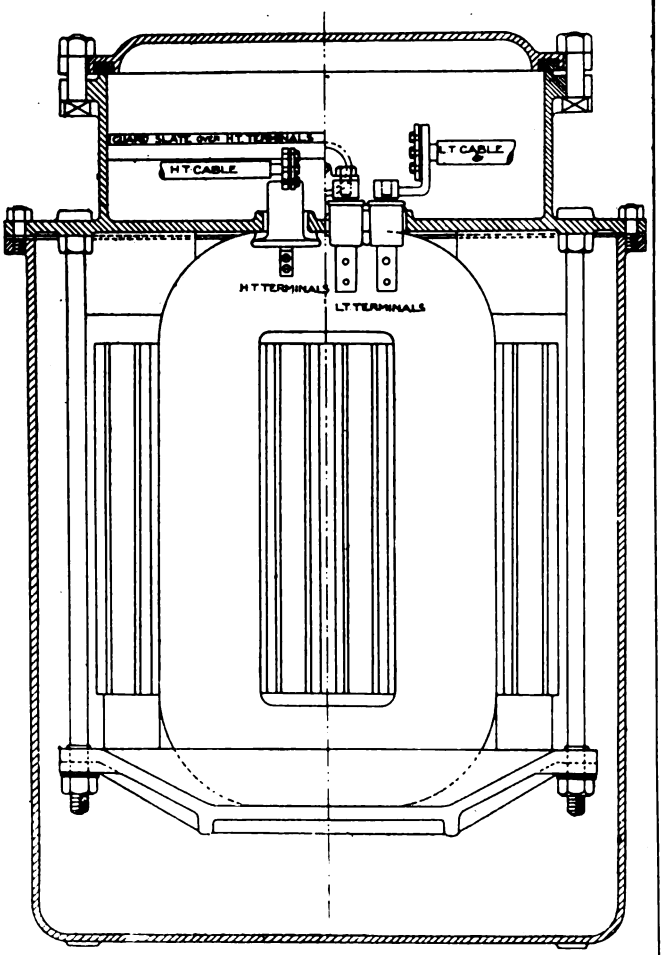

FIG. 26.

boosters where long-distance mains necessitate this complication. The controlling and regulating gears for balancers, battery, battery booster, negative booster, etc., are all arranged in the manner described, the principal aim of the design being to produce a centre of the system which is absolutely reliable, compact, safe, and simple to operate, and by the use of which fire risks are minimised. The connections are all visible from the front of the board, and can be understood at a glance. There is no back, and therefore no tangle of cables and bar connections, the advantage of which has been duly emphasised. The gear can be extended at any time without interfering with the continuity of supply, sufficient space being left in the first instance between the different sections to facilitate this. A Board of Trade panel, of Messrs. S. Z. de Ferranti's design, contains the usual standard instruments of Messrs. Elliott Bros.' make for all regulating tests.

The special construction entailed by the Ferranti switching gear, as compared with the usual type of flat-back switchboard, in connection with which latter instruments, switches, etc., may be indiscriminately placed and connected at the back in accordance with diagrams, is perhaps more costly in the first instance, because each connection has to be carefully and mechanically made, but in the long run it is claimed, with considerable justification, to be more economical, because it will last, and need but little attention. The insulation is perfect, and, what is of utmost importance, the chances of damage by fire are very remote.

In conclusion, we may briefly refer to the winding and transformer shop at the Hollinwood works, a portion of which is shown in the accompanying illustration (Fig. 25). The amount of work executed in this department is, of course, immense, but the alternator parts, etc., which constitute a considerable portion of its turn-out, have been sufficiently described in connection with the completed machines turned out in the main erecting shops. But something may be said about the transformer work of the department, an idea of the extent of which may be gathered from Fig. 25. A useful feature in connection with the Ferranti type of transformer is the containing tank supplied therewith. The Ferranti patent street transformer tank is designed to take any size of transformer up to 50 kw. capacity. The great advantage which this arrangement affords is that when the cast-iron containing tank is once placed under the road or pavement, it need never be disturbed. For instance, should it be desired to change the transformer, this may be readily done by removing the covers of the tanks and withdrawing the plug fuses, thus leaving the transformer free for lifting.

In the street transformers of the Ferranti type the connections are mechanically made, the transformers, together with all connections, being firmly attached to the foundation plate, thus preventing humming and dangers arising from loose cables, bits of insulation, etc. The high-tension connections are arranged for a ring main system, a tapping being taken off from the main through an oil-break fuse to the inner terminals of the transformer, and through a suitable plug to the outer terminal of the same. Insulated plugs are provided, so that the ring main may be broken to enable the repairs of a defective portion of the cable to be executed without disturbing the continuity of the supply to the consumers. Further, the high-tension connections are efficiently guarded and insulated. All the cables are

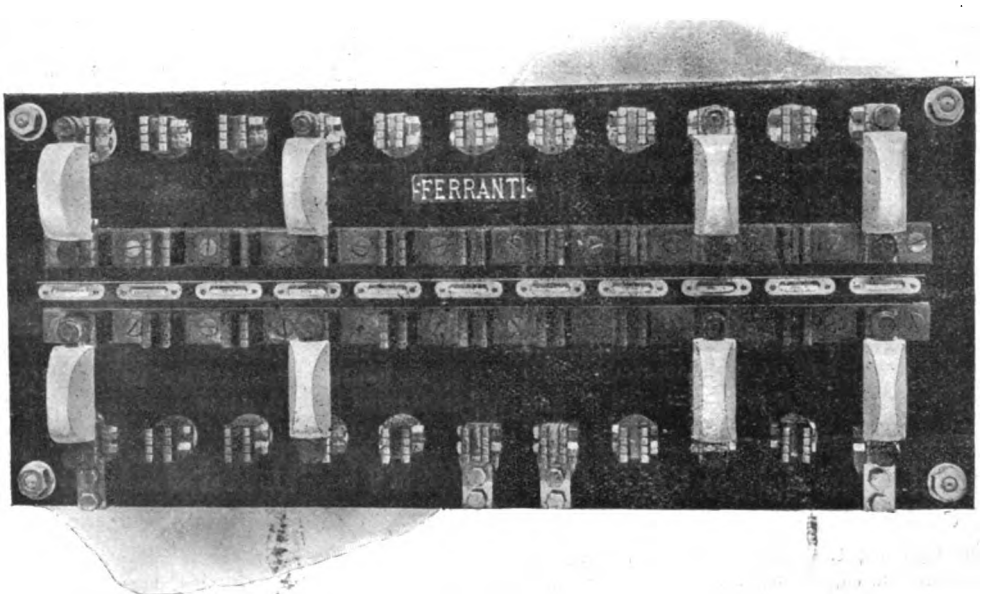

FIG. 27.

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led through watertight glands. Four secondary cables are led in each, connecting to D.P. plug switches or fuses to the terminals of the transformer. A Cardew earthing device is fitted to comply with the Board of Trade rules, while a tray filled with calcium keeps the inside of the tank dry. The transformer itself is of the core type, and is made in the following standard sizes: 5, 10, 15, 20, 25, 30, and 50 kilowatts, for any periodicities. The construction of these transformers is based on a very lengthy experience, the Ferranti transformer being among the first to be made. With the object of producing a transformer which is stable and reliable, with high efficiency, good regulation, and what is most essential, will stand the usages of time without deterioration, the best materials are liberally employed by Messrs. Ferranti, Limited, in the construction of these transformers. Special attention has also been given in the design to use these materials to the best advantage, and at the same time to obtain a maximum cooling surface throughout, particularly on the inaccessible interior parts.

Messrs. Ferranti have also standard designs for transformer tanks suitable for use in sub-stations, these tanks being fitted with perfectly watertight joints. They are also provided with a chamber at the top, which can be readily got at by the removal of a lid. This chamber can be made to contain high-tension fuses, low-tension plug fuses or switches, and all necessary terminals for receiving single or concentric high and low tension cables, and, if necessary, terminals can be provided for two secondary voltages or for a three-wire secondary system. Fig. 26 shows a section of this sub-station transformer, from which its construction will be readily understood.

Mention may here be made of a low-tension plug fuse-board (Fig. 27), specially designed and constructed by Messrs. Ferranti, Limited, for sub-station equipment. It consists of two 'bus bars, inner and outer, divided from each other by a slate partition, contacts and terminals being provided for connecting the secondary of the transformers through plug fuses or plug switches to these bars, and for taking away circuits from the same through a plug fuse or plug switch of similar type. The plugs are of substantial design, each one being capable of carrying up to 300 amperes. The cable terminals can be connected either at the front or at the back of the board. In Fig. 26 one set of transformer terminals is shown on the front, the circuit terminals being behind the slate. The circuit and transformer panels are distinguished by name plates fixed on each panel on the horizontal centre line of the gear. This arrangement is suitable for any voltage not exceeding 220.

A great deal more might be said about Messrs. Ferranti's Hollinwood works and the apparatus through which the firm has become so well known to the electrical world, but the space at our disposal is limited. From what has already been said, however, some idea of the extent and admirable organisation of the works, not to mention the enormous amount of work at present in hand, will have been gathered. It is easy to appreciate the very great skill and energy which has necessarily been expended in bringing the works organisation and various types of apparatus manufactured to the standard degree of perfection indicated. Upon this happy state of things at Hollinwood those who may have contributed to that vast expenditure of energy, and, above all, Mr. S Z. de Ferranti, must be heartily congratulated. Messrs. S. Z. de Ferranti, Limited, are showing the way which might with advantage be followed extensively if the reputation of the old country is to be maintained in the face of outside competition.

ARC LIGHTING OF THE STRAND.

The question of lighting the principal streets of the parish of St. Martin-in-the-Fields by electricity is not a new one, but feeling the necessity for better lighting of the parish generally, the Lighting Committee asked the Vestry on Feb. 2, 1899, to refer the question to them for further consideration and report. This request was granted, and it was taken as a general approval of the principle—viz., that electricity should be used. Upon this the Lighting Committee, on Feb. 14, 1899, instructed the surveyor to report upon the subject and to obtain tenders from the three companies supplying electricity in the parish for lighting the main thoroughfares, and also to report as to the advisability or otherwise of combining the scheme with a refuse destructor for the disposal of house and street refuse.

The surveyor's report, dated March 7, together with the tenders, were duly considered by the committee and recommended to the Vestry, with slight alterations, for adoption on April 20. The principle of electric lighting was agreed to, but the details were referred back, and after further consideration were approved by the Vestry on May 4. The scheme consisted, in round figures, of 100 arc lamps, each giving the light of 1,000 candles. In order to secure the utmost possible safety against accidents and contingencies, the lamps have been ranged in circuits of

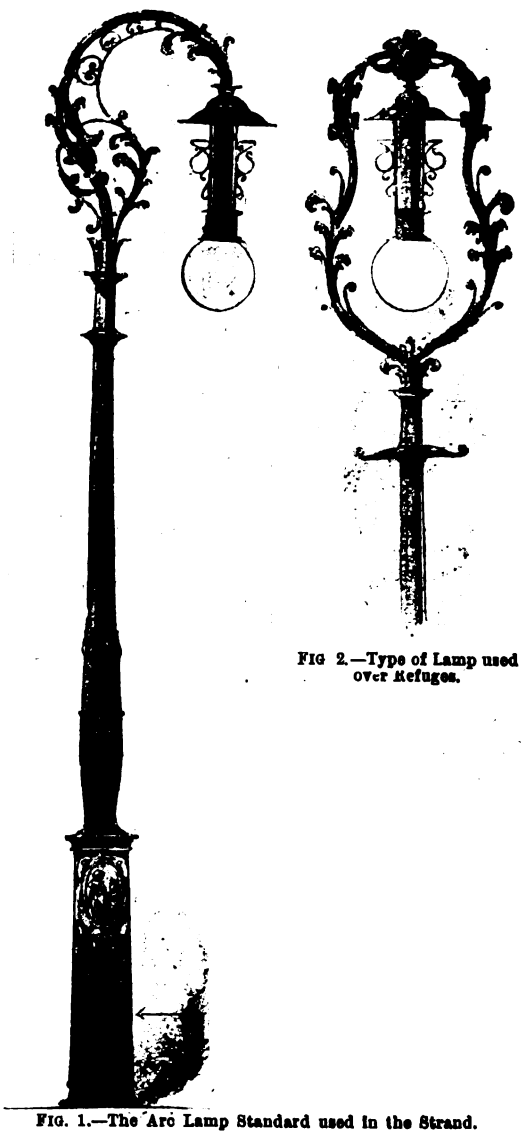

FIG 2.—Type of Lamp used over Refuges.

FIG. 1.—The Arc Lamp Standard used in the Strand.

twenties, so interleaved that no street is dependent upon one circuit alone for its supply. This arrangement of lamps on alternate circuits has two advantages: it not only provides a safeguard in case of accident, but it also will allow a portion of the lamps to be extinguished after midnight, should such a course be found desirable. Arc lamps would also have been provided for Drury-lane and Horse Guards'-avenue, but the adjoining districts of St. Giles and Westminster were not willing to participate in the scheme. The Vestry of St. James's, Westminster, and the Strand District Board of Works, the other neighbouring parishes, are joining in the scheme, in so far as the streets lighted are boundary streets.

In order to obtain suitable standards a competition was invited, and premiums of £10 and £5 were kindly given by the chairman of the committee and Mr. Horner respectively for the best designs. About 50 designs were submitted, and Messrs. Singer and Sons, of Frome and London, obtained the first award, and ultimately the

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contract for the supply of the standards. The second award was given to Messrs. Benham and Froud, of Chandos-street. These standards (Fig. 1) are unique in pattern, and are unlike any previously fixed in London or elsewhere. They consist of three parts: (1) the foundation base, which is buried in concrete beneath the surface of the street; (2) the main standard of cast iron bolted to the lower base, which is decorated with the coat-of-arms and name of the Vestry, a figure of St. Martin, modelled from a sketch by Mr. Seymour Lucas, R.A.—the base of the standard contains the switchboard and other necessary electrical apparatus; and (3) there is the lamp carrier, fixed into the top of the standard, composed of wrought and hammered iron of a simple but elegant design. The lamps (Fig. 1) fixed on the footways differ from those (Fig. 2) on the refuges in the centre of the streets, in so far as the lamps from them "drop" over the carriageway, and are known as the "snowdrop" or "swan-neck" pattern, and these are fitted with hauling gear to enable the lamps to be raised and lowered for trimming purposes without the use of a ladder, otherwise an "extension" or "tower" ladder would have had to be used, which would

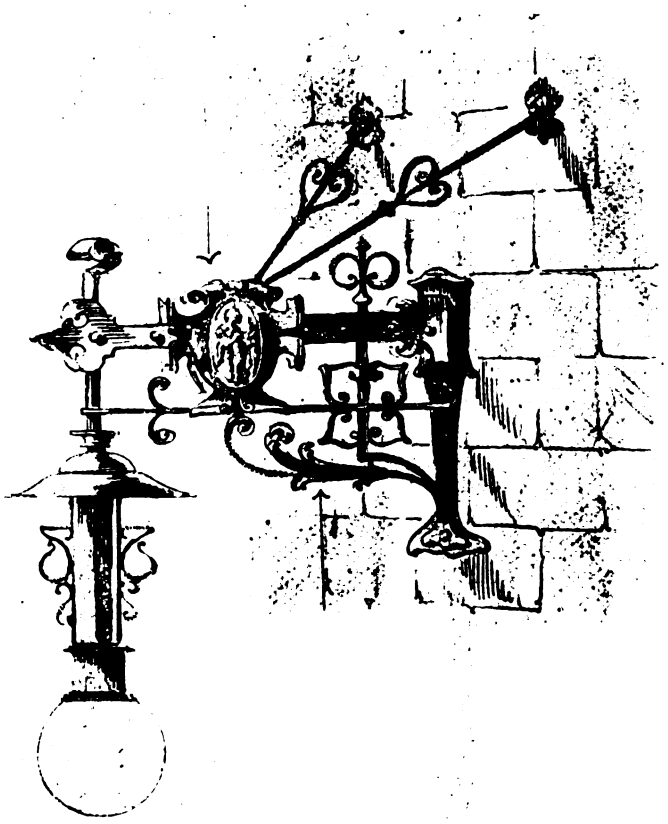

FIG. 3.—Approved Design for Wall Bracket.

somewhat interfere with the traffic. The refuge columns will be trimmed by means of climbing irons, inserted in the column as the man ascends, and withdrawn again when he has finished.

The laying of the cables and the construction of the road and footway boxes were commenced in the autumn by the Charing Cross and Strand Electricity Supply Corporation. The Vestry decided to undertake the rest of the work itself, and the whole of the repaving of the trenches, the fixing of the bases, columns, carriers, and refuges has been done by their own workmen under the personal supervision of the surveyor to the Vestry, Mr. George Green, A.M.I.C.E., to whom great credit is due for the success of the undertaking. The completion of the scheme has been considerably delayed, owing to the enormous pressure of work in the metal trades and the impossibility of obtaining castings with any speed. Owing to the subsoil of the streets being so much occupied by mains and pipes of every description, as well as by innumerable vaults, ovens, cellars, subways, etc., a good deal of difficulty was found in obtaining suitable or possible sites for the bases. No less than six different bases were designed by the surveyor to overcome these difficulties, in addition to which, in many cases, mains had to be diverted, and in some cases piers were allowed to be built on private premises upon which to erect the columns. These circumstances have added materially to the cost.

The extra cost to the parish for the first seven years, over and above the present cost of gas-lighting, is estimated at £1,400 per annum, and after the expiration of that period, when the instalments of capital and interest on the amount borrowed have been paid off, the extra cost will be reduced to some £560 per annum.

Messrs. Oliver and Co., of Woolwich, are the engineers supplying the lamps, hauling gear, and other electrical apparatus. The arc lamps are of this firm's double-carbon type, burning for 36 hours without recarboning. The lamps are of the well-known clutch type, with several improvements recently introduced by Messrs. Oliver and Co., which not only make the lamp more perfect in regard to steady burning, but also in its lasting properties. The general construction is of sound mechanical and electrical

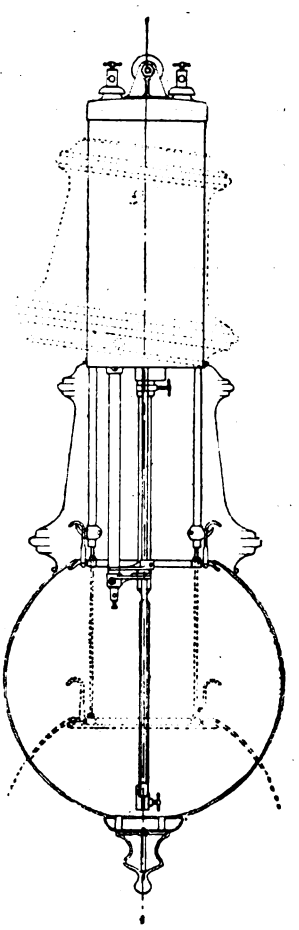

FIG. 4.—The Oliver Arc Lamp, showing Method of Lowering Globe.

design, and a prominent feature is that, by the removal of at most two screws, any single part of the lamp may be removed without in any way disturbing the others. Every part is carefully made by special tools, and a complete system of interchangeability is employed. The raising and lowering gear, to enable the bracket lamps to be trimmed without the use of ladders, has been specially designed for the use on a high-tension circuit, such as the present, and is worked by a handle through a hole in the base of the post. In the base of the post are fixed isolating switches, automatic cut-outs, and substitutional resistances (also of Messrs. Oliver and Co.'s design and manufacture) mounted on a switchboard. Fig. 4 shows a section of the lamp, illustrating the method of securing the globe and the lowering of the same for trimming.

The supply of electric energy to the public lamps was, after competitive tenders had been received by the Vestry, entrusted to the Charing Cross and Strand Electricity Supply Corporation, Limited, who offered the Vestry very advantageous terms.

The street-lighting has been carried out in the following streets: Haymarket, Panton-street, Whitcomb-street, Leicester-square, Pall-mall East, Cockspur-street, Charing Cross, Whitehall, Whitehall-avenue, Whitehall-place,

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Northumberland-avenue, Villiers-street, Strand, Agar-street, Duke-street, King William-street, Chandos-street, Adelaide-street, Duncannon-street, Trafalgar-square, St. Martin's-place, St. Martin's-lane, Charing Cross-road, Green-street, Garrick-street, Cranbourne-street, Long-acre, Bow-street, and Endell-street. The Lighting Committee who have so zealously carried out the scheme consists of Mr. Dudley James (chairman), Mr. E. L. Berry (vice-chairman), and Messrs. Bailey, Daniel, Dovey, Fendick, George, Horner, Jaxone, Slatter, Steele, Tozer, Turner, and Walkley, together with Lieut.-Colonel Probyn, J.P., L.C.C., and Mr. David Laing (chairman and vice-chairman of the Vestry). As St. Martin's is the Royal parish, it was only fitting to select the Queen's birthday as the day when the new lighting should first be inaugurated.

INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the report of the Council presented to the annual general meeting held on May 24, 1900:

Incorporation of the Northern Society of Electrical Engineers with the Institution.—It is with great satisfaction that the Council reports that, in the early part of the period under review, the Institution was approached by the Northern Society of Electrical Engineers with a view to the incorporation of that society in the Institution, and that, as the result of the ensuing conferences and negotiations, the incorporation has since been effected in accordance with No. 67 of the articles of association. The Council has agreed to remit the entrance fees of members of the Northern Society now admitted to membership of the Institution in consideration of the undertaking of the society to transfer to the Institution the cash balance standing to the credit of the society when its accounts are closed. It is confidently hoped that the union will prove to be of great benefit to the members of each of the societies.

Local Sections.—The Council has also the pleasure of reporting that members and others resident in several centres of the electrical industry in the United Kingdom have applied, under articles numbered 65 and 66 of the new articles of association, for the creation of local sections of the Institution in their respective districts, and that, in consequence of these petitions, active local sections are now in operation in Dublin, Glasgow, the Manchester district, and Newcastle, the Manchester section having taken the place of the late Northern Society of Electrical Engineers now incorporated in this Institution. A local section has also been created in Cape Town. General rules and regulations for the management of local sections at home and abroad have been drawn up, and the organisation of the sections has already assumed a definite form. The Council congratulates the Institution on the initial success of a movement which promises not only to make the Institution more directly useful to its provincial and foreign members, but also to strengthen the Institution itself by rendering it more truly representative of the profession of electrical engineering as a whole, and of the interests of the British electrical industry at large.

Elections and Transfers.—The Council has the pleasure to report that during the twelvemonth ending May 24, 1900, acting in accordance with Article 17 of the articles of association, it has elected Mr. Joseph Wilson Swan, F.R.S., the last past-president of the Institution, an honorary member. Notwithstanding the increased severity of the rules relating to the qualifications for membership, and the strictness with which those rules are enforced, the total of the additions to the register by election at ordinary general meetings during the same period has been 401. This number is much above the average, and is made up as follows: 25 members, 88 associate members, three foreign members, 152 associates, and 133 students. Adding to these the honorary members and the new members transferred from the Northern Society of Electrical Engineers at the time of incorporation, the total is 471, comprising one honorary member, 53 members, 113 associate members, three foreign members, 168 associates, and 133 students. Nineteen candidates have also been approved for ballot to-night. Six associate members, one foreign member, and 12 associates have been transferred to the class of members, whilst 85 associates have been transferred to the class of associate members, and 33 students to that of associates.

Deaths and Resignations.—The Institution has to mourn the loss by death of one past-president (Prof. David E. Hughes), nine members (Mark Bevan, T. Buckney, J. D. Doyle, P. B. Elwell, L. Epstein, Frank King, Joseph B. Morgan, Benjamin Smith, and Frederic Wyles), and eight associates (J. Chapman, H. J. Clipperton, H. T. Constable, M. Cooper, W. B. Edgar, J. J. Tough, W. C. Smythe, and L. G. Willmott). Three members, two associate members, one foreign member, 23 associates, and five students have resigned since the date of the last report.

Papers.—In addition to the inaugural address of the President, the following papers have been read and their publication in the *Journal* ordered:—At ordinary general meetings: "The Cost of Steam Raising," John Holliday; "Influence of Cheap Fuel on the Cost of Electrical Energy," R. E. Crompton (past-president); "Electrical Time Service," F. Hope-Jones; "Report of Swiss Visit Committee on the Visit of the Institution to Switzerland"; "An Electrolytic Centrifugal Process for the Production of Copper Tubes," S. Cowper-Coles (member); "The Standardisation of Electrical Engineering Plant," R. Percy Sellon (member); "On the Applications of Electricity in Medical and Surgical Practice," H. Lewis Jones, M.D. (associate); "Storage Battery Problems," E. J. Wade (associate); "The Electrical Equipment of Ships of War," C. E. Grove (member); "The Electrical Transmission of Power," Prof. G. Forbes, F.R.S. (member); "The Calculation of Distributing Systems of Electric Traction under British Conditions," H. M. Sayers (associate-member); "A Frictionless Motor Meter," S. Evershed (associate-member); "Alternating-Current Induction Motors," A. C. Eborall (associate). At meetings of local sections: Glasgow—"The Problem of Arc Lighting from 250-Volt Supply," W. B. Sayers (member); Dublin—"Inaugural Address of Chairman," Prof. G. F. FitzGerald (member); Glasgow—"Method of Charging for Public Supply of Electricity," W. W. Lackie (member); Glasgow—"Some Considerations concerning Electric Driving," H. A. Mavor (member); Newcastle—"Inaugural Address of Chairman," A. W. Heaviside (member). At an extra-ordinary meeting in Zürich: "The Utilisation of the Schaffhausen Water Power," A. Amsler, Ph.D. The attendance at the ordinary general meetings has been well maintained. By the kind hospitality of the two societies, the meetings from November to April have been held, as in previous years, in the rooms of the Institution of Civil Engineers, and two of those in May in the rooms of the Society of Arts. The Institution is now, further, indebted to the Institution of Mechanical Engineers for the privilege of using their new premises for two extra meetings in May.

The Publications of the Institution.—With reference to the *Journal*, the only change of note to be recorded is the alteration in the date of the commencement of the volume, which now runs concurrently with the session. The first number of the current volume, therefore, contained the *Proceedings* of the meetings in November and December, 1899, instead of those in January, 1900, as would have been the case under the old system. Recognising the great value of *Science Abstracts* to the electrical engineer in placing before him an epitome of most of what is valuable in the current literature of his subject throughout the world, the Council has agreed with the Physical Society for the continuance of the publication under the joint control of the two societies for a further period of at least three years, or of so much longer as may be found mutually agreeable. The scope of the *Abstracts* has now been enlarged, sections relating to steam plant, oil and gas engines, motorcars, and medical electricity having been added, so that the work now appeals to a larger circle of readers than it has done previously, and the growing appreciation in which it is held is indicated by a considerable increase in the proceeds from sales to non-members of the two societies. The number of *Abstracts* published was increased from 1,423 in 1898 to 2,000 in 1899. The publication of the following papers in the *Journal* as original communications has been ordered: in Part 142, "How Condenser and Choking-Coil Currents Vary with the Shape of the Wave of the Applied E.M.F.," A. Russell (member); in Part 144, "A Two-Phase Rotary Converter and a Note on the Regulation of Rotary Converters," E. Wilson (member); in Part 144, "The Air-Gap Induction in Continuous-Current Dynamos," C. C. Hawkins, M.A. (member), and R. Wightman (associate); in Part 146, "Note on Air-Gap and Interpolar Induction," F. W. Carter, M.A. (associate); in Part 146, "The Reluctance of the Teeth in a Slotted Armature," W. B. Hird (member); in Part 146, "On the Absolute Values of Capacity Measurements," J. Elton Young (member).

Annual Premiums.—The Council has awarded the following premiums for papers and communications accepted during the current year. No paper on a telegraphic or telephonic subject having been read, the Fahie premium is not awarded. Only those that were in type on May 10 were considered eligible, papers accepted for publication after that date being reserved for consideration in awarding the premiums in 1901: the Institution premium, value £25, to Mr. G. E. Grove, member, for his paper on "The Electrical Equipment of Ships of War." The Paris Electrical Exhibition premium, value £10, to Mr. S. Evershed, associate member, for his paper on "A Frictionless Motor Meter." Two extra premiums, value £10 each, respectively to Prof. George Forbes, F.R.S., member, for his paper on "Distant Electric Power Transmission," and to Mr. H. M. Sayers, associate member, for his paper on "The Calculation of Distributing Systems of Electric Tractions under British Conditions." A premium, value £5, to Mr. A. Russell, member, for an original communication entitled "How Condenser and Choking-Coil

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Currents Vary with the Shape of the Wave of the Applied E.M.F." A premium, value £5, to Messrs. C. C. Hawkins, member, and R. Wightman, associate, for an original communication entitled "The Air-Gap Induction in Continuous-Current Dynamos." The First Students' premium, value £10, to Mr. R. P. Howgrave-Graham, student, for his paper on "Hertz Waves and Wireless Telegraphy." The Second Students' premium, value £5, to Mr. C. B. Nixon, student, for his paper on "Switch Gear for the Generation of the Electric Current." The Third Students' premium, value £5, to Mr. H. J. Humphreys, student, for his paper on "Permanent Magnets."

Salomons Scholarship.—The Council has awarded a Salomons scholarship, value £50, to Mr. R. P. Howgrave-Graham, of the Technical College, Finsbury.

Students' Class.—Twelve meetings of the students' section have been held during the session, at 10 of which papers were read by students, the remaining two having been devoted to discussions on electrical subjects. Visits to the following places were arranged for the students by your secretary during the year, and the Council desires to express its thanks to those who, by opening their works for the purposes of these visits, have contributed much to the usefulness of the section: the Bankside station of the City of London Electric Lighting Company; the Davies-street station of the Westminster Electric Supply Corporation; the London United Tramways; the Waterloo and City Railway; the works of Messrs. Easton, Anderson, and Goolden, the Electric Welding Company, the Incandescent Electric Lamp Company, India Rubber, Gutta Percha, and Telegraph Works, the Langdon-Davies Electric Motor Company, and Messrs. Siemens Bros. and Co.

Annual Dinner.—The annual dinner was held on Dec. 6 in the Grand Hall of the Hotel Cecil, the attendance being practically the same as in the previous year.

Annual Conversazione.—The use of the Museum of Natural History was again most generously granted by the Trustees of the British Museum for the conversazione on June 15, and the number of guests present was 200 above the number of those who attended in 1898.

Annual Accounts and Financial Position.—The surplus of income over expenditure at the end of 1899, as shown in the annual statement of accounts, demonstrates that, notwithstanding the contribution in respect of *Science Abstracts* and the increased expenditure on premiums, the financial position of the Institution is thoroughly sound. It should, however, be stated that a somewhat larger proportion than usual of the income for the year resulted from the payment of arrears of subscription, owing to the fact that a phenomenally large number of members was elected at the end of 1898, and that many of these new members did not pay their entrance fees and subscriptions until January, 1899. The sum of £800. 1s. 2d. was invested on account of life compositions, leaving on Dec. 31 a balance of £44. 9s. 4d., which has since been invested. The estimated realisable amount of subscriptions outstanding on Dec. 31, 1899, was £450, and none of this is taken into account in the balance-sheet now presented. More than £200 of this £450 has since been received. The telegraph jubilee fund and the premium fund have this year, for purposes of the annual statement of accounts, been merged in the general fund. In the books, however, note is kept of these several amounts.

Building Fund.—The importance of erecting a permanent home for the Institution is recognised by the Council, and they have accordingly taken steps to augment the building fund. They have transferred from the general fund the sum of £1,437. 10s. 9d., and they have also invited members to make special contributions to the fund. In response to this appeal £131. 11s. 6d. was paid during the two months of 1899, which remained after the date of the issue of the circular. These sums, with the interest on capital previously invested on this account and other payments, have raised the amount standing to the credit of the fund on Dec. 31, 1899, to £7,044. 5s. 11d., as against £5,277. 0s. 6d. at the end of 1898.

Wilde Benevolent Fund.—During the session, Mr. Henry Wilde, F.R.S., an honorary member of the Institution, generously offered to the Council the sum of £1,500 for the purpose of founding a Wilde Benevolent Fund, to be administered in accordance with the following extract from the declaration of trust: "The annual income of the trust fund shall, subject as hereinafter provided, be applied in such manner as the said President and Council or Committee of Management shall from time to time think fit for the benefit of members (exclusive of honorary members, associate members, foreign members, associates, or students) for the time being of the Institution, but principally, though not exclusively, for those who by their discoveries, inventions, or writings shall have advanced the profession of electrical engineering, and for the benefit of the families of any such members and of any such late members being deceased, and for the benefit of any persons who may have been such members and paid their subscriptions for five years consecutively at least, and of the families of such persons, subject, however, in all cases to the following regulations: (*a*) The income may in any year be applied wholly for the benefit of one person or class of persons, or may be applied equally or unequally for the benefit of two or more persons or classes of persons. (*b*) The total amount applied for the benefit of any one member or late member or his family during one or more years, shall not exceed one year's income of the trust fund. (*c*) There shall be no obligation in any year to apply the whole or any part of the income of that year for the benefit of any person or persons. Any income not so applied may, if and so far as permitted by law, be either retained as income to be added to and applied as part of the income of any subsequent year or years, or may be invested and added to the capital of the trust fund." This trust was gratefully accepted by the Council, and the said sum of £1,500 has been received and invested, although, as it was not made over until the year 1900, it does not appear in the accompanying statement of accounts. It has been decided that for the present the fund shall be administered by the Council.

David Hughes Scholarship.—The Council has the further gratification of reporting that the executors of their revered past-president, the late Prof. David E. Hughes, F.R.S., have announced the bequest by him to the Institution of the sum of £2,000, with the object of founding a David Hughes scholarship, to be awarded under conditions similar to those under which the Salomons scholarship fund is administered. Announcement of the date of the first award will be made when the said amount shall have been received by the Institution.

Local Honorary Secretaries.—The return of Mr. A. P. Trotter to England left a vacancy in the local honorary secretaryship for the Cape and South Africa, and looking to the large number of members in the Transvaal, and to the distance of these members from the previous local headquarters at Cape Town, the Council decided to divide the secretariat into two sections—namely, the Cape, Natal and Rhodesia—for which district Mr. John Denham, M.I.E.E., has been appointed local honorary secretary; and the Transvaal, to which district Mr. J. Hubert Davies, M.I.E.E., was appointed. Two new secretariats have been formed—viz., Italy and Sweden—to which Colonel F. Pescetto (foreign member) and Mr. John Henrik Hammar (foreign member) have been respectively appointed as local honorary secretaries. The Council has now, by way of experiment, entered into an arrangement for a year with the Société Internationale des Electriciens, under which the treasurer of each society undertakes the collection of the subscriptions of members of the other society resident in his country. The Council desires to record its cordial thanks to Mr. Trotter for his services as local hon. secretary at the Cape, and especially for his share in the organisation of the Cape Town local section of the Institution, which was being carried on informally and unofficially prior to his return to this country.

Visit of the Institution to Switzerland.—In previous years the Institution has three times held meetings away from London—namely, at the Paris Electrical Exhibitions of 1881 and 1889, and at the Edinburgh Electrical Exhibition of 1890—but otherwise no organised visits have been paid to foreign or provincial centres. During the twelvemonth now closing, it was decided to arrange a visit to some of the principal electrical works and installations in Switzerland. With the cordial co-operation of Swiss engineers, represented by a Reception Committee consisting of Colonel Huber, Mr. C. E. L. Brown, and Prof. W. Wyssling, a programme was arranged and the visit took place on the 1st to the 10th of September. One hundred and thirty-nine members, and 20 ladies accompanying them, took part in the reunion, and, thanks to the efforts of the Reception Committee in Switzerland and of the Organising Committee at home, and to the untiring labours of our secretary, Mr. McMillan, the Council is able to congratulate the Institution on the success of the visit. The Council has arranged for a joint meeting of this Institution with the American Institute of Electrical Engineers in Paris on Aug. 16 of this year, immediately before the opening of the international electrical congress, and has also accepted an invitation to visit Berlin in 1901.

Common Seal and Diplomas.—During the period under review the engraving of a common seal was completed. The various investments, with the exception of those in respect of the Salomons scholarship fund, have now been transferred from the trustees to the Institution, and are registered under seal. By adopting this course, the trustees will be put to less inconvenience, and the Institution will suffer no expense, at such times as a change of trustees would otherwise have necessitated the transfer of the stocks from the previous trustees, or the survivors of them, to those newly appointed. The Council, being also in a position to issue the diplomas for which provision had been made in the new articles of association, has notified members and associate members that they are entitled to apply for diplomas. As a result, a large number of these certificates has now been issued. To meet a certain demand for diplomas on vellum instead of on paper, the Council decided that any member could demand such a diploma on payment of one guinea, the surplus of receipts over expenditure on account of vellum diplomas being regarded as a subscription to the building fund. Fifty-eight of these vellum diplomas were issued up to the end

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of 1899, and the subscriptions thus accruing to the building fund amounted to £48. 5s. 2d.

Electrical Museum.—Recognising the advantage that would accrue to the profession from the formation of a historical collection of electrical apparatus, and the increasing difficulty in making such a collection representative of earlier work, the Council has appointed a committee, which is now taking active steps to obtain donations or promises of objects of apparatus not now in commercial use, possessing interest in connection with electrical science and its applications.

The Library.—The report of the secretary is as follows: "I have to report that the accessions to the library during the year numbered 57. Of these nearly all were kindly presented by the authors or publishers.

"The presentation of specifications and abridgments of specifications relating to electricity and magnetism has been continued by the kindness of H.M. Commissioners of Patents.

"A few additions have been made to the periodicals and printed *Proceedings* of other societies received regularly in the library. A list is appended.

"The number of visitors to the library during the year has been 555, of whom 50 were non-members."

The Calculation of Distributing Systems of Electric Traction under British Conditions.

BY H. M. SAYERS, ASSOCIATE MEMBER.

(*Concluded from page 742.*)

Appendix No. III.

Calculations for "Boosted" Feeders.

The only special factor in these is the correct value of w. Such value should take into account the transformation loss in the booster, and the annual charges on that machine referred to its output. If n is the cost of a Board of Trade unit at the main switchboard, and the efficiency of the booster at its average working load is $\frac{x}{100}$, the transformed units will cost $\frac{100}{x}n$ in energy alone.

Again, if the machine cost £a per annum in interest and depreciation, and £b per annum for attention and stores consumed per unit of average working output, these charges will add to the cost of the energy $\frac{(a+b)\,240}{365\times h}$ in pence per Board of Trade unit. The value of w will then be

$$w = \frac{240{,}000}{(365h\times n\frac{100}{x} + 240\,(a+b)}.$$

For example, if a booster cost £15 per kilowatt output, and 12 per cent. is charged for interest, etc., and if it costs 10s. per annum for attention and stores, these costs amount to £2·3, or $a+b=2·3$, then if the set is in service 15 hours per day

$$\frac{(a+b)\,240}{365\,h} = \frac{2·3\times 240}{·5475} = ·11 \text{ pence.}$$

With $n=·75$d. and efficiency 75 per cent., the cost per unit transformed becomes

$$(·75\times 1·33)+·11 = 1·11 \text{ pence,}$$

and

$$w = \frac{240}{1·11\times 5·475} = 39·5.$$

The values of w so found should be used in calculating the best density of current in the "boosted" feeders.

It must be noticed that where boosters are used, as on trolley feeders, to keep the drop within certain limits, the boosters have only to supply the difference between the permitted drop and that which occurs in the feeders, and the current density found as here explained is that which should prevail in the corresponding distance beyond the point at which an unboosted feeder will give the limiting drop. Hence the total drop in the boosted feeder should be the sum of the limited, and that in the length beyond at the density here found, and the actual section of the feeder should be such as to give that drop on the actual feeder length. Thus, if the limiting drop is 50 volts, and that is given by an unboosted feeder three miles in length, whilst a boosted feeder is 4½ miles long, and should drop 15 volts in the 1½ miles excess, the proper uniform density in the whole 4½ miles should be such as to give 65 volts drop. Unless supply is given much beyond the limiting drop distance, the decrease in current density as compared with that found for direct feeders will not be large. In track feeders, however, the "boosted" density is practically correct, as the permissible drop is always much exceeded.

The best density for secondary feeders supplied from transformers is found in the same way as for track feeders.

Appendix No. IV.

Calculation for Track Feeder, East of T.

Rail resistance, ·0289 w per mile.
Drop allowed, 5 volts.
Amperes × miles constant for 5 volts = 175.
Current per car, 15 amperes. Cars passing in pairs.
From T Eastwards.

Cars.		Amp.-miles. Product.	Sum.
T to F, 5 cars, ·9 mile.	First pair	30 × ·3 = 9	—
	Second pair	30 × ·6 = 18	—
	One at F	15 × ·9 = 13·5	—
	Two on line D F	30 × ·9 = 27	67·5
F to G, 4 cars, 1·25 miles	First pair	30 × 1·21 = 36·3	103·8
	Second pair	30 × 1·83 = 54·9	158·7
	Two on line, N G	30 × 2·15 = 64·5	223·2

As the sum is brought over the constant by the current flowing in at G from branch N G, G should be a point of change of direction. The product of amperes × miles on branch N G is 15 × 1·1 = 16·5. This added to the 158·7 at G = 175·2, a little over the limit. Hence the whole of the 30 amperes from branch N G should flow east, and the integral of ampere-miles from G to feeding point should be 175 − 16·5 = 156·5, to keep N at five volts.

Then from G Eastwards.—Section G O, four cars; 1·5 miles long; current flowing east 30 amperes from branch N G.

Cars.	Amp.-miles.	Product.	Sum.
At G	—	16·5	—
G to first pair	30 × ·375 = 11·25		27·75
First pair to second pair	60 × ·75 = 45·00		72·75
Second pair to O	90 × ·375 = 33·75		106·50

H being terminus, and only two cars between H and O, it is obvious that feeding point should be west of O, so sum westwards from H. H to O 1·7 m.

Cars.	Amp.-miles.	Product.	Sum.
First pair to O	30 × ·85 = 25·5		—
O to second pair, G O	30 × ·375 = 11·25		36·75
Second to first pair, G O	60 × ·75 = 45·00		81·00

Feeding point will thus be between the first and second pair of cars east of G. It should be exactly ·825 mile east of G. The product from this point will be 54·75 to the terminus, H, and to N, corresponding to 1·58 volts drop. Hence the feeding point may be 3·42 volts above earth. The track feeder will have to carry back 120 amperes, and be 2,975 miles long. Section should be ·39 square inch, and the drop in it will be 15·06 × 2·975 = 45 volts. But as its end may be 3·42 volts above earth, the booster will have to give only 41·58 volts, and have an output of 41·58 × 120 = 5,000 watts, say.

Track Feeder No. 2.

From T Westwards.—It is obvious to inspection that some current should return *vid* D and some *vid* J. The dividing points should be those at equal distance from T by each route. On the branch, D J, this point is practically at the centre of its length, hence half the total current is taken as flowing each way. On the circuit, T D C I J T, it is very close to the junction, I. Hence the current returning by J will be half that on the branch, D J, and the whole of that on branches from J to I, K and L respectively, making altogether 8·5 × 15 = 127·5 amperes, which gives at once the section of the track feeder from T to J. It also follows that the potentials of points D and J should be kept equal. Find feeding points, etc., as before. T to D, seven cars, 2·35 miles. Branch C M, four cars = 60 amperes at ·35 mile from T. Assume one car at D, the other six in pairs at ·59, 1·18, and 1·77 miles respectively from T.

Current Eastwards towards T.

Cars.	Amp.-miles.	Product.	Sum.
T to C	60 × ·35 = 21·00		—
T to first pair	30 × ·59 = 17·70		38·7
T to second pair	30 × 1·18 = 35·40		74·1
T to third pair	30 × 1·77 = 53·10		127·2
T to D	15 × 2·35 = 35·25		162·45 = 4·7 V
T to O, part current from branch D J	4·4 × 2·35 = 10·5		173

giving 5 volts at D.

Current Westwards from D.

D to C, 1·65 miles, six cars, passing at ·41, ·82, 1·23 miles from D, 33 amperes from branch D J also:

Cars.	Amp.-miles.	Product.	Sum.
D to first pair	33 × ·41 = 13·53		—
First to second pair	63 × ·41 = 25·83		—
Second to third pair	93 × ·41 = 38·13		—
Third to C.	123 × ·41 = 50·43		127·92 at C.

Count back from A to find equal point. A to B, two miles, three cars, assume one at A, two in middle.

Current Eastwards from A.

Cars.	Amp.-miles.	Product.	Sum.
A to first pair	15 × 1 = 15		—
First pair to B	45 × 1 = 45		60

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B to C, 1·1 miles, two cars, assume in middle, current of one car from branch B J. Continue assuming from A.

Cars.	Amp.-miles. Product.	Sum.
B to middle	60 × ·55 = 33	—
Middle to C	90 × ·55 = 49·5	142·5 at C.

This indicates feeding point a little west of C, but as 60 amperes more enter from branches north and south of C, and C is the meeting place of four tracks, it is clearly the proper place for the feeder to tap the rails. If this point be kept at earth potential, A, the point farthest from T, will be at 4·1 volts above earth.

The feeder will be four miles long, have to carry 273 amperes back, have a section of ·89 square inch, will drop 4 × 15·06 = 60·24 volts, and booster must give 273 × 60·24 = 16,445, say 17,000 watts.

Track Feeder No. 3.

Inspection of the diagram suffices to show that J must be the feeding point for this. The greatest drop thence will be on branch J K, 2·2 miles long with two cars. Assume one at K and one half-way, then ampere-miles K J will be 41·25 or 1·2 volts. J must then not be more than 3·8 volts above earth. This is lower than D, so that more than the half current on line J D will return by the feeder *vid* J. *Per contra*, part of the current from branch I J will go *vid* I C. The assumed distribution could be obtained by splitting the feeder at J, and connecting the branches at proper points on the three lines, J L, J K, J I.

No practical advantage would result, as in working the load on each feeder is regulated to keep the pilot wire indications within proper limits, by control of the booster E.M.F., and it is quite certain that the actual load and its distribution will vary widely and rapidly in any given case from any assumed distribution, consequently in a network requiring a number of track feeders it is sufficient to ensure that they shall be provided of needful section and number to enable the P.D. on the rails to be kept within limit, and refined investigation of the current distribution is likely to be labour lost.

Hence No. 3 feeder may be safely taken as tapping rails at J. It will be 2·15 miles long, carry 127·5 amperes, have a section of ·415 square inch, drop 32·4 volts, and require a booster to give 32·4 × 127·5 = 4,130, say 4,200 watts.

DISCUSSION.

In opening the discussion, **Prof. Jamieson** said the paper was well worth careful study. At the Cape he had been astonished to find on the overhead line a drop of 30 volts. Such a thing would probably be impossible in this country. The interference was due to external circumstances. Thus the whole of Table Mountain was of a slaty formation, and through this great interference was caused to the tramway and to the submarine cable messages, the strong currents actually stopping in some cases the proper reading of the messages.

Mr. A. M. Taylor said the paper put before them was a practical one. To summarise it briefly, it first discussed the limits to which central stations could be worked, and compared the costs of working a large tramway system, and, lastly, the question of multiphase working was taken up. This was interesting, because they had not only to consider the line data, but also a network. It was not only interesting because of this, but because later on the calculations contained in it might have to be applied to light railways as well as tramways. In the table at the end of the paper the price per unit at high tension was given as ·35d. That might probably be reduced considerably if allowance was made for the losses in the boosters and generators. If this were so, it would change from ·35d. to about ·29d., or about ¼d. per unit. Mr. Sayers had taken the cases rather favourable to the multiphase transmission. The losses in transformers he gave were rather high. As to the cost per unit generated under the conditions shown, in the most favourable light this would be ·29d., and in the least favourable light ·38d. per unit. Taking the car-miles per annum as 20,000 supplied from a sub-station and dealing with it in the same way as Mr. Sayers, the costs per unit delivered to the cars would be ·56d. for the 12 months, and for 20 months ·44d. per unit. As regarded the statement in the paper that the distance to which power could be distributed economically did not depend on the traffic, it seemed that the grade and other things did not affect this limit, it being carried by extra size of feeder. Mr. Sayers placed all the stations on the same footing in giving 15 amperes as being taken by every car, whether the generating station were a single, double, or multiphase station. Mr Taylor then, referring the use of boosters, showed by a mathematical calculation that the whole length of any trolley feeder must be boosted, if such machines were used.

Mr. Eustace Thomas said he was interested to hear someone take up the question of economical distribution. Everyone seemed to go by the cheapness of first cost, and did not consider the future economical distribution. Contractors, of course, could not be expected to make their tenders provide for this. The amount of copper was a great factor in economical distribution. Thus the cost per mile of cable was much greater in proportion per unit with a small cross-section than with a large, and the value of P in the author's paper would vary very much for the size of the cable. Thus, if one thought a certain size of cable would be exactly what he required for his work, he would probably use the next size in order to make sure. He then mathematically demonstrated how to obtain the correct size of cable required, and also how to make allowance for the cost of the insulation.

Mr. B. Jenkin said the paper should not be taken as in any way comparing the relative merits of one station with those of another. It was particularly interesting as being an actual case, but they could not deduce general conclusions from that particular case. It would be interesting if Mr. Sayers would say more as to the running of feeders to individual sections. It must depend entirely on the number of cars on the line and the length of the line. The cars would run more economically if the feeder were connected at a number of places to the trolley wire and in parallel with it.

Mr. E Kilburn Scott said the multiphase system would have been more likely to succeed if, instead of taking 2 500 volts, the author had taken double that. This would have made a considerable amount of difference in the table on p. 27 of the paper. He did not see why at 2,500 volts they could not use high-tension continuous current. If multiphase traction were ever used on tramways, with the omission of the motor-generators the price of the transforming plant would be reduced from £15 to £4 per kilowatt.

Mr. J Swinburne said that in reading a paper like this he always had some fear that they were departing from accuracy in order to get simplicity in calculation. As he had mentioned at the previous meeting, Kelvin's law was Kelvin's law only while it was simple. His law provided for the cost of insulation. Another element of cost was the damage to pipes. These generally belonged to gas and water companies, and the cost was not thus reckoned. The law on this matter seemed to be that if you were a private individual and eat anyone's pipes you were liable to damages, but if you were a public company you could eat as many as you liked provided you did not eat more than was absolutely necessary. The corrosion of pipes was going to be the cause of serious trouble with respect to electric tramways in this country. The three-wire system had not been thought of enough in connection with these tramways. It had been applied to everything except these, and the Board of Trade regulations were not applicable to this. The real reason nothing more had been done in the matter was that an American once said that this was not the practice in America, and thus no one here thought of applying it. He then showed diagrammatically how it could be applied to tramways, the trouble of balancing being overcome by means of a booster. Thus he stated that on the ordinary system the bigger the booster the more trouble was caused, but with the three-wire system the reverse was the case. With this system the corrosion of pipes would in a great measure be overcome, and the only other solution of this difficulty would be the placing of boosters on the pipes themselves.

Mr. A. T. Carter said the three-wire system was used on the City and South London Railway.

Mr. McMahon said that balancers were used with the three-wire system on the above electric railways, and he did not see why they should not be used on tramways.

Mr. R. Quin said he agreed with the author except as to one or two points. Thus he did not agree that the drawing-in system was better than the laying of armoured cables, and he had used both systems. Cables laid on the drawing-in plan would, he thought, soon have to be drawn out. It was far safer to lay them on the solid system. As to roadways and municipal engineers, he did not quite understand the author's remark as to the paving between the lines. Did he infer that there should be no paving there? Granite was not always used, but there was a reason why there should be some paving. Tramways were always placed on the crown of the road, and the crown always wore away twice as fast as the rest of the road. With a tramway this wear was greatly increased. He personally preferred granite setts, because carmen and others did not like them. If wood blocks were used, from 20 to 30 per cent. more traffic passed over the tramways than would otherwise do so. As to the unreliability of tramways, he thought that the value of reliability was the price of a little extra copper.

Major-General Webber stated that he wished Mr. Quin had given his reasons for not liking the drawing-in system, as he had no doubt they were excellent. One reason was that pulling in cable above a certain size was not an easy matter. He thought that probably the best system was to lay the cable bare in wooden troughs. He was watching some time previously the erection of some poles for overhead trolley work, and was astonished at the crude way in which they were put up, no account being taken of the strains they would have to stand, the poles merely being put into a hole dug in the ground. He thought some of their students should give some study to the question of strains. A paper published in 1873 on strains in telegraph posts would be useful in helping them with the subject of trolley-pole strains.

Mr. H M. Sayers, in reply, said he was glad that not much contradiction had been offered to his paper. Mr. Taylor had thought his cost for attention to the generators was low. This might be so, as the figures given were only imaginary figures, given for the purpose of calculation. Mr. Taylor was quite right in saying that the grades did not affect the efficiency of the distribution, and really affected the size of the feeders. As to the trolley-wire boosters, he had only given one to illustrate a section, and they would be provided on the whole length of the line. The size of conductor required could be got from any catalogue very easily nowadays. Mr. Jenkin's remark that the paper must not be taken as a comparison was correct, as it did not pretend to be such. Mr. Swinburne's remarks were well worthy of attention. He had often felt that this system was worth trying. There were many ways in which the difficulties could be got over. The difficulty of shorts between the two trolley wires was not an imaginary one. He had seen an illustration of a

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three-wire system in America, and the look of it prevented him wanting it tried in this country. He should like to say why he preferred the drawing-in system, but it would take too long. As to the construction of the track, he was not a permanent-way engineer, and did not want to discuss it further.

A vote of thanks was then accorded to Mr. Sayers for his paper.

DOVER TELEPHONES.

Mr. A. R. Bennett, C.E., engineer of the Glasgow telephones, in a report on the projected municipal telephone system in Dover and vicinity, gives an estimate of the cost of an exchange, which includes Dover and St. Margaret's. This estimate will be useful as a guide elsewhere, although, of course, local conditions affect the results.

Mr. Bennett estimates that £16 per line would be a liberal provision for a first-class metallic circuit telephone exchange system, constructed in accordance with the specification annexed by the Post Office to licenses to local authorities, within the contemplated Dover telephone area. Probably the cost would not exceed £15 a line. He was informed by Mr. Stilgoe, the borough engineer, that as a rule the telephone conduits could be laid under the footpaths, and assumed that this would be the case. The spare partially completed lines would cost £8 each as a maximum. This works out as follows:

300 subscribers and 20 public telephone lines complete at £16	£5,121
150 partially completed lines at £8	1,200
	£6,320

Tariffs.—An average receipt per working line of about £5. 5s. per annum is necessary to place an exchange on a remunerative basis. Although he should expect that a reduction to an average of £5 or even £4. 15s. per annum would be found possible after a short experience, it would not be judicious to rely upon less than an average of £5. 5s. to begin with.

Estimate of Revenue.

300 subscribers at £5. 5s. average annual receipt	£1,575	0	0
20 public telephone call offices at an average receipt of 3s. per week	156	0	0
Extra mileage charges on lines exceeding one mile in length, say 10 miles at £2, say	20	0	0
Commission on value of messages telephoned to the Post Office for transmission as telephones, express letters, etc., say	7	10	0
	£1,758	10	0

Estimate of Working Expenses.

Manager and engineer at £3 per week	£156	0	0
Clerk and storekeeper at 30s.	78	0	0
One junior or lady clerk at 15s.	39	0	0
One boy at 10s. per week	26	0	0
Corporation establishment charges	50	0	0
Eight girl operators at 9s. week average wage	187	4	0
Rent and rates of central switchroom and offices	50	0	0
Rent of small switchroom at St. Margaret's	15	0	0
Local assessments	8	0	0
Insurance, light, firing, water, cleaning	40	0	0
Stationery, printing, postage, office sundries	26	0	0
Wayleaves	50	0	0
Repairs at £2 per cent. on £5,120	103	8	0
Post Office royalty, 10 per cent. on £1,751	175	2	0
Interest on capital, 3 per cent. on £5,120	153	12	0
Sinking fund, 3 per cent. on £5,120. This, with interest on accumulations at 2½ per cent., will pay off the whole capital in 25 years	153	12	0
Depreciation and renewal fund, 2½ per cent. on £5,120; 3 per cent. with interest on accumulations at 2½ per cent. would renew the whole system in 25 years. But the old material taken out would be worth at least ½ per cent., so that 2½ per cent. would renew the whole system in 25 years	128	0	0
Income tax and sundries	60	0	0
Commission on public telephone receipts	13	0	0
Contingencies	50	0	0
	1,560	18	0
Add on account of lines partly constructed—interest at 3 per cent. on £1,200	36	0	0
Sinking funds at 3 per cent. on £1,200	36	0	0
	£1,632	18	0

Net revenue, £125. 12s.

It will be observed that not only is provision made for recovering the whole capital in 25 years, but for renewing the whole of the plant, so that at the termination of the license the Corporation would be in possession of an efficient up-to-date system which would have cost them nothing. If this provision be deemed excessive, then the amount saved from the depreciation and renewal fund will be available towards a further reduction of rates.

THE MUNICIPAL ELECTRICAL ASSOCIATION.

The programme of the fifth annual convention of this association, to be held in Huddersfield from June 20 to 23 inclusive, has just reached us. The president this year will be Mr. A. B. Mountain; the vice-presidents, Messrs. A. S. Barnard and J. E. Edgcome; and the committee, Messrs. W. A. Chamen, A. Ellis, A. B. Holmes, J. F. Snell, T. P. Wilmshurst, E. T. Ruthven Murray, and Aldermen Norman and Skinner. The hon. secretary will be Mr. E. T. Ruthven Murray. On Wednesday, June 20, the convention will open with a general meeting for the discussion of papers at the Technical College, Huddersfield. Previous to this, however, the associates' prize will be presented to Messrs. J. R. P. Lunn and P. Thompson. Mr. A. B. Mountain will then deliver his presidential address, after which papers will be read by Alderman Potter, of Taunton, and Mr. H. C. Bishop, of Wigan, on "Means for Stimulating the Demand for Electrical Energy," and on "Electricity Works for Small Towns," by Messrs. C. S. Vesey Brown, of Lincoln, and G. M. Harris, of Bray. A lunch will be given by the Corporation of Huddersfield to the members at 1.10 o'clock. In the afternoon a visit will be paid to the Bradford electricity works and electric tramway system. After the inspection the Mayor of Bradford will meet the party at the town hall, when light refreshments will be served. In the evening a dinner will be given at the Huddersfield Town Hall by Mr. J. Hopkinson to the members of the association.

On Thursday the papers for discussion will be on "Electric Motors," by Messrs. T. P. Wilmshurst and C. A. L. Prussman; "The Combined Management of Tramways and Lighting Departments," by Mr. R. C. Quin; and "Methods of Reducing Light-Load Losses," by Mr. H. L. P. Boot. After lunch the Mayor's garden party will be held in Beaumont Park, Huddersfield, and at 7.30 p.m. the association dinner is to take place at the town hall. The price for the tickets for this is 7s. 6d. up to June 15, after which it is raised to 10s.

On Friday the papers for discussion will be on "The Distribution of Electricity in Scattered Areas," by Messrs. L. Andrews and G. Wilkinson; "Maintaining Certain Portions of Electrical Distribution Systems at Earth Potential," by Mr. C. H. Wordingham; "Impressions of Present American Tramway Practice," by Mr. A. E. Le Rossignol; and "Protection of Telegraph and Telephone Wires." After lunch the members will visit Leeds and inspect the Corporation electricity works and tramway power station and car-sheds.

On Saturday, June 23, the annual business meeting will be held at the Technical College, Huddersfield, when the election of officers and other business will be transacted. We are asked to state that copies of papers and all information as to local arrangements may be obtained from Mr. A. B. Mountain, Corporation Electricity Works, St. Andrew's-road, Huddersfield.

BELFAST ELECTRICITY WORKS.

We have received the accounts of the Belfast Corporation electricity works for the year ended Dec. 31, 1899, from which it appears that the total expenditure on capital account amounts to £138,394. 3s. 9d. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., during the past year:

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Redeemable stock	83,610	0	0
Gas Committee—amount advanced	32,500	0	0
	116,110	0	0
Creditors	968	10	7
Renewals suspense account—amount in hand	1,147	16	10
Supense account	5,090	16	3
Redeemed stock account—stock redeemed	250	0	0
Net revenue account—amount in hand	2,655	9	7
Treasurer—balance due bank	16,496	5	6
	£142,718	18	9

Cr. Assets.	£	s.	d.
Capital account	137,714	18	0
Stock on hand	154	19	8
Debtors	4,849	1	1
	£142,718	18	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Units generated	742,590
Number of public lamps	6,192
Quantity sold	622,486
Quantity used on works	33,076
Quantity lost in battery	46,099
Total quantity accounted for	701,611
Quantity not accounted for	40,929
Total maximum supply demanded in watts	955,700

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REVENUE ACCOUNT.

Dr.				£	s.	d.
Public Lamps.						
Attending and repairs	£11	14	6			
Renewals of lamps	5	19	7			
				17	14	1
Generation of Electricity.						
Fuel, gas, and coal	1,754	10	7			
Oil, waste, water, and engine-room stores	246	16	3			
Salaries and wages	1,134	19	9			
Repairs and maintenance	353	5	7			
				3,489	12	2
Distribution of Electricity.						
Wages of linesmen, etc.	330	2	8			
Repairs and renewals of mains	61	7	4			
Repairs at consumers' premises	36	5	6			
				427	15	6
Rents, Rates, and Taxes.						
Rents	149	17	9			
Rates and taxes	574	4	8			
				724	2	5
Management Expenses.						
Salaries—engineer's department	503	15	1			
Meter inspection	29	18	10			
Stationery and printing	200	11	10			
General establishment charges	234	12	2			
				968	17	11
Insurance				104	1	6
Miscellaneous				10	18	4
				5,743	1	11
Amount carried to net revenue account				5,936	5	9
				£11,679	7	8

Cr.	£	s.	d.
Sale of current, £11,328. 16s. 10d.; less discount and bad debts, £21. 1s. 2d.	11,307	15	8
Meter rents, £316. 13s. 9d.; less bad debts, 17s. 9d.	315	16	0
Testing fees	4	4	0
Sale of old lamp	51	12	0
	£11,679	7	8

KINGSTON-UPON-HULL.

From the electric lighting accounts of this city for the year ended March 31, 1900, it appears that the total capital expenditure up to that date amounts to £133,802, 2s. 9d. We give herewith an abstract of the revenue account, general balance-sheet, and statement of electricity, generated, sold, etc. :

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel				3,398	5	11
Oil, etc., and engine-room stores				416	7	7
Wages				1,998	14	6
Repairs and maintenance: buildings, £24. 7s. 3d.; engines and boilers, £186. 15s. 1d.; dynamos, transformers, etc., £17. 7s.; other machinery, £191. 1s. 9d.; accumulators, etc., £513. 2s.				932	13	1
				6,746	1	1
Distribution of electricity: wages, £456. 1s. 6d.; repairs, maintenance, etc., of mains, £495. 10s. 3d.; repairs and maintenance of transformers, etc., £192. 4s. 9d.; repairs, etc., of apparatus at distributing stations, £3. 0s. 8d.				1,146	17	2
Rents, rates, and taxes				1,115	19	3
Management expenses: salaries, £1,154. 13s. 4d.; printing and stationery, £126. 2s. 8d.; general establishment charges, £174. 15s. 11d.				1,455	11	11
Special charges: law expenses, £6. 17s. 8d.; insurance, £159. 16s. 10d.				166	14	6
				10,631	3	11
Balance carried to net revenue account				8,659	8	8
				£19,290	12	7

Cr.	£	s.	d.
Sale of current per meter at 5d., 5½d., and 2½d. for lighting, and 2½d. per B.T.U. for motors	18,390	6	8
Rental of meters and other apparatus	616	18	11
Service connections, testing installations, etc.	253	7	0
Premium, improver	30	0	0
	£19,290	12	7

BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital—loans raised by stock, £53,584. 15s. 11d.; Bank of England, £75,400. 18s. 5d.	128,985	14	4
Sinking fund	11,545	19	5
Reserve fund	10,092	16	4
Sundry depositors, deposits on supply of current	83	12	0
Revenue—sundry creditors	458	8	4
	£151,166	10	5

Assets.	£	s.	d.
Capital—amount expended on works	133,802	2	9
Less instalments written off meters	1,812	0	0
	131,990	2	9
Sinking fund investment—Hull Corporation 3 per cent. redeemable stock	11,545	19	5
Stores on hand March 31, 1900	508	7	2
Sundry debtors for current, etc., and work done	7,122	1	1
	£151,166	10	5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units	1,211,490
Quantity sold to private consumers by meter	940,192
Quantity used on works	160,605
Total quantity accounted for	1,100,797
Quantity not accounted for	109,693
Total maximum supply demanded	1,405

BOLTON ELECTRICITY ACCOUNTS.

From the accounts of the Bolton electricity department just issued we take the following abstracts of the revenue account, balance sheet, and amount of electricity generated, sold, etc., for the year ended March 31, 1900 :

REVENUE ACCOUNT.

Dr. Expenditure.	£	s.	d.
Generation of electricity: salaries and wages, £1,377. 2s. 1d.; fuel, £2 695. 8s. 5d.: oil, waste, water, etc., £399. 13s. 5d.; repairs and maintenance of works and plant, £372. 10s. 4d.	4,844	14	3
Distribution of electricity	7	6	10
Management expenses: salaries and wages, £609. 16s. 9d.; stationery and printing, £106. 5s. 2d.; miscellaneous expenditure, £56. 17s. 11d.	772	19	10
Rents, rates, and taxes	417	7	9
Insurance	13	0	4
Bad debts	11	9	8
Dyson and Co., provisional order charges	128	17	7
Total expenditure	6,195	16	3
Balance carried to profit and loss account	5,902	14	6
	£12,098	10	9

Cr. Income.	£	s.	d.
Sale of electricity, per meter, £10,465. 3s. 3d.; less discounts, £966. 17s. 5d.	9,498	5	10
Rental of hired meters, £296. 12s. 6d.; less allowances, 3s. 3d.	296	9	3
Fittings sold and work done, £8,089. 0s. 11d.; less wages, materials, etc., used in fittings trade, £7,379. 0s. 3d.	710	0	8
Amount of charge for current for cars, 255,000 at 1½d.	1 593	15	0
	£12,098	10	9

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Trustees, Preston Savings Bank debenture, £50,922; less repayments, £5,428. 4s.	45,493	16	0
Leeds, etc., Savings Bank debenture, £17,300; less repayments, £2,244. 9s. 3d.	15,055	10	9
Ordinary mortgages	49,500	0	0
District funds, proportion of profit due	1,000	0	0
Sundry creditors	3,753	16	5
Manchester and County Bank, amount overdrawn	9,588	0	9
Reserve fund	963	7	9
Surplus assets, being amount of loan debt extinguished	7,672	13	3
	£133,027	4	11

Cr. Assets.	£	s.	d.
Land	4,709	2	8
Buildings	20,557	19	2
Machinery	49,889	3	8
Accumulators	1,661	0	6
Mains	26,453	6	0
Transformers, motors, etc.	7,406	17	7
Electrical instruments	331	8	5
New meters, including fixing	6,580	17	2
Supply of current	5,427	8	1
Fittings account	4,987	19	7
Meter rents	82	16	6
Reserve fund investment in Government consols	512	10	8
Stocks on hand	4,426	14	11
	£133,027	4	11

GENERATION AND SALE OF ELECTRICITY.

Total B.T. units generated			1,174,478
Quantity sold	Tramways	255,000	
	Private consumers	559,406	
	Public lamps	10,386	824,792
Used on the works			89,883
Total accounted for			914,675
B.T. units unaccounted for			259,803

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NONE SO BLIND AS HE WHO WILL NOT SEE.

Almost every change has been rung on the bells of municipal accounts, yet ever and anon a new combination is made prominent, and the wonder goes round that more had not long since been heard of it. There is another old saw, that any stick is good enough to beat a dog with, which may be applied to accounts above mentioned. It does not always pay to tell the whole truth, and just now some municipal officials are faring badly at the hands of local critics because the said critics do not or cannot see that too much success may bring about momentary troubles of various kinds. Here is a by no means uncommon tale. Little Pedlington some years ago obtained a provisional order, erected and equipped a central station. The estimated demand fell short of the actual demand, and the station plant was fully loaded almost before the installation was completed. The designer probably expected a loss on working for a year or two while the load gradually came on. His expectations have been falsified and the balance-sheet has shown from the very first, or almost from the first, a good credit balance. All the while applications for connections pour in. This, we maintain, is a condition by no means unknown. As a result, the committee go in largely for extensions at the stations and of mains, thus increasing the capital account. The capital account is thus divided into two distinct parts—one productive, the other not productive; but interest and sinking fund are required from the time of borrowing, whether dealing with the productive or the unproductive portion. Further, the time necessary for the first portion of capital expended in the way indicated to be thoroughly productive, is usually far shorter than in the case of the second equal amount. In fact, the first picks up all the plums, the next has to labour over its task. Now, municipal accounts are made to look exceedingly bad in these cases, because the productive part of the capital is handicapped, and according to the red-tapism of the powers that be has to pay interest and sinking fund for the total capital, or the affair must be put down as a failure. A simple measure of relief would be to remit, say, three or five years of time before the repayment fund became operative. What the Government officials say is practically this, "You must earn at least 6 or 7 per cent. the first and every succeeding year upon the total capital, or you don't succeed." The local and other wiseacres, parrot fashion, echo this cry, and thus contribute to swell the chorus of adverse comments, without even thinking of the facts of the case. And this is supposed to be the age of morality, of truth, and of newspaper responsibility! Why, the facts all tend to prove the very reverse, and that one-sidedness is rampant; that the aim is to make out a case for a particular side, and no trouble taken to ascertain the truth. "'Tis pity; pity 'tis, 'tis true." The position of municipal officials is not an envious one at the best of times, but when they are roughly criticised for things over which they have no control, they sometimes find it

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difficult to retain their temper. If due attention was given to the shortcomings of the Board of Trade and the Local Government Board it would be more to the purpose, but we all know when these departments are criticised it is with halting tongue and in hushed tones, with a peremptory request not to publish. It is with these departments the fault lies, and it is by their aid the remedy should come.

CHAMBERLAIN AND HOOKHAM v. BRADFORD CORPORATION.

The judgment given in this case is in the direction generally expected, and may have widespread influence. As will be seen, the judgment holds that an energy meter even with one of the factors it registers constant cannot be held to infringe a meter that only registers the other factor. That, in our opinion, was the important point to be decided, the other questions being subsidiary, and, if we may say so, of more legal than technical subtlety. This case was one of infringement, not of validity, yet naturally a large part of the evidence was upon points which might be held to affect validity. However, Mr. Justice Farwell held there was no infringement, and that he had not to consider any new evidence over and above that presented to Mr. Justice Wills on the question of validity. The sale of both energy and meters is very large, so that the interests involved by a case of this kind are correspondingly great, and the users of energy meters will feel relieved with the decision.

THE ELECTRIC POWER BILLS.

(Continued from page 746.)

WEDNESDAY.

The Select Committee presided over by Sir James Kitson, and consisting of Sir A. Scoble, Mr. Barkley, Mr. Ashton, Mr. Howard, Mr. Billson, and Colonel Long, entered upon the consideration of the Lancashire Electric Power Bill on Wednesday, May 23. Mr. Worsley Taylor, Q.C., Mr. Erskine Pollock, Q.C., and Mr. Shaw appeared for the promoters. There was a large number of appearances against the Bill, amongst them being the Liverpool Corporation, the Manchester Corporation, the Corporations of Widnes, Wigan, Ashton-under-Lyne, and Leigh, represented by Mr. Balfour Browne, Q.C., Mr. Freeman, Q.C., Mr. Lewis Coward, and Mr. Rhodes; Warrington, Salford, Bacup, Bolton, Oldham, Stockport, Eccles Corporations, with counsel reserved; the Southport Corporation, represented by Mr. Davies Williams; the Urban District Councils of Stretford, Withington, Moss Side, Levenshulme, Worsley, Farnworth, Hindley, Abram, Gorton, and Withnell, and the Manchester Ship Canal Company and the Manchester Carriage and Tramways Company.

The CHAIRMAN, at the outset of the proceedings, said: I have to state on behalf of the committee that they have arrived at the following opinion: "That the value of electrical enery as a means for the transmission and application of power has been amply demonstrated, and its importance to the industries of this country is admitted. The committee accordingly advise that it is of public advantage to facilitate measures which may ensure a general supply of electrical power to all consumers who may seek to avail themselves of the economy and efficiency offered in the service of these sources of application of power." The point of this declaration is that the committee do not require the constant repetition of scientific evidence to prove what has already been proved to their satisfaction.

Mr. WORSLEY TAYLOR, Q.C., in opening the case for the promoters, said the pronouncement of the committee had considerably narrowed the observations it would be necessary for him to make in presenting the Lancashire Electric Power Bill before them. The points to which he would direct his attention were these: (1) the scope of the powers of the Bill in relation to the area they proposed to serve and to the public in that area; (2) the question of the suitability of the area for supply; and (3) as to the financial capacity of the promoters to carry out the undertaking. Upon the first point he would say that, under clauses introduced into the Bill, they could not compete, either directly or indirectly, with any local authority or company already authorised by license, order, or special Act to supply energy within the area of supply. The promoters could not supply directly to the customers of those local authorities or companies. They sought authority to supply on behalf of a local authority which had already got the power to do so, but only as the agents of that local authority. Eliminating, therefore, the power to supply as agents, all the promoters asked power to do was to supply in a general supply district, and to distribute in that district if they had got a provisional order or an Act of Parliament. The powers of the company were, therefore, strictly limited. The only question between the promoters and the opponents was whether in any particular case there were some special circumstances for taking them out of the general rule that there ought to be a wayleave through their district. As to the suitability of the area, this comprised all Lancashire south of the Ribble. It was the manufacturing part of Lancashire, an area said by one of their opponents to have a population of three millions and a ratable value of £14,000,000. It was the great coalfield of Lancashire, which was traversed in all directions by good main roads and by the systems of the various railway companies, and, therefore, eminently suitable for the placing of their central generating stations. The whole of the area, with the exception of the more agricultural part in the neighbourhood of Southport, was one great mass of industries and manufactures of one kind or another, and it would be impossible, he submitted, to find an area more in need of this supply. The mains would run along about 1,500 miles of roads, and the County Council had decided to support the scheme. At first many public authorities opposed the scheme, but that was because they were ignorant of its provisions. The promoters could not supply any town with energy unless the Council assented. The scheme was more for the benefit of smaller districts who could not afford to supply themselves, but some local authorities who were already providing their own electricity might find it cheaper to take it from the promoters than to enlarge their generating stations. There were 129 local authorities in the county, 16 of whom possessed electrical works, and five had them in course of construction. The generating stations of the 16 authorities cost 1½ millions sterling, the aggregate generating power produced in them being 15,000 kw. Two-thirds of this power was produced by Manchester and Liverpool, the other third being allocated amongst 19 stations. In consequence of the difficulties in the way, 87 local authorities in the county had not applied for provisional orders to supply themselves with electricity within their area, the population of these averaging from 8,000 to 10,000. The promoters intended to erect four generating stations—at Little Lever, near Bolton, Aspull, near Wigan, St. Helens, and Trafford Park, on the Manchester Ship Canal. All would be situate conveniently near coalpits, and would have good railway facilities and good water. The capacity of the Wigan station would be 15,000 kw., and the cost about £375,000. From each station there would be 125 miles of cable at a cost of £1,000 a mile, and the total cost of each station would be about £500,000. The capital of the company was proposed to be £3,000,000, and the usual borrowing powers would bring it up to £4,000,000. The promoters were a combination of local gentlemen largely interested in various industries in Lancashire and gentlemen who were experts in electricity and connected with

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very large electrical undertakings. Dealing with various petitions, counsel said that Manchester seemed responsible for a good deal of the opposition to the Bill. If the opposition of Manchester and Liverpool and the other large towns resulted in rejecting the Bill, small local authorities would be prevented from getting electricity except through wealthy corporations like Manchester and Liverpool. Sixty-five urban districts out of 84 in the county did not oppose the Bill, and their only chance of getting electricity was by a scheme of this kind.

Mr. F. E. GRIPPER, electrical engineer, one of the promoters of the scheme, said they proposed to generate electricity on a larger scale than ever before attempted in this country, and with the exception of Niagara they would produce the current cheaper than any water power in the world. The possibilities of generating electricity on a large scale were not yet exhausted, in his opinion. He corroborated counsel's opening statement as to the character of the area the promoters would supply, and as to the convenience and benefit it would be to local authorities to receive such an economical supply. Unless invited by the local authority the promoters would not supply electricity to any district. The only compulsory powers sought by the Bill were to lay mains through the various districts. In the mains they proposed to have a voltage of 10,000 volts, which could be transformed down to suit the requirements of local authorities or companies. The capacity of the plant at each generating station would be 12,500 kw. Assuming a load factor of 25 per cent., the output would be 27,375,000 units, and the estimated cost of generation and distribution would be 0·7d., amounting to about £79,800 per annum. They would supply the current at an average price of 1½d. per unit, which would produce about £142,000, leaving a profit on the business of £62,000 per annum on each generating station. He had not the least doubt that the promoters would be able to raise the required capital. They were Messrs. Percy R. Sellon and Norman Scott Russell, of the Brush Electrical Engineering Company; H. Edmunds, W. P. J. Fawcus, and G. B. Samuelson, of W. T. Glover and Co.; F. E. Gripper and W. B. Hopkins, of Edmundson's Electricity Corporation; G. Caldwell, colliery owner, West Houghton; Major W. H. Edwardes, member of the Liverpool Corporation; Messrs. Malcolm Guthrie, Liverpool; Frederick Kitchen, of Liverpool; Robert Matthews, of Armstrong, Whitworth, and Co., Manchester; J. E. Prestwich, cotton spinner, Farnworth; and W. W. Rutherford, member of the Liverpool Corporation.

The committee then adjourned.

THURSDAY.

On Thursday Mr. F. E. GRIPPER was cross-examined by Mr. Freeman, Q.C., on behalf of the Liverpool Corporation, the Manchester Corporation, and other local authorities. The witness said that by the Bill the promoters would be obliged to supply any corporation and company with electrical energy who asked for it, but they could not supply any individual person unless the local authority gave its consent. Public bodies and companies who received the supply would have to guarantee to take an amount of energy equivalent to 20 per cent. of the cost of the mains for seven years. Such a condition was not unusual. He was not aware that a considerable number of local authorities had obtained provisional orders and had agreed to hand them over to Manchester. The local bodies could retain control of their own streets and roads; they ought not to be able to say that the promoters should lay their mains only on the outskirts of their respective areas. The scheme would touch about 20 places of over 10,000 inhabitants. It was proposed to take the mains on the outskirts of Manchester to supply several places outside that city. He was not aware that those places did not want the promoters' supply. Their mains would be laid to Liverpool and Bootle, but they would not supply those places unless they asked for it. In reply to counsel's statement that Liverpool and Bootle might as well be struck out of the Bill, the witness replied that they might want them by-and-by.

Cross-examined by Mr. Wedderburn, Q.C., on behalf of various urban district councils, Mr. Gripper said no doubt some local authorities had delayed putting their provisional orders into effect because of the present high cost of material. Local authorities might be induced to take their supply from the promoters because it would be cheaper than they themselves could produce it.

Examined by Mr. Davies Williams for the Southport Corporation, he stated that, assuming that Southport could produce electricity as cheaply as the promoters could, the probability of the borough's asking for the promoters' supply would certainly be remote. Southport would be about 20 miles from the nearest generating station, whence the mains would have to be laid through an agricultural district at a cost of £1,000 a mile. They hoped to supply most of the manufacturing districts. With the exception of potting shrimps there were no manufactures in Southport. As to whether he had ever heard of electricity being required for potting shrimps, he stated that he was not an expert in potted shrimps. The witness further said that the promoters hoped to supply Birkdale. He understood that Birkdale had arranged with an existing company to supply them, but such arrangements did not last for ever.

In answer to the committee, he said, as the promoters would be responsible for the mains, he would strongly object to these being laid by the local authority. There was no objection to the local bodies opening the streets, but he thought Mr. Ritchie made a mistake when he stated in the House of Commons that they were also to lay the mains. Up to the present Lancashire had done practically nothing in the way of supplying power. As they would only pass through the suburbs of Manchester, the promoters would not object to a clause protecting the central part of Manchester.

Mr. W. W. B. HULTON, chairman of the Main Roads and Bridges Committee of the Lancashire Council, was then called, and said the committee had passed a resolution approving of the principle of the Bill, and had authorised him to give evidence in support of it. The information brought to the committee from the various localities was that they needed this electrical supply, which would assist them to develop their industries. On that ground, and having secured a clause protecting their roads and bridges, the County Council welcomed the scheme.

Mr. A. VICKERS, a managing director of Messrs. Vickers, Maxim, and Co., then gave evidence in support of the Bill.

Colonel G. H. MORRISON, of Liverpool, stated that the Liverpool Chamber of Commerce had approved the principle of the Bill, and had passed a resolution supporting the scheme, provided municipal interests were protected.

Cross-examined by Mr. Freeman, he stated that as an individual manufacturer he thought the scheme would give great advantages to manufacturers. The concentration of power in one station would be advantageous, and manufacturers would economise their capital if the promoters could apply electrical energy to them at even no greater cost than they could produce it themselves.

Mr. W. H. HEWLETT, resident manager of the Wigan Coal and Iron Company; Mr. J. GARNETT; and Mr. ROBERT MATTHEWS, a director of Armstrong, Whitworth, and Co., also supported the Bill, and the committee then adjourned.

FRIDAY.

On Friday, Mr. W. P. J. FAWCUS, one of the promoters of the Bill, was examined by Mr. J. Shaw. He stated that he was of opinion that the scheme would give an efficient supply of electricity at a cheap rate. As an expert, he considered the works could be carried out for the estimated amount, and there would be no difficulty in getting the necessary capital. The road authority would, under the ordinary law, have the power of opening up the street and charging the promoters with the cost, but the actual laying of the mains he thought ought to be in the hands of the company.

Cross-examined by Mr. Freeman, Mr. Fawcus said the company would supply individual firms through the local authority, who probably would not give their consent where they themselves were in a position to supply. This was by far the largest of any of the schemes before the committee, the area of supply being some 1,100 square miles.

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Prof. SILVANUS THOMPSON gave evidence as to installations at Ogden (U.S.), Geneva, Niagara, Lauffen, etc., where power is generated on a large scale and distributed over a wide area. The present scheme was perfectly feasible. There was no distance proposed to be covered under this scheme that was too great to be successfully managed.

In answer to the committee, Prof. Thompson said the company were proposing to carry 5,000 h.p. in one main. The Board of Trade did not at present permit more than 1,300 h.p. to be carried in one cable. If, therefore, the Board refused to modify its rules, the company would have to lay four cables to transmit the requisite power. He could not say whether the four cables would be allowed in one conduit. This no doubt would to some extent increase the cost and also the interference with the streets.

Mr. JOHN RAWORTH was examined, and said he considered that the absence of means for distributing electrical power in Great Britain was a serious detriment to the development of its industries, and, among other inconveniences, tended to perpetuate the smoke nuisance. The promoters, he thought, should lay the cable.

Cross-examined by Mr. Freeman, he said he was aware that most of the large towns in Lancashire had provisional orders, and this company could not enter those towns except with the consent of the local authority, and this was a weak point in the scheme.

Examined by Mr. E. Pollock, he said the overhead transmission wires in America and on the Continent were bare, which would not be allowed in England. For this reason overhead wires could not be used.

Mr. G. CALDWELL, mining engineer, and one of the promoters of the Bill, was examined, and stated that various collieries with which he was connected would be glad to see this scheme through and to take power at a reasonable rate. He thought there would be no difficulty in raising the requisite capital.

This concluded the case for the promoters of the Bill.

Mr. WEDDERBURN then opened the case on behalf of the 15 urban district councils represented by him. After the intimation of the views of the committee on the general principle, he proposed to confine himself to the question whether the passing of this particular Bill would be likely to ensure cheap and efficient power. His contention was that the Bill would legalise an experiment which in all probability would fail, and which while going through this process of failure would have a hindering effect on the use of electrical power. This Bill was differentiated from the other Bills before the committee by the fact of the enormous area proposed to be supplied—some 1,100 square miles, as against 250 or 125 square miles proposed to be served by the Durham Bills. The proposed area was vastly too large. It would be infinitely more reasonable, he submitted, to apply to serve a limited area, and having done that successfully they could then come for further powers. What he thought would occur was that as soon as they had obtained power over the whole district they would form subsidiary companies, who would go for provisional orders, and, having done that, would supply them with their power. Thus in time the company would be supplying other companies which, in effect, would be their nominees. They would, in effect, endeavour to acquire a monopoly, and this was one reason why out of 128 local authorities only eight or nine were supporting this scheme. The local authorities also opposed, because they could, and in some cases did, supply themselves as cheaply as this company could do the work, and if there was a profit they held that the profit should go to the municipality and not to shareholders.

The CHAIRMAN: If it cannot be supplied without the consent of the local authorities, where are you injured?

Mr. WEDDERBURN submitted that the promoters must make out a case. It was not enough to show that a Bill was a harmless experiment. They must show a public advantage, especially in view of the powers they sought in regard to the roads.

Mr. W. ASPINALL, clerk to the Abram Urban District Council, gave evidence against the scheme.

Mr. R. HAMMOND, called on behalf of the district councils, said he should be delighted to see the whole country covered with power-distributing undertakings, but he considered that in this case the *quid pro quo* was by no means adequate—in fact, local authorities were not being offered as good a condition of things as they could create for themselves. As to the price charged in other places, Mr. Hammond handed in a long list of towns with the charges at each.

In answer to the Chairman, Mr. Hammond said he considered the proposed generating stations at St. Helens, Ince, Eccles, and Little Lever were, on the whole, well placed for the purpose in view.

Asked whether he objected to this Bill on the ground that competition would be excluded, Mr. Hammond said his contention was that a better Bill would be excluded.

As to his view of a better Bill, Mr. Hammond said that, granted that distribution of power was to be a great business, a company might come and say, "We will put our maximum rate at 2d. instead of 4d." He should call that a better Bill—a Bill which offered a *quid pro quo* for the use of the roads. If this company got in upon these roads, another company would not be able to get in. Of course, they could have more companies, but the result in practice would be that there would be no competition.

The further consideration of the Bill was then adjourned until June 18.

PHYSICAL SOCIETY.

At the ordinary meeting held on May 25, 1900, Prof. Everett, F.R.S., vice-president, in the chair, **Prof. S. P. Thompson** showed some "**Experiments Illustrating the Aberration called Coma.**" If a converging lens is placed obliquely in a parallel beam of light, instead of forming a point image, it produces unilateral distortion, and the bright central spot is accompanied by a pear-shaped tail, which is known as a coma. The direction in which this tail points depends upon the side of the lens which is presented to the light. With a concave-convex lens the convex surface gives an inward pointing coma and the concave surface an outward pointing coma. The existence of this phenomenon is due to unequal magnification from different zones of the lens, a fact which was shown by covering the lens with a zone plate of three or four rings and viewing on a screen the distorted images of the several zones. The form of a coma varies greatly with the distance of the screen from the lens. A parallel beam of light which has passed obliquely through a convex lens is capable of producing some curious shadows. The shadow of a rod can be obtained as a circular spot, and that of a grating made by stretching threads between rods, as concentric circular rings. Prof. Thompson also showed a stringed model illustrating the paths of the light rays in the formation of a coma.

Mr. R. T. Glazebrook then read some "**Notes on the Measurement of Some Standard Resistances.**" Three methods have been employed by the author for building up multiples of a standard resistance, such as a one-ohm coil. The first method consists in making as accurately as possible three three-ohm coils. These in parallel can be compared directly with the standard by Carey Foster's method. Their resistance in series is very approximately nine times that in parallel, and hence an accurate determination of a resistance about nine ohms can be obtained. If, then, this resistance is put in series with the standard, an accurately known 10-ohm resistance is obtained. By a similar process a 100 or a 1,000 ohm coil can be built up. The second method consists in calibrating a resistance box. The one-ohm coils of the box are compared directly with the standard, and the other resistances determined accurately by a building-up process, using a subsidiary resistance box. In comparing the high resistances, the difference between the two boxes may be so great as to send the balance off the bridge wire. In these cases the third method is employed. The equal arms of the bridge are accurately known, and one of them is shunted with a resistance, which need not be accurately known, until the reading is brought back into the wire. The coils chiefly used throughout the experiments are made of platinum-silver.

Mr. Campbell asked if the same degree of accuracy could be obtained with manganin coils. If so, then the small temperature change of manganin would be an advantage.

Mr. Trotter asked if proper allowance could be made for the large number of mercury-cups used in method 1.

Mr. Reanie advocated the use of the built-up box in preference to the first method. With two mercury-cups there was less chance of errors escaping notice than with eight. Every 10 or 100 ohm coil tested at the Board of Trade was subjected to a comparison with a box calibrated by a build-up process.

Dr. Harker asked if the resistance of the eight mercury-cups in series had ever been measured, and, if so, what was the magnitude of the result and what the uncertainty?

Mr. Glazebrook said he had investigated the resistance of the mercury contacts, and it was negligible. In answer to Mr. Campbell, the author said he had no experience of manganin coils himself, but he had seen some figures for German coils which agreed very closely.

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Mr. J. J. Guest then read a paper "**On the Strength of Ductile Materials under Combined Stresses.**" The author throughout his expeiments has used the "yield point" of a material as the true criterion of its strength, and has rejected the elastic limit as being modified by local yielding. At present two theories are used in the calculation of strengths of materials. The first is that the material yields when one of the principal stresses reaches a certain amount. This theory, which was adopted by Rankine, and is used by engineers in England and America, is not in accord with recent experiments. The second theory is that the material yields when the greatest strain reaches a certain amount. This was advocated by St. Venant, and is used by engineers on the Continent. Besides these, there is a third theory of elastic strength, in which the condition of yielding is the existence of a shearing stress of a specific amount. In the case of a solid bar subjected to torsion, there is a variation in the strain from the axis outwards, and consequently the materials have been used in the form of thin tubes. This allows the application of an internal fluid pressure. The specimens were of steel, copper, and brass, the state of set caused by drawing having been removed by annealing. The tubes were subjected to (1) torque; (2) torque and tension; (3) tension only; (4) tension and internal pressure; (5) torsion and internal pressure; and (6) internal pressure only. The axial elongation, the twist, and occasionally the circumferential strain were measured. Towards the end of the experiments observations were made on bending. The results disprove the maximum stress theory, and are at variance with the maximum strain theory. The maximum shearing stress developed and the corresponding shearing strain were comparatively constant throughout the experiments, and no other simple relation between the stresses or strains was even approximately constant. The results of the experiments have been plotted synoptically on a curve, and the several lines have been drawn upon which these points should be according to the various theories. It is readily seen that the points cluster round the line which represents the existence of a specific shearing stress. The author therefore favours the resistance of this stress for any material.

The **Chairman** read a communication upon the subject from **Dr. Chree**. Mr. Guest, in his paper, has regarded the shearing-stress theory as a little-known one As the shearing stress is half the difference between the greatest and least principal stresses, this theory is the same as Prof. G. H. Darwin's maximum stress-difference theory. All the theories suppose that the stress-strain law is linear, and that strains are so small that their squares and products can be neglected. Mr. Guest concludes that in ordinary materials the law is linear to the elastic limit, which answers to a stress lower than that which answers to the yield point, and that yield point phenomena arise between these. Nevertheless, he focusses attention on the yield point as the criterion of strength, and assumes that Hooke's law holds up to it.

Prof. Perry congratulated the author upon his paper, and said there was no time left to discuss it at length. The results obtained gave information upon a subject of which very little is known experimentally.—The society then adjourned until June 8.

KINGSTON-UPON-THAMES.

The following is the sixth annual report of the borough electrical engineer (Mr. J. E. Edgcome, M.I.E.E., etc.) to the Lighting Committee:

I beg to present herewith my report for the 15 months ending March 31, 1900, being the sixth annual report on the working of the electricity undertaking of the borough.

Machinery.—The foundations for the new 200-kw. combined steam alternator are now being put down, and I expect the plant will be at work within the next two months. This will add further plant to the works capable of lighting 6,500 8-c.p. lamps burning at one time, or sufficient to allow of a further 10,000 8 c.p. lamps being installed on the circuit.

Mains.—Considerable extensions of mains have been made during the period embraced by this report. All the new cables laid are of the same type and class as those previously put down, and which have proved so thoroughly satisfactory—namely, concentric cables, heavily insulated, lead sheathed, and armoured with steel tape—the cables being laid direct in the ground.

High-Tension Feeder Cables.—No. 6 feeder has been extended from Richmond-road throughout King's-road, and a through connection made along Queen's-road and Wolverton-avenue to Coombe-lane sub-station. The Hill district has therefore now two separate feeders, which can be worked independently or in conjunction.

Low-Tension Distributing Cables.—A considerable number of extensions of the distributing cables have been carried out, amongst others, in St. James's-road, Penrhyn-road, Fairfield-road, Fairfield, Knight's-park, Orchard-road, Cobham-road, New-road, King's-road, Alexandra-road, Geneva-road, Grove-crescent-road, Gloucester-road, Richmond-road, and London-road. By the completion of the network of low-tension mains throughout the main streets it is now possible to carry out work on any high-tension feeder (which is, of course, thrown "dead" for this purpose) without interfering with the supply of current to consumers, as all the high-tension mains as now designed and laid down feed into the network, so that one or more feeders can be disconnected whilst the supply is being carried on by the other feeders. This is a matter of great convenience, and tends to carry out the chief feature of a satisfactory lighting system—namely, a constant and uninterrupted supply.

Public Lighting.—Five alternating current arc lamps, fitted with incandescent side lamps, have been erected in Fife-road, Kingston-hill, and Surbiton-park-terrace, the arcs being lighted from dusk till midnight, and the incandescent lamps from midnight till dawn. Experiments are being carried out with various classes of incandescent electric lamps with a view of their being adopted for lighting side streets.

Motors.—Several motors have been installed, and are working satisfactorily, driving printing machines, chaff-cutters, etc. As the price of current for this purpose has been reduced by 50 per cent., to 3d. per unit, there should be a considerable future for motors among power users, and I am confident that when the public appreciate the many facilities offered by electric motors, their ease of starting, absolute cleanliness, and simplicity of control, a large number will be used for driving printing presses, sausage machines, sewing machines, and for all purposes where power is required, whether constantly or intermittently.

Progress.—I have included several tables in my report; a new table showing capital expenditure, a table showing expenditure and receipts on revenue account, and tables showing comparative results since the opening of the works in 1893, comprising consumers and lamp connections, total units supplied, receipts, revenue summary, electricity supplied (excluding public lighting). The total loans sanctioned by the Local Government Board amount to £58 426, and the total amount spent to £50,674. 0s. 3d. The gross profits on the works before paying interest and repayment of capital are £2,737. 9s. 4d., and after paying off the interest there still remains a profit of £1,298. 11s. 4d. towards the repayment of capital, which, amounting to £1,346. 10s. 3d., leaves an adverse balance of £47. 18s. 11d., as against an adverse balance of £1,112. 0s. 9d. in 1898. Fortunately, a very favourable coal contract was made in 1899, some months before the abnormal rise in prices; but I fear that the inflated price of fuel, which will undoubtedly rule for a considerable time, will operate very prejudicially on the next balance-sheet of the undertaking, notwithstanding the increasing output of electricity. It is very satisfactory also to note the rapid increase in the number of consumers and lamps connected to the circuit, which is far above the average of former years, the number of consumers having increased from 211 to 311, and the number of lamps from 11,856 to 16,130.

Future Extensions.—Owing to the increased demand for current, it will be necessary to carry out some considerable extensions to the boiler-house, to contain new boilers, condensing plants, pumps, filters, and economiser; a new shaft will also be required, together with necessary flues. A considerable number of distributing mains will have to be laid to join up outlying portions of the low-tension system to the network, and to connect up new consumers from time to time. It will probably be found expedient and desirable to continue the public arc lamps throughout the main roads, so that there will be a complete line of arcs erected from end to end of the borough throughout the principal streets.

Revenue Account.

Expenditure.

Dr.				£	s.	d.
Generation of Electricity.						
Coal and other fuel, including carting	£2,407	14	1			
Oil, etc., and engine-room stores	209	12	2			
Wages at generating station	613	3	3			
Repairs and maintenance: buildings, £115 8s. 4d.; engines, boilers, £114. 8s. 3d.; dynamos, exciters, £64. 16s. 2d.; other machinery, instruments, £66. 13s. 7d.	361	6	4			
				3,601	15	10
Distribution of Electricity.						
Repairs, maintenance, and renewals of mains and apparatus on consumers' premises, including wages				147	4	9
Public Lamps.						
Attending repairs, including carbons and renewal of lamps				207	16	7
Management.						
Salaries, engineers' department	303	9	8			
Clerical	101	11	2			
Stationery, printing, and advertising	59	16	9			
General establishment charges	53	16	10			
				518	14	5
Rents, Rates, and Taxes.						
Rates and taxes	159	11	4			
Insurance	77	16	9			
Law charges	36	12	9			
				274	0	10
Special Charges.						
Interest on loans	1 438	18	0			
Repayment of principal	1,346	10	3			
				2,785	8	3
Lamps, stores, etc.				24	17	0
				£7,559	17	8

Cr.	Receipts.	£	s.	d.
Sale of current per meter		6,177	0	10
Sale of current for launch and battery charging		54	3	8
Rental of meters and apparatus on consumers' premises		179	6	6
Public lighting—arc and incandescent		1,048	17	6
Sundry sales		52	10	3
Deficit balance		47	18	11
		£7,559	17	8

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QUESTIONS AND ANSWERS.

Questions.

275. Describe a good form of artificial load suitable for a six hours' full-load test of a steam dynamo or alternator.—J. A. S.

276. I have frequently noticed that with three or four alternators running in parallel, all on the governors, an inclination to pull out of step can often be cured by considerably overexciting the field of one of them. What is the full explanation of this?—F. H. C.

Answers.

Question No. 269.—What is the best practical method of measuring the power absorbed in a three-phase circuit?

Best Answer to No. 269 (*awarded* 10*s.*).—The method of measuring power absorbed in any three-phase circuit may vary with the conditions under which the circuit is working. If the load on a three-phase circuit is symmetrical, it is obvious that it is only necessary to connect a wattmeter into one of the branches. The readings on this instrument multiplied by 3 will give the total power absorbed. Now, in any ordinary supply system, as from a central station, for motive power and lighting, the above conditions would not exist, as the load on the three branches or phases would never be more than approximately equal, and might vary between large limits. It is only necessary to connect up two wattmeters suitably for measuring power in three-phase systems, the manner of connecting them varying with the form of grouping of the circuits—*i.e.*, in star or mesh. This may be shown as follows:

1. *Mesh Grouping* (see Fig. 1).—Let a, b, and c be the currents in the three circuits, $o\,m$, $m\,n$, $n\,o$, respectively,

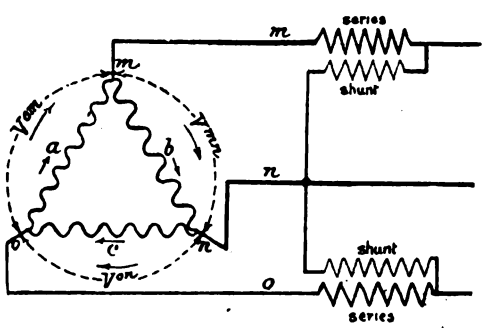

Fig. 1.

and let the pressures in volts across each circuit be represented by V^{om}, V^{mn}, V^{no}. Assuming the positive sense as shown by the arrows in the diagram (Fig. 1), it is evident that at any instant

$$W \text{ (the watts absorbed)} = a\,V^{om} + b\,V^{mn} + c\,V^{no} \quad . \quad . \quad (1)$$

Now, the algebraic sum of the voltages, or

$$V^{om} + V^{mn} + V^{no} = \text{(at any instant) } o,$$

or,
$$V^{om} = -V^{mn} - V^{no};$$

substituting in (1) we have

$$W = -a\,V^{mn} - a\,V^{no} + b\,V^{mn} + c\,V^{no}$$

$$= V^{mn}(b-a) + V^{no}(c-a).$$

If m, n, and o denote the currents in the lines leading to the circuits or mesh,

$$(b-a) = m,\ (a-c) = o,\ \text{or}\ (c-a) = -o.$$

$$\therefore W = V^{mn}\,m - V^{no}\,o.$$

The negative sign in this expression appears because of the direction assumed as positive. If the direction, say, in $n\,o$ be reversed, it is easily seen that

$$W = V^{mn}\,m + V^{no}\,o.$$

From this last expression it will be seen that, if the current m be passed through the series coil of a wattmeter, and the shunt coil of the instrument is connected across m and n, the second wattmeter having the current, o, passed through its series coil and the shunt connected across n o, then the sum of the readings on the two instruments is the total power absorbed in the three phases or circuits connected in mesh.

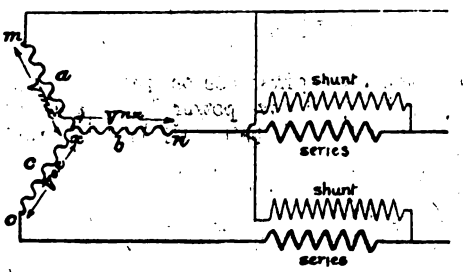

Fig. 2.

2. *Star Grouping* (see Fig 2).—Here we have the total watts absorbed, or

$$W = V^{mx}\,a + V^{nx}\,b + V^{ox}\,a \quad . \quad . \quad (2)$$

where a, b, and c are the currents in the three limbs of the star, and V^{mx}, V^{nx}, and V^{ox} the voltage across each limb. In a star-connected circuit the algebraic sum of the currents in the limbs is at any instant o,

or, $$a + b + c = o;$$

or, $$a = -b - c;$$

And $$V^{ox} - V^{mx} = V^{om};$$

similarly, $$V^{nx} - V^{mx} = V^{mn}.$$

Substituting in (2) we get

$$W = -V^{mx}\,b - V^{mx}\,c + V^{nx}\,b + V^{ox}\,c;$$

or, $$W = b\,(V^{nx} - V^{mx}) + c\,(V^{ox} - V^{mx}).$$

$$\therefore W = V^{mn}\,b + V^{om}\,c;$$

or the power, as in the mesh grouping, can be measured by means of two wattmeters suitably connected. Any difference of load in the three phases is fully accounted for.

Dr. Aron has adapted his well-known meter for polyphase working. The second pendulum is accelerated by the two movable coils of the wattmeters. Mr. Shallenberger has devised an ingenious method of using only one instrument, which, in the integrating wattmeter, consists virtually of an aluminium disc, driven by three coils connected as shown in Fig. 3. The shunt coil of the instrument is connected across two of the lines, and the series coil or coils in the other line. The current in the shunt coil is in quadrature with the E.M.F. of the series circuit, the torque exerted by the disc (which is controlled by permanent magnets) being proportional to the sine of the angle of phase difference of the shunt and series currents. A suitable non-inductive resistance is inserted in the shunt circuit to obtain a correct constant for the instrument.

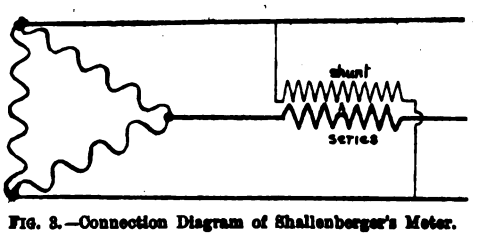

Fig. 3.—Connection Diagram of Shallenberger's Meter.

In the above it has only been shown how power may be measured for commercial purposes. There are several laboratory methods, the "three voltmeter method" being one; but none of these are of any practical use for central-station work.—J. S.

Answer to No. 269 (*awarded* 5*s.*).—The best practical method for the measurement of power in a three-phase circuit is that which uses an electro-dynamometer, and as this method finally reduces to a measurement of power in an ordinary alternate-current circuit, it will be well to consider this latter case first, and to see whether an electro-dynamometer actually gives a correct measurement of the power in an alternate-current circuit. Assume a circuit in which the sine law holds good. Let E and C be the maximum values of E.M.F. and current respectively. Then at any moment which may be assumed as occurring at a time, t, after the commencement of a period whose length is T, the instantaneous values of E.M.F. and current, e and c, may be represented as follows:

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$$e = E \sin\left(2\pi \frac{t}{T}\right)$$

$$c = C \sin\left(2\pi \frac{t}{T} + \phi\right)$$

where ϕ = the phase difference between E and C.

If P is the mean effective power during a period T, then the work done during that period is P T, and this is evidently also equal to $\int_0^T e\,c\,dt$, which is again equal to

$$\int_0^T E \sin\left(2\pi \frac{t}{T}\right) C \sin\left(2\pi \frac{t}{T} + \phi\right) dt.$$

Hence $$P = \frac{1}{T}\int_0^T E\,C \sin\left(2\pi \frac{t}{T}\right) \sin\left(2\pi \frac{t}{T} + \phi\right) dt.$$

The expression $2\pi \frac{t}{T}$ may be replaced by the expression α, denoting an angle, and the limit of integration, T, then becomes 2π. Hence the expression for power becomes

$$P = \frac{E\,C}{T}\int_0^{2\pi} \sin\alpha \sin(\alpha+\phi)\, d\alpha$$

$$= \frac{E\,C}{2\pi}\int_0^{2\pi} \left[\sin^2\alpha \cos\phi + \sin\alpha\cos\alpha\sin\phi\right] d\alpha$$

$$= \frac{E\,C}{2\pi}\left[\cos\phi\left(\frac{\alpha}{2} - \frac{\sin 2\alpha}{4}\right)_0^{2\pi} + \sin\phi\left(-\frac{\cos 2\alpha}{4}\right)_0^{2\pi}\right]$$

$$= \frac{E\,C}{2\pi}\left[(\cos\phi \times \pi) + 0\right]$$

$$= \frac{E\,C}{2}\cos\phi.$$

The mean effective rate of doing work is then $\frac{E\,C}{2}\cos\phi$, which has been deduced from the original formula $\frac{1}{T}\int_0^T e\,c\,dt$.

The wattmeter reading is not directly equivalent to this at first sight, as it is the mean value of all the expressions $e\,c$, where e and c are instantaneous values. What this mean is may be seen from the clock diagram

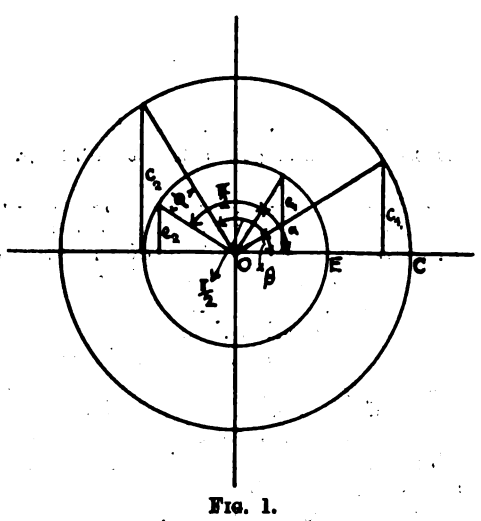

Fig. 1.

in Fig. 1, where O E and O C are the maximum values of E.M.F. and current respectively, and e_1, c_1 are two corresponding instantaneous values, e_2, c_2 being two others separated from the former by an angle $\frac{\pi}{2}$.

In the first position the force between the wattmeter coils is proportional to $e_1\,c_1$, which is equal to (E C sin α sin β). After an angle $\frac{\pi}{2}$, the force is proportional to $e_2\,c_2$, which again is equal to $\left[E\,C \sin\left(\frac{\pi}{2}+\alpha\right) \sin\left(\frac{\pi}{2}+\beta\right)\right]$, or (E C cos α cos β).

The mean of these two positions is

$$\frac{E\,C}{2}\left[\sin\alpha\sin\beta + \cos\alpha\cos\beta\right]$$

$$= \frac{E\,C}{2}\left[\cos(\alpha-\beta)\right];$$

but $(\alpha-\beta)$ is constant and equal to ϕ, the phase difference between E.M.F. and current.

Similarly, the mean of each pair of values 90deg. apart is $\frac{E\,C}{2}\cos\phi$, which is a constant. Hence, taking all possible values of pairs at right angles (which is equivalent to taking every value possible and dividing up into sets whose mean can be easily found), it is evident that the deflection of the dynamometer, which is proportional to the force between the coils, is proportional also to $\frac{E\,C}{2}\cos\phi$, which has already been shown to be the power in the circuit containing ordinary alternate current. Hence a wattmeter will give correct indications of power for a circuit with sine law. This holds also for other wave forms in sensitive instruments, and therefore a wattmeter may be regarded as an instrument which is admirably adapted for measurement of alternate current power.

It remains to be seen how the foregoing can be applied to the case of a three-phase power measurement. Let a, b, and c be the three leads; 1, 2, and 3 the three parts of the machine producing the three phases. Corresponding to these, let c_a, c_b, c_c be the currents in the leads; e_a, e_b, e_c the tensions between pairs of leads $b\,c$, $c\,a$, $a\,b$ respectively; and c_1, c_2, c_3, e_1, e_2, e_3 the currents and tensions in the three parts of the machine. These all denote instantaneous values. Then the rate of doing work in the circuit at any instant is given by

$$p = e_1 c_1 + e_2 c_2 + e_3 c_3.$$

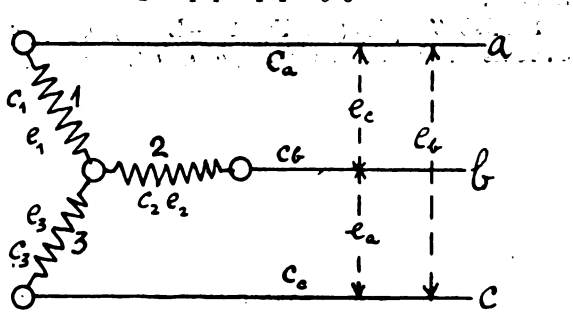

Fig. 2.

Consider (a) Y connection (Fig. 2).

Then $$e_1 - e_2 = e_c\ ;\ e_2 - e_3 = e_a\ ;\ e_3 - e_1 = e_b\ ;$$
$$c_1 = c_a\ ;\ c_2 = c_b\ ;\ c_3 = c_c\ ;$$
$$c_a + c_b + c_c = 0\ ;\ c_1 + c_2 + c_3 = 0.$$

Hence, also, $$e_1(c_1 + c_2 + c_3) = 0\ ;$$

i.e., $$e_1 c_1 = -e_1 c_2 - e_1 c_3.$$

Hence $$p = -e_1 c_2 - e_1 c_3 + e_2 c_2 + e_3 c_3$$
$$= c_2(e_2 - e_1) + c_3(e_3 - e_1).$$

Hence, finally, for Y connection,

$$p = e_b c_c - e_c c_b.$$

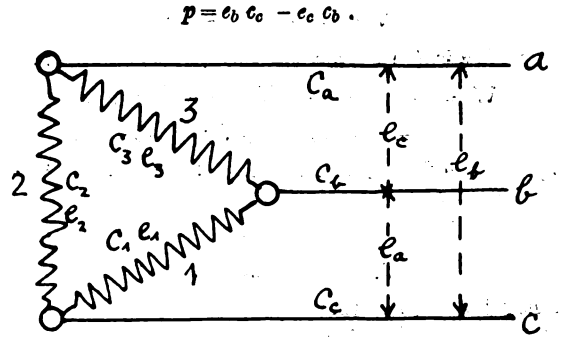

Fig. 3.

Consider, now (b) Δ connection (Fig. 3).

Here $$c_2 - c_1 = c_c\ ;\ c_3 - c_2 = c_a\ ;\ c_1 - c_3 = c_b\ ;$$
$$e_1 = e_a\ ;\ e_2 = e_b\ ;\ e_3 = e_c\ ;$$
$$e_1 + e_2 + e_3 = 0.$$

Hence $$c_1(e_1 + e_2 + e_3) = 0,$$

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and $$c_1 e_1 = -c_1 e_2 - c_1 e_3 ;$$

therefore $$p = -c_1 e_2 - c_1 e_3 + e_2 c_2 + e_3 c_3$$
$$= e_2 (c_2 - c_1) + e_3 (c_3 - c_1)$$
$$= e_b c_c - e_c c_b .$$

Hence, in either case, the momentary power, p, has the same form as an algebraical expression.

The mean effective power, P, is the mean of all values of p, and it has been before shown that the dynamometer will measure either of the parts of the above expression, and that they are equal respectively to

$$P_1 = \frac{1}{T}\int_0^T e_b e_c \, dt,$$

and $$P_2 = \frac{1}{T}\int_0^T e_c e_b \, dt,$$

which are expressions for the power in two ordinary alternate-current circuits. The measurement is carried out, therefore, by using two dynamometers, putting the current coil of one in c, and joining its shunt coil from e to a, while the current coil of the other is put in b, and the shunt coil connected from b to a.

In regard to the negative sign of P_2 on the right-hand side of the power equation, it is to be noted that the dynamometers are to be connected in the same way exactly in each case, and then their indications are to be algebraically added—*i.e.*, if they are on opposite sides of zero, they must be arithmetically subtracted—in which case the original assumption regarding the relation between the various E.M.F.'s and currents was right as regards sign, giving $(P_1 - P_2)$. But if the deflections are both to the same side, arithmetical addition takes place, giving $(P_1 + P_2)$. If only one dynamometer is to be had, then it can be used in connection with a set of two-way switches for each coil, the connections being so simple as not to require sketching. The only precaution necessary is that the current coil must be short-circuited before being cut out so as to avoid breaking the main circuit.

This concludes a description of the measurement as it is to be theoretically carried out. In practice, errors may come in owing to the self-induction of the coils of the instrument. The full consideration does not belong to this answer, which describes "the best practical method" of measurement, and, therefore, selects one in which self-induction corrections are practically unnecessary. The most exact method is with a mirror instrument, but this is not technically available, and the next best is that using a dynamometer or wattmeter, on the principle of Ganz and Co., with two coils whose planes are at right angles to one another, and entirely without iron. In such an instrument the error introduced by the phase difference between E.M.F. and "volt current" in the fine-wire coil is, from actual measurements, about 3 in 1,000—*i.e.*, may be neglected. This result is for 50 periods per second.

In other types of instruments the correction is greater, and may in cases require to be introduced. It is difficult to determine, and, as the question concerns the best practical method, need not, as said, concern us here. The best practical method is to take an instrument with negligible self-induction. Thus all the necessary points have been discussed, and so the question is completely answered.—T. C.

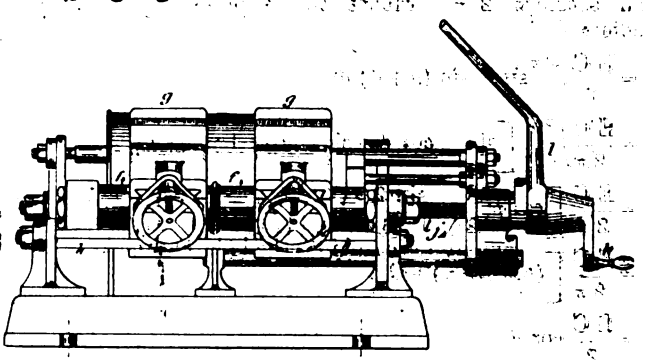
[N.B.—While we wish those answering the questions to make use of technical literature on the subjects, we do not propose to publish answers which are merely copied literally from text-books, as some sent in on the above subject were.—Ed. *E. E.*]

Question No. 270.—What advantage does the electric welding process possess over ordinary forge welding? Describe some form of electric welder.

Best Answer to No. 270 (*awarded* 10*s.*).—Nothing is of more importance in the constructive part of engineering than the efficient union of the materials used in a structure; especially is this true of those parts which have to bear a tensile stress. Although large structures of wrought iron and of mild steel commonly have their parts united by bolting or riveting, cases occur where the union of these metals by welding becomes almost a necessity or a matter of economy and convenience. Before electric welding was brought into practical use there was always a feeling of doubt about a weld, although they were and are of necessity largely trusted.

In all methods of heating (except by electricity) that are employed, involved that the heat should proceed from the outside, inwards, with the result that there were the chances of inadequate heat or an excess according to the skill of the workman. Moreover there was the difficulty of ascertaining to what state the heat had attained; commonly in small welds the pieces were withdrawn from the fire, with the consequent risk of picking up dirt during reintroduction.

Among the many advantages of electrical welding are that of uniform heating throughout the sectional area to be welded, that it admits of absolute regulation of the heat, that it is free from the possibility of introducing either particles of fuel or gases between the welding surfaces, and admits also of complete inspection during the time the heating is going on.



The illustration shows a large electric welding machine, which is supplied with a high-pressure current (alternating), which current embraces in its course the transformer, which is of suitable construction. It will be seen that one of the holding jaws, *g g*, in addition to sliding on the prolongation of the conductors, *f f*, is guided on a bar, *h*, along which it can slide, the other jaw being fixed so as to prevent its endway movement. The operative jaw which gives the endway pressure has its position controlled by the screw, *j*, on the handwheel, *k*, by which the rapid setting up and also the withdrawal of the pieces from contact, the one with the other, can be effected, while the final pressure is given by the ratchet lever arrangement, *l*, operating on the same screw, *j*. The jaws are bored up, to admit of the passage of water through them, and the flow is maintained by means of indiarubber pipes, but this provision is only necessary in cases of long-continued working. With this arrangement of machine the electric current is conveyed by conductors of large area, and of admirable conducting power, to the pieces to be heated, and very near to the ends of those pieces—that is to say, the distance the current has to travel is short, and thus the effective head or pressure used is low. Some 3in., or even less, of the pieces to be welded are heated up; 6in. could, of course, be equally well heated up by the same current, but if there were no other resistance than the metal being heated, then the operative electric pressure would have to be doubled and the horse-power would be doubled. The dynamo used in conjunction with this machine is an alternating-current dynamo, and is called a 40,000-watt machine, having its field magnets excited by a small Thomson-Houston dynamo.—R. E. P.

Answer to No. 279 (*awarded* 5*s.*).—The process of welding by electricity has many advantages over the ordinary forge welding: (1) The ease by which heat can be produced at any point by means of an electric current is a great advantage in welding. Take the case of a large steel casting, which on being machined up develops several large blowholes; with ordinary forge welding it would be impossible to weld up these holes, and the casting would be scraped, but with the electric welder the holes are filled up and a perfectly sound job results. (2) The time taken for an electric welding varies from 10 seconds to three minutes to complete, according to the size of the weld. This is far in advance of ordinary welding for saving time. (3) Very little scale is formed during heating with electric welding,

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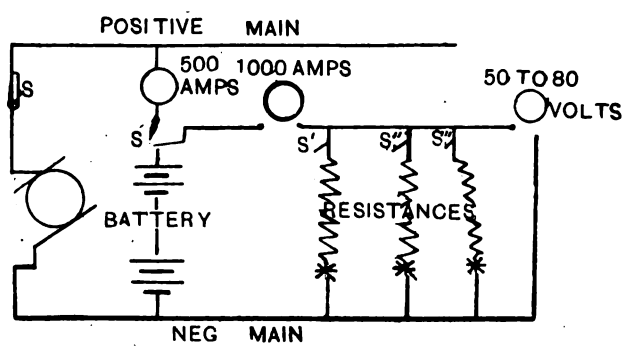
as the metallic vapour formed keeps the atmospheric oxygen from reaching the heated metal.

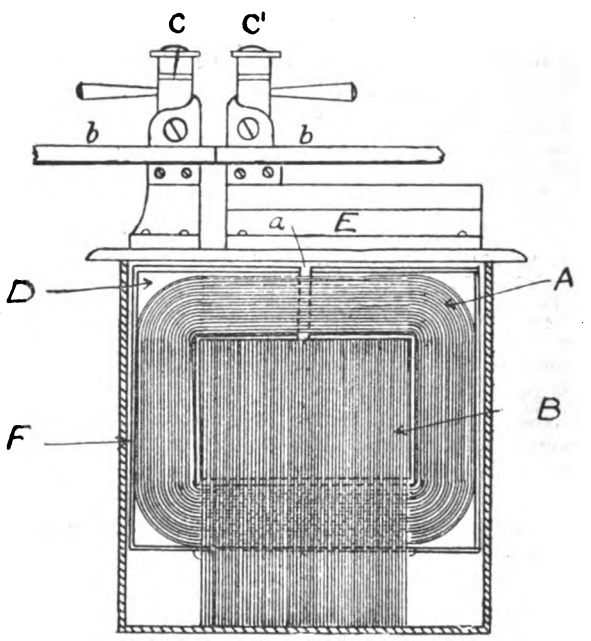
There are two distinct systems of electric welding: (*a*) The system commonly called the Thomson system employs the heating effect of the current working through a dead resistance. This process is used in butt welding, and the two pieces to be welded are brought together end on and a large current passed across the junction. The loose contact at the junction causes a great amount of heat to be developed there, and when the metal is raised to a welding temperature they are firmly pressed together and the weld is complete. This system employs a special dynamo, or transformer, giving a small voltage with a large current. (*b*) The other process takes advantage of the heating power of the electric arc, and is known as the Benardos process. The Benardos patents are owned in country by Messrs. Lloyd and Lloyd, of Birmingham. The method of welding is exceedingly simple. An ordinary electric light carbon is clipped in a special holder, which is held in the workman's hand. This holder consists of a wooden handle, through which a flexible conductor passes, carrying the current to the carbon; an asbestos-faced shield protects the workman's hand. This carbon is connected to the positive main, whilst the article to be welded is connected to the negative main. The carbon is now touched against the metal and drawn a short distance away, the electric arc is struck, and the metal is heated. About 12 to 14 seconds is time required. If a blowhole is to be stopped, pieces of steel or iron are run into the hole, and make a first-class job. The current usually employed is about 15 amperes at 70 volts. Messrs. Lloyd and Lloyd adopt an arrangement to supply the requisite current, as shown in the diagram.



The dynamo, D, generates 500 amperes at 150 volts, and is connected with the battery through suitable switches and ammeters. The battery must have an high discharge rate without seriously damaging the plates. Welding arcs are taken off the battery mains through switches and resistances. The resistances are adjustable, and under control of the workman. Volt and ammeters are coupled as shown. The battery is not necessary, but a machine for 70 volts at 1,000 amperes must be provided if the battery is not used. The workman protects his eyes and face from the arc by a mask.—F. M. M.

Answer to No. 270 (*awarded* 5*s.*).—The following are some of the many advantages possessed by electric welding over forge welding: (1) The weld is perfectly homogeneous, as the structure of the metal at the joint before and after welding is unaltered. Oxidised surfaces are excluded from the joint, and clean metal only comes into contact. (2) The amount and localisation of the heat is under absolute control, and the operation can be made automatic, thus securing uniformity of result. (3) The process can be continually watched, as the metal while heating is visible, instead of being covered with coal or hidden by flame, as in the forge process. (4) Flaws in welding are easily discovered and prevented, as the union commences at the interior of the joint, and not in an uncertain way, as in ordinary lap welding. (5) The process is extremely rapid, being almost instantaneous with small diameters, while with larger sizes it requires but a few seconds, depending upon the horse-power used. (6) Electric welding possesses great flexibility, as it can be applied to various kinds and forms of metal, including those which have hitherto been united only by brazing, and may be used for making endless structures—such as rails, pipe lines, etc.—*in situ.* (7) Blistering and scaling of the parts to be welded is prevented, and finished parts may be made to retain their finish during welding. (8) The process effects great economy both in time, labour, and material.

One of the best-known forms of electric welder is that known as the "Thomson," the invention of Prof. Elihu Thomson, of America. The welder consists of an alternating-current transformer having its primary coil wound with many turns, while the secondary is of a single turn only, and is usually made in the form of a solid copper casting. On passing an E.M.F of, say, 300 volts through the primary, a current of some thousands of amperes is induced in the secondary. The ends of the secondary circuit terminate in massive copper clamps, which serve to hold the articles to be welded in contact with one another, thus completing the circuit. The primary circuit is then closed, and the induced current is passed through the parts to be welded, causing them to heat very rapidly. As soon as the welding point is reached the clamps are made to approach each other, forcing the heated parts together and making the joint.



The appended sketch represents in diagram the construction of a small "Thomson" machine for welding iron and steel rods of small diameter. A is the primary coil, surrounded by the laminated iron core, B. The secondary casting, D, is grooved so that it may contain the primary coil. The secondary circuit is interrupted at *a*, and the ends of the circuit are led to the clamps, C, C^1. C is fixed, but C^1 is capable of being moved along the stock, E; *b b* are metal rods which it is desired to weld together. The rods are fixed in the clamps by means of the handles, as shown, and are brought into contact by adjustment of C^1. The secondary circuit being thus closed, the primary circuit is then closed by a switch on the top of the machine. As the metal becomes hot, C^1 is made to approach C, thus welding the rods together. The movement of C^1 is regulated by a spring and handwheel not shown. The primary switch is now opened, either automatically or by hand, and the welded articles are removed from the clamps. The transformer is completely enclosed in a massive cast-iron case, F, and the latter is insulated from the clamps by red fibre insulation. The power required for electric welding varies nearly as the sectional area of the material at the joint where the weld is to be made. The following table gives the power and time required for various sizes of round iron or steel and iron piping:

Round iron or steel.			Iron or steel pipe.		
Diameter. Inches.	Watts.	Time. Seconds.	Inside diameter. Inches.	Watts.	Time. Seconds.
¼	1,500	10	½	6,700	33
⅜	2,500	15	¾	7,800	40
½	4,800	20	1	12,250	47
⅝	6,700	25	2	31,350	84
¾	10,000	30	3	72,000	106

—T. F. T.

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COMPANIES' MEETINGS AND REPORTS.

CALLENDER'S CABLE AND CONSTRUCTION.

The fourth annual general meeting was held on the 24th ult. at the Cannon-street Hotel.

Mr. Henry Drake, who presided, referred to the rise in the price of practically all the materials used at the factory, chiefly in the cost of copper, tin, and lead. The result of the year's working was a balance of £33,221. The directors proposed a dividend to the holders of the original ordinary shares at the rate of 10 per cent. per annum, clear of income tax, or 10s. a share, of which 5s. a share was paid last November as an interim dividend; £10,000 would be added to reserve leaving £8,221 to be carried forward. The reserve fund would now stand at £73,881, and the dividend on the ordinary shares would be 15 per cent., or the same as was paid in the year 1898. The Company's business had increased very largely. Last year the directors issued 10,000 ordinary shares of £5 each at a premium of £5 a share, producing £100,000, and the shareholders might naturally suppose that this would have lasted a considerable time. The increase in the property had been £47,000, on cable drums £5,000, on stock £26,000, in expenditure on contracts £26,000, and in debentures £118,000. These items amounted together to £222,000. On the other hand, there had been a diminution in the cash of £10,000, and the increase in the item of creditors was £104,000, being together £114,000, and leaving a balance of £108,000 They were, therefore, really at the present time £8,000 worse off in this way than they were a year ago. The issue of the new preference shares would be made as soon as the arrangements could be completed.

Lieut.-Colonel G. A. Elliott seconded the adoption of the report, which was carried.

TELEGRAPH MANUFACTURING.

The report for the year ended March 31, to be submitted to the meeting to be held at Liverpool to-day, states the profit of the year's working, including £5,162 brought forward, at £46,446. Deducting the managing director's salary, including a special grant of £1,000 and the directors' fees (£2,400), the preference dividend (£4,833), the interim dividend (£3,000), depreciation account (£3,887), and reserve fund (£17,500), there remains £14,825, out of which the directors recommend the payment of a further dividend at the rate of 14 per cent. per annum for the half year (7s. per share) and a bonus of 2 per cent. (2s. per share), being in all at the rate of 12 per cent. for the year, leaving £5,825 to be carried forward. Large extensions have been and are being made to meet the increasing trade, and, in consequence it is proposed that the capital be increased by the creation of 20,000 additional ordinary shares of £5 each.

WEST INDIA AND PANAMA TELEGRAPH.

The ordinary meeting was held at Winchester House on Wednesday.

Mr. W. Andrews, who presided, said in the past half-year the receipts had fallen to £22,643, against £51,937 in the corresponding six months of the previous year, showing a decrease of £29,294, mainly on account of the cessation of the Spanish-American war. A comparison with the last half of 1897 reduced the difference to £9,584.

The report, already noted by us, was carried. An increase in the Company's charges was hinted at.

REUTER'S TELEGRAM.

The annual general meeting was held at the offices, Old Jewry, on Wednesday. **Admiral Sir J. C. D. Hay**, who presided, announced the customary 5 per cent. dividend. Referring to war, he said that at the present they had as many as 30 special correspondents engaged. The report, noted in our last issue, was passed without debate, **Mr. F. J. Griffiths** seconding.

ISLE OF MAN TRAMWAYS.

The annual meeting of the Isle of Man Tramways and Electric Power Company, Limited, was held at Derby Castle, Douglas, on the 24th inst. Mr. John R. Cowell, one of the directors, presided, and there was a large attendance of shareholders. The following report appeared in the *Belfast News-Letter*, and we take the liberty of reproducing the same at length on account of the great attention recently drawn to the affairs of this Company on account of the failure of Dumbell's Bank.

The **Chairman** explained his own position. He had been elected director in March last year, had afterwards been in America for six months, and on returning had been ill. The first notice to attend a meeting of the Board received by him was for Feb. 7 last, four days after the failure of Dumbell's Bank. He at once proceeded to carefully examine the affairs of the Company, and found them to be in an exceedingly difficult condition, but did not resign, as he thought it would have been cowardly to have done so when his colleagues were faced with serious difficulties. He proceeded to lay before the shareholders a statement of the amount required to enable the Company to meet its liabilities and continue its business. The liabilities of the general undertaking were £84,967, and adding £10,000 for working capital, £95,000 was arrived at as the amount required for the general undertaking. For the separate Ramsey undertaking he estimated that £35 000 would be required. Referring to Messrs. Turquand and Youngs's report, he described it as being extremely severe, and in some parts hardly fair. He admitted, however, that steps should long ago have been taken to increase the capital. Summing up the financial position, Mr. Cowell took a middle course between Messrs. Turquand and Youngs's figures and those prepared by the secretary. He estimated that after increasing the capital of the general undertaking, and providing for all existing and additional charges, the amount available for dividend would be £2 447, which represented 3 per cent. on preference shares, and left a small balance. As to the separate undertaking, he estimated a sum of £12,000 would be required to pay all charges, and that the shareholders could expect nothing. He, in conclusion, spoke hopefully of the prospects of the Company.

Mr. Young, the late secretary, was present, and, in reply to a shareholder, he announced that he had resigned in 1898 on account of friction with the directors. He had frequently urged lower dividends, but got no support. The position of the Company in February, 1898, was so weak that the Board passed a resolution to include in revenue accounts as profit £6,000 said to be portion of the profits made upon a purchase of engines for the Laxey-to-Ramsey tramway, and the auditors agreed that this was a perfectly legitimate course. He protested, and the matter was so strained that he tendered his resignation as secretary and called in the aid of the legal advisers of the Company, with the result that the resolution previously passed was rescinded, and the dividend for that balance-sheet was reduced by 1 per cent. Notwithstanding this, at the Board meeting in September, 1898, a dividend at the rate of 7½ per cent. was declared upon the Chairman announcing that a profit of £10,000 had so far been made on the construction and equipment of the Ramsey line. He (Mr. Young) was dumbfounded. The dividend warrants were sent out, and his notice of resignation was sent to the chairman at the same time.

This statement was greeted with loud cheers, and several shareholders expressed their admiration of Mr. Young's conduct.

The **Chairman** formally moved the adoption of the report and balance sheet.

Mr. Mitchell Eccles, of Blackburn, immediately opposed, and declared that, in the face of Turquand and Youngs's report, the meeting would never accept the sheet before them.

The **Chairman** suggested the appointment of a committee of investigation representative of the shareholders and creditors, and this course was eventually approved of.

The meeting terminated shortly afterwards.

In the report of Messrs. Turquand, Youngs, and Co. above referred to, amongst other strictures passed it was stated that the auditors came to the conclusion that the profits shown by the accounts of the Company as having been earned during the years 1894 99 were not in their entirety legitimately earned, with the result that the dividends appear to have been paid otherwise than out of profits to the extent of £15,645. 15s. 3d. The auditors state the outstanding liabilities of the general undertaking requiring settlement as follows: bills payable, £86,843. 12s. 4d.; sundry creditors, £18,022. 2s. 4d.; Dumbell's Banking Company, £2,113. 7s. 3d; unpaid dividends, £1,303. 3s. 2d.; interest on debentures and mortgages, £3 568. 0s. 3d.—total, £111,850. 5s. 4d. "Bills payable" appear as £86,843, and £85,000 of this is represented by promissory notes granted by the tramway company to Dumbell's Banking Company. This amount (with accrued interest, £4,743) still stands at the debit of the tramway company in the books of the bank, although the bank has apparently negotiated the promissory notes to other banks. These assets are set down at £26,883. 4s. 9d., and any future profits not hitherto appropriated in the account. The auditors do not include in the assets the investment in the Snaefell Railway, the shares and debentures of the Isle of Man Breweries, sundry debtors (£5,013), nor the deferred debt due to the Company by the Douglas Corporation at the termination of the lease (£3,000), as these assets do not appear to be promptly available. Proceeding on the assumption that £125,000 would be required for additional capital, and that this money could be raised on prior lien, the share and loan capital of the general undertaking would then stand as follows: share capital—ordinary shares, £95,000; preference shares (6 per cent.), £70,000; debentures—series A (at 5 per cent.), £50,000; series B (at 4 per cent.), £100,000; additional capital, £125,000. Total, £440,000. Gross revenue earned during 1899 (but without making depreciation for wasting assets), £14,000; deduct interest on additional capital at, say, 4 per cent., £5,000; debenture interest, £6,500; dividend on preference shares, £4,200—total, £15,700, or a deficiency of £1,700, equal to about two-fifths of dividend on the preference shares. The auditors are unable to indicate any economies which can be effected to enable the Company to earn sufficient income to meet this deficiency and pay dividends on the ordinary shares.

OSWESTRY ELECTRIC LIGHTING AND POWER.

The annual meeting of shareholders was held at the Coach and Dogs, Oswestry, on Monday.

Mr. E. Bremner Smith, who presided, said for the past four years the amount of current sold in round numbers was 16,000 units, 24,000 units, 31,000 units, and 40,000 units respecively. In 1898 they sold double the quantity they sold in 1896, when they first started, and in 1899 they sold still more. The sale of current during the past year had brought in £896. 15s. 4d. compared with £662 last year. The balance sheet showed the value of the land and buildings at their cost price to be £6,731. 5s. 9½d., of which £263. 17s. 4½d. had been written off for depreciation of plant. The amount representing the depreciation would increase until

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they had as much as the plant cost, and they would have either its value in hand or new plant. They preferred to husband their money, for there was no doubt the number of new applications to be supplied would be such that they would want a heavy expenditure of capital, yet as long as they could get plenty of customers it was to their advantage to spend money. They wanted to keep the dividends down, and, as far as possible, to get money in hand for eventualities.

The report was carried, and a dividend at the rate of 4 per cent. for the year was declared. Mr. George Perks was re-elected a director, and Mr. T. Holland Crowther was reappointed auditor.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Dudley.—The Corporation invite tenders for Section H, free wiring contract. Tenders by June 15. Details in our advertisement columns.

St. Pancras.—The Vestry invite tenders for rearranging and additions to bare copper strip conductors. Tenders by June 7. Details in our advertisement columns.

Blackpool.—The Corporation invite tenders for the electrical equipment of 15 single-truck tramcars. Tenders by June 18. Details in our advertisement columns.

Larne.—The Urban District Council invite tenders for lighting their district by coal or acetylene gas or electricity for three years from Aug. 1. Tenders by June 18.

Manchester.—The Tramways Committee invite tenders for the overhead equipment of three routes of tramways. Tenders by June 9. Details in our advertisement columns.

Nelson.—The Corporation invite tenders for the supply of storage battery and switchboard for their electricity works. Tenders by June 12. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each. Tenders by June 12. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the excavator work required in the construction of Section No. 2 (north) of the new generating station at Port Dundas. Tenders by June 11.

Egremont.—The Wallasey Urban District Council invite tenders for the maintenance of the electric installation on their steamers for 12 months from July. Tenders by noon on June 12.

London, S.E.—The Bermondsey Vestry invite tenders for the supply and laying of insulated electric mains, conduits, junction boxes, etc. Tenders by noon on June 18. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for outside coal storage and steel structure for coal handling, and locomotive travelling cranes for outside coal handling. Tenders by June 21. Details in our advertisement columns.

Bootle.—The Corporation invite tenders for the supply and laying of underground electric cables, the erection of arc lamps, and the supply of mechanical stokers. Tenders by June 16. Details in our advertisement columns.

Crewe.—The Town Council invite tenders for the wiring of the municipal offices, market hall, and corn exchange, and for supplying lamps and fittings for electrically lighting the same. Tenders by June 11. Details in our advertisement columns.

Partick.—The Corporation invite tenders for the construction, supply, and erection of dust destructor, with furnaces, flues, water-tube boilers, economiser, fans, and forced-draught appliances. Tenders by June 8. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the supply and erection of a switchboard for a pressure of 500 volts, or for alterations to existing switchboard, at their electricity works, Valley-road. Tenders by June 14. Details in our advertisement columns.

London, S.W.—The Fulham Vestry invite tenders for the wiring of their electric lighting works. Specifications, etc., may be obtained at the offices of Mr. F. Hastings Medhurst, B.Sc., M.I E.E., 13, Victoria-street, S.W., on payment of a deposit of £3. 3s. Tenders by June 4.

Wolverhampton.—The Tramways Committee invite tenders for the construction of tramway track and contingent work in Dudley-road, Cleveland road, Bilston-street, Piper's-row, and Fiveways, amounting to a route length of about one mile seven furlongs, mainly double track. Tenders by June 26.

Bridgwater.—The Town Council are prepared to receive tenders for the supply and erection of boiler-house plant (boilers, fittings, steam and exhaust pipes, etc.), engine-house plant (steam dynamos, pumps), switchboards, etc., underground mains, lamp-posts, etc., accumulators, meters, and crane. Tenders by June 7. Details in our advertisement columns.

London, S.E.—The South London Electric Supply Corporation, Limited, invite tenders for the complete installation of 3,000 lights on the premises of 500 consumers in any part of the area of the company's supply, and also for the installation of two arc lights on the premises of any consumer in the same area. Tenders by June 2. Details in our advertisement columns.

Madrid.—The Secretary of State for Foreign Affairs has received a dispatch from her Majesty's Ambassador at Madrid, stating that tenders are invited by the Spanish Government, to be received not later than July 7, for the concession of an electric tramway from the Puerta de Hierro, Madrid, to Aravaco and Pozuelo. Such particulars as have been received may be examined on personal application at the Commercial Department of the Foreign Office any day between 11 a.m. and 5 p.m.

London, S.W.—The Asylums Committee of the London County Council invite tenders for (1) the installation of electric lighting and power (except generating plant); (2) the installation of telephones, tell-tale clocks, fire-alarms, and call bells at the Horton Asylum, near Epsom, Surrey. Tenders, endorsed "Tender for Electric Lighting, Horton Asylum," or "Tender for Telephone, &c., Installation, Horton Asylum," by 10 a.m. on June 16. Details will be found in our advertisement columns.

Brussels.—The Council of St. Jilles, lez-Bruxelles, will receive tenders for the installation and the setting to work of a distribution of electricity upon a part of its district. Conditions of contract, with plan, may be obtained on payment of 3fr., at the office specially dealing with the above, No. 14, Parvis St. Jilles, St. Jilles (Brussels). Tenders should be addressed to the Mayor of St. Jilles, lez-Bruxelles, before 2 p.m. on Sept. 19.

Port-y-waen and Llangynog.—The Cambrian Railways Company invite tenders for the construction of a light railway, about 15 miles long, 4ft. 8½in. gauge, commencing by a junction with the branch of the Cambrian Railways at Port-y-waen, in the county of Salop, and terminating at Llangynog, in the county of Montgomery. Plans can be seen, and copies of specification and quantities obtained, on payment of £1. 1s., at the office of Mr. A. J. Collin, engineer to the Tanat Valley Light Railway Company, Oswald-road, Oswestry. Tenders by June 5.

Sutton Coldfield.—The Corporation invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, etc., pipework, etc., in engine and boiler house, three steam dynamos (vertical enclosed high-speed engines) and motor boosters, storage batteries, main switchboard and connections, eight-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed) and posts, and station lighting. Tenders by June 21. Details in our advertisement columns.

Durban.—The Corporation invite tenders for supply, delivery, and erection of materials under the three following sections: (Part A) comprising the supply, delivery, and erection of the entire overhead equipment for about 16 miles of equivalent single track, including poles, overhead trolley wire, distribution boxes, etc.; (B) comprising the supply, delivery, and erection of 22 double-deck motorcars, complete; (C) comprising the supply and putting into working order of a complete steam and electric generating plant in a power station to be built by the Corporation, including three 250-kw. direct-coupled generators, boilers, condensers, cooling tower, switchboard, etc. Parts A and B will not be separated, but will be let to one contractor. Part C may be let separately. Preference will, however, be given to a contractor who will undertake all three sections, and a separate form of tender for all three sections will be supplied. Specifications, bills of quantities, forms of tender, and lithographic drawings may be obtained on application to Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation, on and after 29th inst. A deposit of £10. 10s. must accompany application for specifications and forms of tender. The deposit will be returned on the receipt of a bona fide tender. Sealed tenders, in duplicate, under separate cover, in specially-provided envelopes, to be delivered to Messrs. Webster, Steel, and Co., by June 29, or to the Town Clerk of Durban by mail delivery on or about July 23. The successful tender will be accepted by cable from Durban.

RESULTS OF TENDERS.

Bedford.—The tender of Grafton and Co., Bedford, for the supply of a six-ton hand travelling crane, at £75, has been accepted.

Heckmondwike.—The Electric Lighting Committee have accepted tenders amounting to £14,842. 14s. 6d. for an electric lighting system.

Wigan.—The Electric Light and Tramways Committee have accepted the tender of Messrs. Dick, Kerr, and Co., Limited, for 12 electric cars, and that of Messrs. Askham Bros. for materials for the Wigan-lane section.

Wolverhampton.—The tender of the Bedford Engineering Company, amounting to £670 (less an allowance of £40), for the supply and erection of a 20-ton overhead crane at the electric light works, has been accepted.

Sheffield.—The Corporation have entered into a contract with the firm of J. Brown and Co., Limited, Atlas Works, for the supply of three marine boilers to the electric power station at Kelham Island, at £2,850 each. About five years ago a boiler of the same type and size was purchased by the late Electric Light and Power Company for £1,450. Eighteen months ago two more were required for the power station, but by this time the price had gone up to £1,950 per boiler.

Devonport.—The Corporation have received the following tenders for the supply, delivery, and laying of electric light and traction feeders, distributors, boxes, etc.:

Section G.—Cables.

Callender's Cable and Construction Company (recommended for acceptance)	£12,433	6	10
St. Helens Cable Company	12,379	1	5
Henley	12,555	6	4
Siemens	12 690	3	5
British Insulated Wire Company	12 875	0	0
Glover	12 963	0	0
Western Electric Company	14,149	18	8

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Leicester.—The Council have accepted the tender of the Brush Electrical Engineering Company, at £22,837, for two inductor alternators of 1,000 kw. each, with Hick, Hargreaves, and Co.'s horizontal engines, and other plant in connection therewith.

Southampton.—The Corporation have received the following tenders for the supply and erection of one 300-kw. continuous-current generator, coupled direct to a medium-speed vertical compound steam-engine:

I.—Combined plant within limit of speed specified.

Bow, McLachlan, and Co., own engine, speed 180, delivery in 4 months	£3,960	0	0
Witting Bros., Ball and Wood, 180, 6-7 months	4,724	0	0
British Schuckert Company, Browett-Lindley, 180, 7½ months	4,789	0	0
British Schuckert Company, Ball and Wood, 180, 6 7 months (?)	5,035	0	0
Bruce Peebles and Co., Browett-Lindley, 180, 7 months	5,087	0	0
F. Nell, Ball and Wood, 180, 7 months, from approval of drawings, Schuckert dynamo, does not include spares called for in specification, which on schedule of prices submitted amount to about £85	5 039	0	0
British Schuckert Company, Yates and Thom, 180, 6 months	5,125	0	0
Mavor and Coulson, Browett-Lindley, 180, 8 months	5,286	15	0
Bruce Peebles, Ball and Wood, 180, 7 months	5,480	0	0
Ashton, Frost, and Co., Browett-Lindley, 180, 8-10 months	5,492	0	0
Ashton, Frost, and Co. (alternative), Browett-Lindley, 180, 8-10 months*	5,282	0	0
F. Suter and Co., Browett-Lindley, 180	5,575	0	0
F. Suter and Co., Browett-Lindley, 180*	5,525	0	0
Brush Company, Brush Universal, 180, 12 months	5,585	0	0
Electric Construction Company, Ball and Wood, 180, 7 months, subject to conditions	5,924	0	0
Electric Construction Company (alternative), Ball and Wood, 180, 7 months*	5,789	0	0
British Schuckert Company, McLaren and Co., 125, 6 or 8 months	5 925	0	0
Crompton and Co., Browett-Lindley, 180, 10-11 months	6,085	0	0
Crompton and Co. (alternative), Browett-Lindley, 180, 10-11 months*	6,070	0	0
Mather and Platt, own, 120, 5 months	6,154	0	0

* If not required to charge battery.

II.—Combined plant running at a higher speed than that specified.

C. A. Parsons and Co, own turbine, 3,000	3,322	0	0
C. A. Parsons and Co. (alternative), own turbine, 3,000, generator smaller than specified	2,706	0	0
Ferranti, Limited, own, 250, 4 months, Schuckert dynamo	3 600	0	0
Bruce Peebles and Co., Ferranti, 250, 7 months	4 250	0	0
British Schuckert Company, Willans, 300, 6 months	4 510	0	0
Ferranti, Limited, own, 250, 7 months, Bruce Peebles dynamo)	4,540	0	0
Ferranti, Limited (alternative), own, 250 11½ months, Crompton dynamo	4 700	0	0
F. Nell, Ball and Wood, 190-200, 7 months from approval of drawings, Schuckert dynamo	4 939	0	0
F. Nell (alternative), Ball and Wood, 190-200, 7 months from approval of drawings	4,979	0	0
Electric Construction Company, Willans, 300, 6 months	5,057	0	0
Electric Construction Company (alternative), Willans, 300, 6 months (if not required to charge battery)	4,934	0	0
Crompton and Co., Ferranti, 250, 10-11 months	5 078	0	0
Crompton and Co. (alternative), Willans, 300, 10-11 months	5,689	0	0

The tender of Messrs. S. Z. de Ferranti, Limited, at £3,600, has been recommended for acceptance, subject to the electrical engineers being completely satisfied as to the design of the Schuckert dynamo.

Rhyl.—The following tenders have been received in response to specification prepared by Mr. G. R. Peers and Mr. W. H. Trentham:

Section A.

Babcock and Wilcox*	£2 013	10	0
Blackwell and Co.	2,058	0	0
Crompton	2,058	0	0
G. Hill and Co.	2 350	0	0
Stirling Boiler Company	2,490	0	0

Section C.

Clayton Engine Company*	590	0	0
Lowdon	599	0	0
Brook, Hirst, and Co.	745	0	0
General Electric Company	765	10	0
Lewis, Bayliss, and Co.	782	0	0
Veritys	851	0	0
Ashton, Frost, and Co.	896	0	0
Johnson and Phillips	900	0	0
Crompton	902	0	0
J. Fowler	920	0	0
Dorman and Smith	930	0	0
H. Wright	991	0	0
Mechan and Sons	999	0	0
Electric Construction Company	1,085	0	0
Siemens	1,242	0	0

Section B.—Engines, dynamos, boosters, etc.

Parsons and Co. (own engine)	5 017	0	0
Thames Ironworks (Allen)	5,133	0	0
Thames Ironworks (Reavell)	5 268	0	0
Lancashire Dynamo Company (Reavell)	5 359	0	0
Crompton and Co. (Allen)	5,519	0	0
Lancashire Dynamo Company (Browett and Lindley)	5,551	0	0
Westinghouse Company (Allen)	5 560	0	0
General Electric Company (Reavell)	5 572	0	0
Electrical Company	5 641	0	0
Lowdon (Reavell)	5 682	0	0
Lancashire Dynamo Company (Alley)*	5 759	0	0
British Schuckert (Reavell)	5,762	0	0
Allen (own)	5 771	0	0
Lowdon (Browett and Lindley)	5 809	0	0
Electric Construction (Reavell)	5 832	0	0
Johnson and Phillips (Willans)	5,870	0	0
British Schuckert (Browett)	5 992	0	0
Westinghouse (Browett)	5,995	0	0
J. Fowler (Reavell)	6 042	0	0
Thames Ironworks (Willans)	6,112	0	0
Heywood (Alley)	6 156	0	0
Lancashire Dynamo Company (Willans)	6 204	0	0
G. Hill and Co. (Browett and Lindley)	6,210	0	0
Crompton (Davey-Paxman)	6 385	0	0
Siemens (Browett-Lindley)	6 444	0	0
Lowdon (Belliss compound)	6 569	0	0
Westinghouse (Willans compound)	6 620	0	0
Westinghouse (Belliss compound)	6 650	0	0
Lowdon (Willans compound)	6 677	0	0
General Electric (Willans compound)	6 702	0	0
Scott and Mountain (Scott and Mountain)	6 750	0	0
Electric Construction (Willans compound)	6,763	0	0
Clayton Engine Company (Alley)	6,784	0	0
Crompton (Belliss)	6,806	0	0
Crompton (Willans)	6 849	0	0
Electric Construction (Willans)	6 852	0	0
Lowdon (Belliss triple)	6,869	0	0
Crompton (Belliss triple)	6 903	0	0
General Electric (Belliss triple)	6 925	0	0
Westinghouse (Belliss triple)	7 040	0	0
Siemens (Belliss triple)	7 204	0	0
Frank Suter (Willans triple)	7,205	0	0
Thames Ironworks (Willans triple)	7,230	0	0
Siemens (Willans compound)	7,239	0	0
Siemens (Belliss compound)	7,264	0	0
Lancashire Dynamo (Alley triple)	7 453	0	0
Lancashire Dynamo (Willans triple)	7 470	0	0
Lowdon (Willans triple)	7 677	0	0
Westinghouse (Willans triple)	7 680	0	0
British Schukert (Willans triple)	7 702	0	0
General Electric (Willans triple)	7 768	0	0
Heywood (Alley triple)	7,811	0	0
Crompton (Willans triple)	7 880	0	0
Electric Construction (Willans triple)	7 931	0	0
Scott Anderson (Willans triple)	7 935	0	0
Johnson and Phillips (Willans triple)	8 090	0	0
Siemens (Willans triple)	8 249	0	0
Brush	8 314	0	0
Ashton-Frost (Willans triple)	8 525	0	0

Section D.—Arc lamps, underground mains, street work, etc.

Western Electric*	5 911	11	0
St. Helens Cable Company	6 125	0	0
Dennis	6 184	0	0
Oliver	6,229	0	0
British Insulated Wire Company	6 545	0	0
Oliver	6,758	0	0
Callender	6 797	0	0
Siemens	7 013	0	0
Glover	7,455	0	0
Henley	7,464	0	0
Johnson and Phillips	8,181	0	0
Telegraph Manufacturing Company	9,233	0	0

Section F.—Accumulators.

Dutilh Smith (Marquand)*	1,304	0	0
Hart Battery Company	1,361	0	0
Tudor	1 395	0	0
Electrical Power Storage Company	1,425	0	0
Johnson and Philips (Hart)	1 430	0	0
D.P. Battery Company	1,446	0	0
Chloride	1 500	0	0
Heywood	1 577	0	0
Scott Anderson	1,900	0	0

Section G.—Crane.

Marshall, Fleming, and Jack*	145	0	0
J. Carrick and Sons	152	0	0
Carrick and Ritchie	159	0	0
Stocks and Co.	167	0	0
Isles, Limited	220	0	0

* Accepted subject to the sanction of the Local Government Board to the loan.

Bridgend.—The English Industrials, Limited, are about to register a company to be known as the Bridgend Electric Light and Power Company, which latter will lay down electric plant at Bridgend.

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BUSINESS NOTES.

TRACTION.

Beeston.—The Council are corresponding with Mr. Gerald Barker (London) in regard to the proposed electric light railways from Beeston to Nottingham.

Southwark.—The Vestry have agreed to consent, when the proper time arrives, to the introduction of a Bill to confer powers on the London County Council with regard to the tramways in their district.

Hyde.—The joint tramway scheme of the Corporations of Mosley, Stalybridge, Dukinfield, and Hyde, which we alluded to recently, renders the Corporations of the four towns responsible for an outlay of about £278,000.

Birmingham.—A Board of Trade inspector made an official inspection of the extension of the City of Birmingham Tramway Company's Sparkhill line on the 29th ult. The line will be probably opened for ordinary traffic to-day.

Willenhall.—The District Council are urging the Light Railway Department of the Board of Trade to take such steps as might be necessary to expedite the passing of the British Electric Traction Company's Light Railways Bill.

Lewisham.—Letters from the London County Council with regard to widenings, etc., in connection with the proposed tramway from Rushey Green to the Crystal Palace are before the Works Committee of the District Board of Works.

City and South London Railway.—The electric railway company will open their new extension to Clapham Common on Whit Sunday, and a special service of trains will be run on Whit Monday from Moorgate-street and Bank to Clapham Common.

Teddington.—The District Council have joined the Heston and Isleworth and Twickenham District Councils, who have requested their representatives on the County Council to oppose the further action of the County Council in opposing the Tramway Bill.

Tottenham.—The North Metropolitan Tramways Company purpose doubling their lines in the Hertford main road, Tottenham, between Bailey's-lane and Seven Sisters'-road. The Middlesex County Council have consented to the improvement being effected.

Todmorden.—The Town Council have disapproved of Mr. Gerald Barker's scheme for a light railway between Todmorden and Bacup. They have also refused an application from the Yorkshire Electric Power Company as to a proposed supply of electricity in bulk.

Stoke-on-Trent.—The borough surveyor has been instructed to test the speed of the cars at such intervals as he thinks best. The Council have decided to inform the Potteries Electric Traction Company that no delay should take place in dealing with the headlights complained of.

Manchester.—At a meeting of property owners and ratepayers in Fennel-street on Monday a resolution was passed appointing a deputation of property to wait upon the local members of Parliament to request them to oppose the second reading of the Corporation Bill so far as it affected the using of Fennel-street for tramways.

Sheffield.—We learn that a number of changes will shortly be made in the management of the city tramways. The former manager of the company, Mr. H. Mallyon, who has acted as general manager since the Corporation have taken over the undertaking, is to leave in three months owing to the introduction of electric traction.

York.—A special meeting of the City Council has been summoned for July 2 to consider a resolution to the effect that the Council give notice to the City of York Tramway Company, Limited, requiring them to sell so much of their undertaking as is authorised by the York Tramways Order, 1879, and all property suitable to and used by them for the purposes of such part of their undertaking.

Holborn.—The Holborn Board of Works will not consent to the introduction of a Bill into Parliament by the London County Council empowering them to construct tramway lines from the present terminus in Farringdon road to Ludgate circus. It is stated that no extension of the tramway lines along Farringdon-road is possible until legislation had been enacted for the regulation of costermongers' stalls, etc., and street traffic.

Bilston.—At the last meeting of the District Council, a letter was read from the superintendent of the British Electric Traction Company stating that the work of providing an electric service and of laying the line to the Fighting Cocks would be taken in hand when the company had received its full parliamentary powers. The people of Bilston and Willenhall are complaining about the disconnected state of the service to Wolverhampton. The question was referred to a committee of the whole Council.

Southampton.—The Council have accepted the Law Accident Insurance Company's offer for third party insurance as follows: (1) for an indemnity of £250 for any one accident and an unlimited amount for any one year, a rate of 10d. per car per diem; (2) for an indemnity of £500 for any one accident and an unlimited amount for any one year, a rate of 1s. per car per diem. Colonel Yorke, of the Board of Trade, has now made the official inspection of the town section of the new municipal electric tramways at Southampton. He intimated that he would report favourably.

Bootle.—The matter in dispute existing between the two Corporations of Liverpool and Bootle will be submitted to the Board of Trade for settlement, but pending the decision of that authority the two Corporations have decided to inaugurate the electric car service, and the first car was run shortly after nine o'clock on the 24th ult. Mr. C. R. Bellamy (general manager) and Mr. C. W. Mellins (traffic superintendent) were present during the day and watched the arrangements for the running of the cars carried out. Everything passed off satisfactorily. Mr. W. R. Wright (Bootle electrical engineer) had the arrangements for supplying the current.

Cowpen.—At the last meeting of the Council a letter was read from the British Traction Company in connection with the objection raised by the Council against the projected system of tramlines for the district. The company stated, in regard to the question of the length of lease, they were of opinion that 35 years was not an extravagant period, having regard to the population of the district and the magnitude of the scheme. They would pave the streets on the understanding that they received the assent of the Council by the date of the proposal following on June 21 next. It was resolved to withhold the sanction of the Council unless the company decided to take in the Newsham and Cowpen districts.

Bradford.—The results of the working of the electric tramways for the week ended May 27 are reported as follows: On the Bolton section 3,513 miles have been run, and the receipts amount to £173. 18s. 4d., which is equal to 11·88d. per car mile. The workmen's checks issued numbered 1,282, and 1 232 have been returned. The total receipts since April 1 amount to £1,132. 7s. 5d., or 10 57d. per car mile. On the Horton section during the past week 6,651 miles were run, and the receipts were £353. 16s. 1d., which is equal to 12 76d. per car mile. The workmen's checks issued numbered 1,699, and 1,579 were returned. The total receipts since April 1 amount to £2,538. 2s. 10d., which is equal to 12·13d. per car mile.

Burnley.—At the meeting of the Town Council on Wednesday, it was announced that terms had been arranged with the Lancashire and Yorkshire Railway Company, the Leeds and Liverpool Canal Company, and the Nelson Corporation, whereby their opposition to the Burnley Tramway Bill, now before Parliament, should be withdrawn. The following resolution was also agreed to: "That, in the opinion of this committee, it is desirable to reconstruct and electrically equip the tramways within the borough on a gauge of 4ft. as soon as practicable after their acquisition by the Corporation; that the borough surveyor and electrical engineer be instructed to prepare preliminary plans and specifications for the work, and, in conjunction with the town clerk, to make enquiries with a view to retaining the services of a consulting engineer."

Cardiff.—The *South Wales Daily News* says appearances point to a determination on the part of Cardiff Borough Council to push forward energetically all the work of extensions to the system which may be done before the local tramways become municipal property in 1901. Recently the Tramways Committee of the Council decided to lay down forthwith the following sections of new routes sanctioned under the Corporation Act of 1898: (1) from Newport-road to Penylan-road at the junction with Ninian-road, *vid* Castle-road and Wellfield-road; (2) from Clarence-road to Cathedral-road near the junction of Sneyd-street, *vid* Corporation-road, Clare-road, Clare-street, and Lower Cathedral-road. It was further decided to advertise for 1,000 tons of rails and necessary accessories for the lines. As the Tramway Committee will lay the space between the metals and 18in. outside with Australian hardwood blocks, the Public Works Committee is to be asked to complete the paving of the roadways along the routes in similar style. The Borough Engineer reported that there was nearly £18,000 worth of wood blocks now in possession of the Corporation.

Huddersfield.—The electrical equipment of the line from Longroyd Bridge to the Longwood tram terminus is to be proceeded with. The Crosland Moor section will be equipped for electric traction. A 40 minutes' service of cars is to be run on the Linthwaite section, and a 30 minutes' service on the Longwood section. With regard to overhead equipment and cable ways, it has been decided that suspension poles should be utilised, and that the use of bracket poles should be resorted to only under exceptional circumstances. We are indebted for the following interesting extract to the *Leeds Mercury*: "Mr. Jeffreys, reporting from the committee of the House of Commons on Group 2 of Railway Bills, says the committee 'in the case of the Huddersfield Corporation Tramways (Recommitted) Bill, had taken additional evidence as to the expediency of reinserting in the Bill the power to construct additional tramways to and in the borough districts and parishes hereinafter mentioned adjacent to the borough, that is to say, the borough of Brighouse, the urban districts of Mirfield, Marsden, Slaithwaite, Linthwaite, Lepton, Kirkburton, Honley, Thurstonland, New Mill, Netherthong, Holmfirth, and the parishes of Fixby, Clifton, and Hartshead in the rural district of Halifax, and are of opinion that, having regard to the special local circumstances and that the said tramways will be in connection with the tramways authorised to be constructed by the Corporation of Huddersfield within the limits of their district, such power may be given.' The committee say it was not necessary to insert in the Bill a clause for the protection of the local authority of the district in which the tramways are situate, inasmuch as the provisions of the Tramways Act, 1870, are incorporated with the Bill. The length of the tramways in Brighouse is 2 miles 1 furlong, in Holmfirth 1 mile 6 furlongs 2 chains, Honley 2 miles 7 furlongs 4 chains, Kirkburton 1 mile 1 furlong 9 chains, Lepton 7 furlongs 3 chains, Linthwaite 3 yards, Marsden 1 mile 3 furlongs 2 chains, Mirfield 2 miles 2 furlongs 7 chains, Netherthong 6 furlongs 4 chains, New Mill 4 furlongs 4 chains, Slaithwaite 1 mile 1 furlong, Thurstonland 7 furlongs 9 chains, and Halifax 1 mile 7 furlongs.

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LIGHTING AND GENERAL.

Horsham.—Application is to be made for sanction to borrow £15,000 for electric supply works.

Redruth.—Electric lighting provisional orders for Barnstaple and Redruth were published last week.

Havant.—The National Telephone Company have opened an extension of their trunk line to Havant.

Larne.—The Town Council have decided to advertise for tenders for the public lighting of Larne for three years.

Scarborough.—The Corporation have decided to illuminate the Scarborough St. Nicholas Gardens by the electric light.

Bath.—The Council has decided not to make any reduction in the price of current at present owing to the high coal prices.

Brynamawr.—The question of lighting the town by means of electricity has been further adjourned for future consideration.

St Annes.—The new police station, which is to be ready for occupation by September, will be illuminated by the electric light.

Belper.—The estimate for lighting of the hospital by electricity is £600. The question has been referred to a sub-committee for reconsideration.

Trowbridge.—The Urban District Council have been discussing the electricity question. Its adoption is favoured, and an expert is to be consulted.

West Ham.—The Town Council have decided to cover the electric light station by insurance in the Norwich Union Fire Office at 5s. per cent.

Greenock.—The Police Board Committee have decided that several of the electric lamps along the main streets shall be removed and new ones put in their place.

Durham.—The Guardians have received a letter from Mr. G. R. Peers, electrical engineer, Manchester, calling attention to the question of electric lighting of workhouses.

Hoylake.—Mr. Albert Holland, at present assisting in the office of the surveyor, has been engaged as clerk of works in connection with the erection of the electric lighting station.

Harrington.—A motion asking the District Council to consider the advisability of taking steps to obtain an electric lighting provisional order, which was on the agenda last week, has been withdrawn.

Nantwich.—At the last meeting of the Urban District Council the Clerk stated that the Council's Electric Lighting Bill would shortly be presented for the third reading. It had been accepted as an unopposed Bill.

Twickenham.—The application of the National Telephone Company for permission to lay underground wires along certain streets in the district has been left in the hands of the clerk and surveyor to see what arrangements the Telephone Company were willing to agree to.

Camberwell.—The Vestry are prepared to consent to the London County Council's proposals for widening streets in their district in connection with the doubling of existing and the opening of new tramways, but the Vestry do not intend to contribute towards the cost of the improvements.

Barrow.—At the last meeting of the Town Council it was stated that in spite of the adoption of electricity there had been an increase of 437 in the number of gas consumers. The income from gas was £29,562, an increase of £738, although the steel company were now using electricity instead of gas.

Inverness.—At a recent special meeting of the Town Council a long discussion took place in reference to Mr. E. G. Craven, the engineer, who had been appointed to prepare and carry out the scheme of electric lighting for the town. It was decided to refer the whole scheme to a neutral expert for report.

Dewsbury.—The Town Council do not regard favourably the intention of the Yorkshire Electric Power Company to promote a general electric power scheme for the manufacturing portion of the West Riding somewhat on the lines of the Lancashire electric power scheme now before the House of Commons.

Dover.—Permission has been given to lay mains along Maison Dieu-road from Park-street to the sea-front, and then along the Marine-parade as far as the East Cliff jetty. The cables will be under the footpath. We refer elsewhere to an important report by Mr. Bennett on the proposed municipal telephone exchange.

Leatherhead.—The National Telephone Company proposes to start the laying of the underground cable between Dorking and Leatherhead. Mr. Walker, the surveyor, has been empowered to meet the manager of the National Telephone Company and make the best arrangements he could for the laying of the cable on the footpath.

Colwyn Bay.—The surveyor has been directed to ascertain from the frontagers their views on the suggestion to substitute electric lighting for the gas lighting provided for under the contract. It was estimated that the whole scheme, including the sea-defence works, would cost about £4,000, and the District Council have decided to apply for sanction to borrow that sum.

London Gazette.—The discharge of Mr. W. P. O'Reilly, manufacturing electrician, of 397, Edgware-road, Middlesex, has been suspended for three years. Bankrupt to be discharged as from April 27, 1903, his public examination having been concluded on Aug. 5, 1892, bankrupt's assets not being of a value equal to 10s. in the £, and he having twice compounded with his creditors.

Leeds.—At the last meeting of the City Council it was decided that advertisements be published inviting tenders for the supply of two or three 1,000 h.p. (600 kw.) sets of two-phase alternators, and that a quotation be obtained for the supply of a 1,000-h.p. Babcock and Wilcox boiler, to replace the old 100-kw. engines and dynamos. The Sub-Lighting Committee, which has charge of extensions, have received 18 tenders.

Gravesend.—Mr. W. H. Trentham has been asked to prepare a full report upon the lighting of Gravesend by electricity, upon the subject of dust destruction in combination therewith, and also upon the supply of electric energy for the local tramways, make all surveys, preliminary plans, give advice and attend at committee meetings, prepare all necessary information for the Board of Trade and the Local Government Board, etc.

Stock Exchange.—The Stock Exchange Committee has been asked to appoint a special settling day in Nernst Electric Light, Limited, 180,000 vendors' ordinary shares of £1 each, fully paid, Nos. 1 to 180,000, and 25,000 vendors' 7 per cent. non-cumulative preference shares of £1 each, fully paid, Nos. 115,001 to 140,000. A call of 25 per cent. has been made on the Kensington and Notting Hill Electric 4 per cent. debenture stock.

Middlesex.—The County Council have adopted a report of their Parliamentary Committee recommending, with regard to local electric lighting orders, "that it be referred to the county solicitor to take the necessary steps to oppose the Bill confirming the orders as regards the Twickenham and Uxbridge schemes, and that the necessary petitions and other documents, in a form approved by the county solicitor, be sealed with the common seal of the County Council."

Midland Electrical Corporation (1900), Limited.—This Company has been registered with a capital of £200,000 in £1 shares, the object being to promote the development of the undertakings and business for the time being, and from time to time, of the Midland Electric Corporation for Power Distribution, Limited, and, if thought fit, to take over the same, to adopt and carry into effect an agreement expressed to be made between the British Insulated Wire Company, Limited, etc.

Abercarn.—In view of the Electrical Powers Distribution Bill now before Parliament, the Abercarn District Council (who are opposing the Bill) have decided to appoint a committee to consider the whole question of the public lighting of the district, including the advisability or otherwise of the Council undertaking to provide a system of electric light within the Council's area, or the advisability of joining with local authorities to provide an electric scheme for the western valleys of Monmouthshire.

Buxton.—The electricity works, for which the Local Government Board have sanctioned the borrowing of £24 769, have just been opened. The principal streets are now lighted by arc lamps, and a large number of private consumers have had the current laid on. A continuous-current three-wire system, with lamps running at 230 volts, has been adopted. The station has cost £5,000. Mr. Edward Calvert is the chief engineer appointed by the District Council, and Mr. Kenneth Watson represents Prof. Kennedy, who is the consulting engineer. About £22 000 has been so far expended.

Bradford.—At a meeting of the Guardians on Wednesday it was stated, with regard to the proposed installation of the electric light, that the Local Government Board had written asking for an assurance that the estimated cost of £5,150 should be adhered to in the execution of the work. The Chairman said that he had asked the clerk to reply to this letter, pointing out that since the estimates were prepared an increase in the price of materials had taken place to the extent of 10 per cent. upon the total cost, which would be £6,500. In proposing to obtain this amount by loan, the Guardians undertook to see that none but absolutely necessary work should be done. It was resolved that the reply so drafted should be sent to the Local Government Board.

Gelcar.—At last week's meeting of the District Council the clerk read a letter from the Yorkshire Electric Power Company, stating that shortly they would submit particulars to the Council on behalf of an influential syndicate for the general electric power supply scheme for the manufacturing portion of the West Riding of Yorkshire, which was said to be on the lines of the Lancashire electric power scheme. The Bill would be promoted as soon as the decision of the committee had been given on the Lancashire scheme. The principal object was to supply low-priced electricity to the local authorities and other large consumers for lighting, power, and other purposes. The Council declined to commit themselves, and nothing was done in the matter.

Appointments Vacant.—The Corporation of Birmingham require the services in September next of two lecturers for the electrical and engineering departments.—The council of the Municipal Electrical Association are requiring the services of a secretary.—There is also wanted by a large firm in the North several practical electricians and fitters.—The Electric Committee of the county borough of Belfast invite applications for an engineer-in-charge and a junior assistant. Particulars of these and other vacancies appear in our advertisement columns. The vacancies of a depôt superintendent and an inspector for Southport Corporation tramways, and for three pupils at the Redditch electricity works, and those of Messrs. Johnson and Phillips's Electric Cable Works, are still open.

Personal.—At a special meeting of the York Electric Lighting Committee, Mr. George E. Heath, of Dundee electricity station, was appointed second assistant at their electric light station. Previous to going to Dundee, Mr. Heath was a student at the Hull Municipal Technical School.—A sub-committee of the Electric Lighting Committee of Leith Town Council last Friday drew up a short leet of candidates for the vacancy caused by the resignation of Mr. W. A. Bryson, electrical engineer. It is understood

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that Mr. Bryson will continue to act as electrical engineer until a successor is appointed.—The Hastings Electrical Committee have appointed Mr. Charles Dudding—at present one of the assistant engineers at Yarmouth—to fill the vacancy recently advertised. There were 95 applications for the post.

Bermondsey.—The Vestry have agreed to the laying of electric mains in various streets in the parish at a total estimated cost of £9 310. At the last meeting of the Vestry Messrs. Kincaid, Waller, and Manville reported that the cost of laying extra ducts in connection with the Vestry's electric lighting scheme, so that a supply of electricity could be given to the whole of the new borough of Bermondsey, would be £450. These ducts would be placed in suitable directions to enable the feeders for supplying the added areas to be drawn in when required. The additional cost involved in laying mains and erecting lamps in Long-lane and Southwark Park-road would be £2,500. The Vestry adopted the report, and the clerk was instructed, after the specifications had been prepared, to advertise for tenders for carrying out the work.

London County Council.—Several promotions are being made amongst the staff of the electric lighting, etc., branch. At the meeting of the Council on Tuesday it was agreed to lend the Battersea Vestry £20,000 for electric lighting purposes; the St. Martin's Vestry £6,010 for street-lighting purposes; and the Islington Vestry loans of £18,261 and £3,200 towards defraying the cost of an electric light installation. Doubt having been thrown in legal circles upon the validity of the vote a week ago deciding to purchase certain tramways, Mr. Benn, chairman of the Highways Committee, announced that another special meeting of the Council would be held. Mr. Benn withdrew his report on telephones, the Government having in the meantime made known their intentions. He said he believed that the Post Office were making every effort to cope with the difficulty.

Gloucester.—Mr. R. H. Bicknell on the 24th ult. held an enquiry into the application of the City Council for sanction to the borrowing of £9,425 for purposes of electric lighting, and £8,576 for the erection of a refuse destructor on a portion of the Beanland Estate. The enquiry was purely formal. The Town Clerk stated that the loans applied for were in addition to £43,450 already borrowed for electric lighting. The works were practically completed and would be ready for turning on the current in about a week. The formal opening, however, would not take place until next month. Mr. R. Hammond said the present application was on account of the large number of applicants for the electric light compelling the Corporation to extend the plant. At present 135 customers had signed contracts for taking the light, these representing over 13,000 lights, and over half of these had already been wired. He promised to give attention to the inspector's recommendation to provide a messroom for the employés. Mr. R. Read gave evidence on the dust destructor.

Catalogues.—We have received from the International Electric Company, of 55 Redcross-street, E.C., a copy of their latest catalogue of bell and telephone material. The catalogue is profusely illustrated, and should be handy to those requiring bells, telephones, or their accessories. The list includes electric bells, switchboards and accessories, accumulators, pushes of various kinds, indicators, contacts for different positions, cables, meters, portable and stationary telephones, wire for conductors, testing instruments, receivers and transmitters, etc. The list is very useful, as giving a fair indication of the average price to be paid for the various articles catalogued.—We have also received from Messrs. G. Braulik, of Upper Thames-street, E.C., a price-list of the various types of arc lamps manufactured by them. In the list the advantages of the continuous-current (shunt) arc lamp are dwelt upon, and the price of which ranges between £3. 18s. and £7. A light intensity table is given, which shows the candle-power for various currents. Besides the lamps, particulars are given in the catalogue of carbons, lamp globes, resistances, coupling devices, etc.

Leicester.—The special committee appointed by the Council to consider and report as to the advisability of the establishment by the Council of a municipal telephone exchange have had the question under consideration. The committee have retained the services of Mr. A. R Bennett. The committee think that, failing a competitive service being introduced, there is no likelihood of the existing rates of subscription being reduced. They are of opinion that a remunerative municipal service might be given on the following terms: £6. 6s. per annum for an unlimited number of calls, or, alternatively, £3. 10s. per annum and 1d. a call for each call originated by the subscriber. They are not prepared to recommend the Council to apply to the Postmaster-General for a license to establish a municipal exchange unless 1,000 subscribers are obtained to start with. A canvass is to be made in the town to ascertain how many subscribers there would be if a municipal telephone exchange were established. The Gas and Electric Lighting Committee's last report states that a commencement has been made with the extension of the central station in accordance with the scheme authorised by the Council.

Maidstone.—Colonel W. R. Slacke, R.E, has held an enquiry into the application of the Urban District Council for permission to raise a loan of £40,000 for the purpose of carrying out the provisional order granted by the Board of Trade, in 1892, to supply the borough with electric light. Messrs. Stevens and Barker, electrical engineers, of Maidstone, whose scheme for the work has been accepted, were present, with Mr. Geo. Watson (managing director) and Mr. Somerset Butler (London manager), of the Horsfall Destructor Company, Limited. There was considerable opposition, and finally the Corporation withdrew the application for a loan so far as the dust destructor was concerned. This, of course, made a difference in the figures which had been placed before the inspector. On the two schemes there was a profit shown of £540, but this, it was stated, would now be increased to £1 015. 11s. 9d., as the loss on the dust destructor would not have to be allowed for. The capital expenditure for the electric light was put at £33,598, but then half the expense of the very high shaft, which would have been necessary if they had had a dust destructor, was allocated to that building. The shaft could now be reduced somewhat in size, and he proposed to ask for a loan of £34,000. This part of the scheme having been withdrawn, the breweries withdrew their opposition.

Mile End.—The special committee on the electric lighting question of the Guardians have reported that Mr. Knight attended a meeting of the committee and informed them that the boilers were wrong, the installation was wrong, and the cells were wrong, that the engines should be fast ones instead of slow ones, and that in regard to cost £3,000 would put the service in good working order, excepting the provision of storing-rooms; that three boilers would cost £1,800, and that the total cost would be £6,000. The committee visited the boiler-house, the works generally, and saw the master of the workhouse and the engineer in reference to the quality of the coal. They also saw the electrician about leaving the premises, and were informed by him that he had done so to relieve his eyes, which were bad, and that in doing so no encroachment had been made on the time of the Guardians. The committee further reported that in 1895 the cost of the coal bill was £565 1s. 3d., and labour £215. 16s.; at Lady Day, 1900, it was as follows: coal £2,298, and labour £508. In regard to the engineering staff, it was resolved that the same be reorganised, and that it be referred to the committee to give effect to the same, and in regard to the coal the committee recommended that the contractor be called upon to supply steam coal of the very best quality. The report was referred back after further discussion.

Parliament.—During the last week, in the House of Lords, the Royal assent was given by commission to a number of public and private Bills, including the City and South London Railway Act, the Charing Cross, Euston, and Hampstead Railway Act. The Vale of Rheidol Light Railway Bill was read a second time. The following Bills were read a third time and passed: the Fishguard and Rosslare Railways and Harbours, the Margate Corporation, and the Motherwell and Bellshill Railway. The South Staffordshire Tramways Bill, the Mersey Railway Bill, and the Barnsley Corporation Bill were read a third time. In the House of Commons the third reading of the following private Bills was agreed to: Devonport Corporation, Ilfracombe Improvement, London County Council (Improvements), and the City of London Electric (after verbal amendments). The London United Tramways Bill was read a third time. The Metropolitan District Railway Bill was considered and ordered for third reading. Second reading was given to the following Bills: Cork Electric Tramways, Dearne Valley Railway, Plymouth, Stonehouse, and Devonport Tramways, Rhymney Railway, and Taff Vale Railway. The following Bills have passed the committee stage: Salford Corporation, Glasgow District Tramways (in so far as it proposes the construction of electric tramways from Paisley to Johnstone, Renfrew, and Gleniffer Brae), Blackpool, St. Annes, and Lytham Tramway (arrangements having been made with Blackpool securing a complete interchange of traffic at South Shore Station), Kingscourt, Keady, and Armagh Railway scheme, and the Newry, Keady, and Tynan Light Railway. The tramway schemes promoted by the Bournemouth Corporation and the Bournemouth, Westbourne, Poole, and Christchurch Electric Traction Company, Limited, came before a committee of the House of Lords on Friday, and the committee ordered interchange running powers to Christchurch and Poole. The Electrical Power Distribution Company and the County of Durham Electrical Power Distribution Company have withdrawn their opposition to the Jarrow and Hebburn Electric Supply Bill. The Walker Urban District Council and the Walker and Wallsend Gas Company have withdrawn their opposition to the Newcastle-on-Tyne Electric Supply Bill. Bills for confirming electric lighting provisional orders applied for by the Long Eaton Urban District Council, the Corporation of Boston, the Sleaford Urban District Council, the Bridlington Corporation, and the Urban Electric Supply Company, Limited, have passed for second reading in the House of Lords. Petitions praying to be heard against the Rawmarsh Urban District Council (Tramways) Bill have been deposited on behalf of the Sheffield and South Yorkshire Navigation Company and Rotherham Corporation. The omnibus Bill of the joint railway companies, dealing with that portion of the measure which empowers the construction of a railway from New Romney to Hythe, to avoid the present long detour *vid* Ashford, came before Lord Brougham's committee of the House of Lords at the same time as a Bill promoted by the Sandgate and Hythe Electric Company, Limited, to empower them to construct tramroads, which was in the nature of a competing scheme. At the conclusion of the meeting Lord Brougham said: We will take the South-Eastern Bill first. The company are willing to insert clauses in the Bill which will provide for the construction of a heavy railway from Hythe and New Romney, and the committee assent to the Bill subject to the insertion of a clause to provide for the conveyance of traffic without change of carriage. We have been told that the proposed line is without any engineering difficulties, and there will be no cuttings or tunnels. We think, therefore, that five years is altogether too long for its construction, and we propose to insert three. With regard to the Folkestone, Sandgate, and Hythe Tramway Company, the committee are of opinion that the preamble is not proved.

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Fulham.—At the meeting of the Vestry on Wednesday a report was submitted by the Electric Lighting, etc., Committee, embodying the following report from the consulting engineer: "Referring to my estimate for additional mains and machinery submitted about a month ago, amounting to £49,540, I have now estimated the cost of these, assuming that the work in the streets is confined to the part of King's-road from Harwood-road to New King's-road, New King's-road itself, and Wandsworth Bridge-road. In these streets I have provided 50 arc lamps, with incandescent brackets as before, and distributing mains along both sides of the streets. In addition to the above, I have provided for distributing mains along both sides of High-street from the end of New King's-road to the bottom of Fulham-road, as it would be well for engineering reasons to connect the distributors in this part of the district. One additional sub-station would be built at the top of Wandsworth Bridge-road, and one additional rectifier would be put down in the station for the new arc lamps. Assuming that the fourth engine and the additional boilers are put down at once, which would certainly be desirable, the estimates for the work are as follows: Mains, conduits, house and lamp services, boxes, excavation, etc., £6,580; arc lighting plant, arc lamp-posts, and sub station equipment, £2,612; builders' work, £150; boilers, engine and alternators, steam, exhaust, etc., pipes, condenser, foundation, etc., as before, £12,150; engineering expenses and contingencies, £1,720—total, £23,212." The question has been adjourned for two months. The sub-committee appointed to enquire into the terms of the consulting engineer's agreement so far as regards "personal supervision," and the consulting engineer's explanations having been considered, it was decided to take no further action in the matter. It was recommended that steps should be taken to appoint the permanent staff at the station. The consulting engineer submitted the following report as to meters: "As instructed at your last meeting, I wrote to the British Thomson-Houston Company, Messrs. Venner and Co. (agents for Chamberlain and Hookham), and the General Electric Company, whether, in the event of the Vestry passing an order to them for 100 meters, their prices for these would remain the same, proportionately, as for the 250 meters for which they originally tendered. I received replies from all three in the affirmative, but Messrs. Venner and Co in their reply (which accompanies this report) rightly draw attention to the fact that the Vestry, in thus ordering these meters, are not abiding by their stipulation that the whole of the meters must be made in England. I have ordered 40 5 ampere meters, 40 10-ampere meters, and 20 20-ampere meters from each of these contractors, stating that the whole of them will be taken up before the end of the current year."

LEGAL INTELLIGENCE.

CHAMBERLAIN AND HOOKHAM v. THE MAYOR, ETC., OF BRADFORD.

Mr. Justice Farwell on Friday last gave judgment in the above case as follows: The plaintiffs seek for an injunction to restrain infringement of their patent, No. 4,225 of 1887, for improvements in electricity meters, parts of which improvements are applicable to dynamo-electric generators and motors. The defence is a denial of the infringement and a plea of the invalidity of the patent.

The plaintiffs' patent has been before the Court in another action tried before Mr. Justice Wills in February, 1897, when, on the evidence before him, he granted the relief asked against Johnson, the defendant in that action, and gave the usual certificate that the validity of the patent had come in question. I propose to adopt the judgment of Mr. Justice Wills on all questions of the law determined by him in that action. The plaintiffs' complaints in the present action are confined to Claims 1 and 3 in their specification. With respect to the first claim, Mr. Justice Wills has held both sides agree that this is a claim for a combination—that is to say, that the invention consists in the combination in the plaintiffs' meter of a number of appliances either for the purpose of producing a new result, or for the purpose of producing an old result by new means. The appliances combined may be either new or old, or partly new and partly old, and the patent may, if aptly framed, effectually claim protection for such of the appliances as are novel as subordinate integers, in addition to the invention contained in the combination and protected by the patent. (See Clark *v.* Adie, 2, Appeal Cases, p. 321, per Lord Cairns.) It is contended in the present case that the third claim is not merely a branch of the combination, but is also an independent integral claim. It is also contended by the plaintiffs that they introduced for practical purposes a new principle or idea in the construction of meters. It is, of course, well settled that a mere idea or principle cannot be the subject matter of a patent; there must be some concrete form to which the principle is applied, and that concrete form must be defined and limited, for if the claim is in general terms for every mode of carrying the principle into effect, it becomes a claim to the principle itself, and therefore fails. (See per Lord Justice Cotton, Automatic, etc., 6 Patent Reports, p. 304.) I propose to apply these propositions in determining this action. The first question that I have to consider is that stated by Lord Justice Cotton in Proctor *v.* Bennis, 36 Chancery Division, p. 754. "Has the plaintiff's combination in substance been taken; has the defendant, though not taking exactly the whole combination patented, taken by slight variations or mechanical equivalents the substance of it so as produce the same result by practically 'the same means,'" and in answering this question I have to bear in mind the distinction pointed out by Vice-Chancellor Wood in Curtis *v.* Platt (3 Chancery Division, 135 Note) and Lord Justice Cotton in Proctor *v.* Bennis (36 Chancery Division), that where the invention is for the production of a result already known and attained, the protection afforded by the patent is confined to the particular means pointed out by the specification, and the same result may be attained without infringement by another person by the use of mechanical equivalents; in other words, the invention of a combination of processes leading to a known result does not prevent other persons from arriving at the some result by a combination of other processes; but if the result is novel, in that it produces a new instrument, or involves the practical application of a new principle, the defendants infringe by substituting known equivalents. To use Lord Bowen's words (36 Chancery Divisions, 764); "When there is really an ingenious novelty in the idea that the combination will produce a new result, that novelty in the idea is part of the merit of the very combination." Now, in this case, the object to be produced is an electricity meter for lighting and motor purposes. Such meters were not new in 1889; electricity as a mode of lighting was well known certainly before 1882, when the first general Act relating to electric lighting was passed, and meters for the purpose of measuring the articles supplied were a necessary adjunct for the commercial success of any system of lighting. Mr. Ferranti made meters in 1884, and Prof. Edison at or before the same time. These meters were of course of a different type to the plaintiff's, but they were not the less instruments for measuring electricity. But then it is said that the plaintiff discovered and applied for the purpose of his meter a novel principle—namely, that magnets could be at the same time permanent and powerful. He stated that before 1887, although permanent magnets had been known and used as constant with a weak field, yet when magnetised so as to become powerful, their constancy was not only unknown, but not believed in. He said, in effect, that permanent magnets were really considered inapplicable for the purposes of a meter by reason of the supposed incompatibility of power and constancy, a fallacy which he considers that he exploded. This is material from the point of view of the principles which I have already stated, for if this idea were really novel it would form part of the merit of the invention found in the combination within the meaning of the words of Lord Bowen quoted above. But, on the evidence, I find the contrary to be the fact. I think I do no injustice to the plaintiff if I look at his own specification to assist me in judging of the probability of the reality of this alleged discovery. One would expect to find there a statement of the new principle, and not the less because it was destructive of an old fallacy. If a patentee had really discovered, for the first time that power and constancy were compatible, and knew that all other electricians believed them incompatible, he would never direct the construction of an instrument with very powerful and very constant permanent magnets without calling attention to the fact that the existing belief with reference the.eto was fallacious. He would surely know that the expert, uninstructed as to this, would at once cast aside his specification as that of an impractical dreamer. I have further than this the oral evidence of witnesses of experience and standing entirely contradicting the plaintiff's statement. Further than this, the specification really states no tangible principle at all. All magnets necessarily have some constancy and some strength. To say that magnets are to be used which are both powerful and constant, is simply to state that you must make your magnet as powerful as is consistent with its constancy. It becomes a mere question of degree, with no principle involved and no practical directions given in the specification. Further, it is, I think, clear on the evidence that before 1887 the practice of ageing powerful magnets and thereby making them constant was well known. There was nothing to prevent the defendants from rendering their magnets constants by artificial ageing, and from using two or three if one was found insufficient, and the defendants, in fact, formerly used three, and now use two, comparatively weak magnets, which have been rendered constant by a very special process of ageing described by one of the witnesses. I conclude, therefore, that there is neither novelty of object aimed at, nor of idea or principle involved, and I approach the consideration of Claim 1 as a combination patent pure and simple. Now, the objects aimed at by the plaintiffs and defendants are different in this respect; both make a meter, but the plaintiffs' is a current meter, the defendants' is an energy meter. The distinction is, to my mind, material. The current meter measures current only, and is incapable of measuring anything else. The energy meter measures the energy—*i.e.*, both the pressure and the quantity. The Board of Trade unit is energy, not current. Mr. Ferranti stated the essential difference to be that in an energy meter the two parts of the motor—namely, the armature and the field—must be connected, the one in circuit with the lamps to be measured, and the other across the circuit so as to receive the voltage of the circuit. The current meter deals only with the main current of the circuit flowing to the lamps. Further it is essential to a current meter, and is so stated in the specification, that there must be of necessity an electromotor with a constant or nearly constant field. In an energy meter such a constant field would be destructive. Further, the energy meter will not directly measure current at all. It is true that if you have, in fact, a constant potential you can calculate from your energy meter, and the amount of energy shown thereby what amount of current has passed. Mr. Moulton founded an ingenious argument on this. He said that by Act of Parliament the potential was allowed to vary only to the extent of 3 or 4 per cent., so that it must be practically constant, and that at Bradford

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9492. Improvements in ceiling roses and other similar electrical connections. Walter McGregor Douglas, 15, Water-street, Liverpool.

9496. An improved method of increasing the sound of the phonograph, graphophone, gramophone, and other talking machines. Sidney Oldridge, 38, Charlotte-street, Portland-place, London.

9503. Improvements in electric igniters for explosion engines. Theodor Bergmann, 72, Cannon-street, London. (Complete specification.)

9507. Improvements in apparatus for exciting dynamo-electric machines. Alfred George Cooper, Fernlea, Ellesmere-terrace, Colne, Lancs.

9511. Improvements in the construction of swivel heads of electric car trolleys. Isaac Fitchew Cuttler, Sunbridge-chambers, Bradford.

9533. Method of exciting alternating-current machines. Paul Marie Joachim Boucherot, 60, Queen Victoria-street, London.

9534. Improved method of starting multiphase-current motors. Paul Marie Joachim Boucherot, 60, Queen Victoria-street, London.

9552. Improvement in electric arc lamps. Hugo Bremer, 42, Neuenweg, Barmen, Germany. (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on June 16.

1899.

10682. Telephonic appliances. Andrews.

10903. Telegraphic transmitters and receivers. Wise. (Crehore and Squier.)

11345. Cartridges to be fired by electricity. Friese-Greene and Knell.

13054. Holders for globes and shades of gas, electric, and other lamps. Sanders.

13996. Electric arc lamps. Veritys, Limited, and Ridings.

14907. Electric circuit breakers. Davis and Wright. (Date applied for under International Convention, March 23, 1899.)

15128. Ring contacts or contact plugs for electric circuits. Lucas.

15973. Direct coupling or connection of rotary fans or pumps with electric or other motors or engines driving same. Davidson.

21302. Electricity measuring instruments. Sondermann and Berlow.

25632. Method of telegraphing on telephone lines, and telegraphic recorders for use in connection therewith. Thompson. (Sinding-Larsen.)

1900.

5178. Means for connecting electric cables. Day. (White.)

6526. Electric fire-alarms. Münker.

6951. Instrument for measuring electric currents. Steele.

7108. Magneto-electric machines. Simms and Bosch.

7109. Electromagnetic coils. Varley.

7562. Third-rail insulators for electric railways. British Thomson-Houston Company, Limited. (Rice.)

7567. Electric bonds for electrically connecting the meeting ends of two contiguous electric conductors. Brown.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	May 26	672	507	+ 165	30,135	25,948
Birmingham Tramways Co.	,, 26	4 555	4,510	+ 45	86,725	82,266
Blackburn Corp'rat'n	,, 26	474	507	- 33	7,356	8 441
Blackpool Corporatn.	,, 24	353	828	- 475	2,815	2,775
Blackpool-Fleetwood	,, 26	413	1,435	- 1,022	5,523	6,483
Bolton Corporation..	,, 20	1,230	—	—	8,172	—
Bradford City Trams	,, 27	527	544	- 17	3,670*a*	2,943
Bristol Tramways Co.	,, 25	3,169	3,816	- 647	—	—
City & South London	,, 27	1,355	912	+ 443	26,319	22,234
Dover Tramways ...	,, 26	207	214	- 7	3,402	3,260
Dublin U.T., elec. cars	,, 25	3,494	2,265	+2,137	—	—
Dublin S.D. Electric	,, 25	823	1,357	- 233	—	—
Halifax Corporation	,, 26	747	583	+ 164	5,371	3,709
Hull Corporat'n E.S.	—	—	—	—	— *a*	—
Liverpool Corporat'n	,, 19*b*	7,882	6,627	+1,255	139,350	121,537
Liverpool Overhead	,, 27	1,429	1,825	- 396	29,657	28,848
Sheffield Corporation	,, 27	2,321	—	—	—	—
South Staffordshire	,, 25	710	948	- 238	13 639	13,264

a Since April 1. *b* Partly electrical.

Apparent decreases due to Whitsuntide falling in corresponding week last year.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 6½
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	¾-1
—— 6 per cent. Cum. Pref., 1-50,000	1	..	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	103	—	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	109-114
—— 4½ per cent. 2nd Debenture Stock	100	—	103-105
Callender's Cable, Debentures.	100	—	112-116
—— Ordinary	5	—	14¼-15¼
—— 5 per cent. Pref.	5	—	5¼-6
Crompton and Co.	3	—	3¾ 4
—— 5 per cent. Debentures	—	—	100-103
Edison and Swan United, Ordinary	3	—	2-2¼
—— 5 per cent. Debentures	5	—	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	—	93-95
Electric Construction	2	..	2-2¼
—— 7 per cent. Cumulative Pref.	2	..	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	103-106
W. T. Henley's Telegraph Works, Ordinary	5	—	13¾-14¼
—— 4½ per cent. Preference	5	—	5¼-5¾
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	..	100-103
Telegraph Construction and Maintenance	12	..	34-38
—— 5 per cent. Bonds	100	—	103-105
Telegraph Manufacturing, Ordinary	5	—	11¼-12½
—— 5 per cent. Cum. Pref.	5	..	5¾-6
Willans and Robinson, Ordinary 1-80,000	5	..	11¼-12½
—— 6 per cent. Cum. Pref., 80,001-60,000	5	..	7-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	7-7½
Charing Cross and Strand	5	..	8½-9½
—— 4½ per cent. Cum. Pref.	5	—	5¾ 6
Chelsea Electricity Supply	5	—	6¾-7½
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	..	9½-10½
—— 6 per cent. Cumulative Pref.	10	..	12-13
—— 5 per cent. Debenture Stock	100	..	122-127
County of London and Brush Provincial, Ordinary	10	..	9¼-10¼
—— 6 per cent. Cum. Pref.	10	..	11¼-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	110-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4¾-5
—— 4½ per cent. First Mort. Deb.	100	..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¼-10½
London Electric, Ordinary	3	..	1¾-2
—— 6 per cent. Pref.	5	..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	13¾-14¼
—— 4½ per cent. First Mortgage Debenture Stock	100	..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	..	96-98
Notting Hill Electric Lighting	10	..	15¾-16½
Oriental, 1879	1	..	1¾-1¾
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	6¼-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,810	5	..	6¾-7
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	$ 00	..	170-190
—— 4½ per cent. First Shares Mortgage Debentures	$ 00	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14¼-15½
—— 7 per cent. Pref.	5	..	8¾-9½
Westminster, Ordinary	5	..	14½ 15½
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-Shares	5	..	4¾-5¼
—— ,, ,, deferred	5	..	5-5¼
City and South London, Consolidated Ordinary	100	..	61-64
—— Ordinary	10	—	5¼-6¼
—— 4 per cent. Debenture Stock	100	—	123 128
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	..	13¾-13¾
Waterloo and City, Ordinary	100	..	100-103
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17½-18½
Brisbane Tramway	100	..	102-104
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10¼-10¾
British Electric Traction, Ordinary, 1-80,000	10	..	15¼-16¼
—— 60,001-75,000	10	..	15½-16¼
—— 6 per cent. Cm. Pf. 80,001-60,000	10	..	12-13
—— 5 per cent. Perpetual Debenture Stock	100	..	124-127
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf, 1-40,000	5	—	5-5¼
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	—	4-4¼
—— 5 per cent. Deb. Stock, Red.	100	..	103-106
Isle of Man Electric Power, 1-95,000	1	..	¼-5/16
—— 6 per cent. Preference, 100,001-170,000	1	..	15/16-1
Kidderminster and District Lighting and Traction, Pref.	10	..	9¼-10
New General Traction, Ordinary	5	—	3¾-4
—— 6 per cent. Cum. Pref.	5	—	4¼-5¼
North Staffordshire Trams	6	..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— Preference	10	..	10¾-10
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11¼-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9¼-10¼
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	½-½
National Telephone, Ordinary	5	..	4¼-5¼
—— 6 per cent. Cum. First Pref.	10	..	12-15
—— 6 per cent. Cum. Second Pref.	10	..	11-13
—— 5 per cent. Non. Cum. Third Pref.	5	..	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	..	97-100
Oriental Telephone and Electric Company	1	—	13/16-1 1/16

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NOTES.

Fire.—A fire which recently occurred at the premises situated next door to the Nernst Electric Light Company spread to the laboratory of this company, and considerable damage was done. The company, however, state that this check will not delay their work seriously.

Electrical Engineers Volunteers.—We notice in the *London Gazette* of June 5 the appointment by the War Office of Mr. Edward Huntingdon Leaf as second lieutenant in the Corps of Electrical Engineers (Royal Engineers) Volunteers, the appointment dating from June 6.

The Incorporated Gas Institute.—The thirty-seventh annual general meeting of this institute will be held on June 12 and 13 at the Royal United Service Institution, London, the president, E. Herbert Stevenson, Esq., M.I.C.E, in the chair. Five papers are down for reading and discussion.

German Cables.—Reuter's correspondent at Emden, Germany, informs us that the new cable recently laid between that place and the Azores was tried for the first time on May 30. The experiments so far have proved far more successful than was anticipated, and without doubt Germany will gain considerably from this latest addition to the world's cables.

Wireless Telegraphy in Zanzibar.—In a letter recently sent by General Sir L. W. Matthews from Zanzibar, he states that it was proposed to establish communication between Zanzibar and Pemba by means of wireless telegraphy. An interesting feature is the proposition to instal as telegraphists old members of the Universities' Mission to Central Africa.

South African Telegraphs.—The war in South Africa has created a considerable demand for telegraphic apparatus of various kinds. Thus we learn that for the purpose of repairing the damage done by the Boers to the telegraphic system in the districts affected, 1,000 iron telegraph posts, supplied by Siemens Bros., Charlton, recently left London in the "Braemar Castle."

Boston Elevated Railway.—In a previous issue we described the various experimental electric trams which were competing for the contract for use on the Boston Elevated Railway. There were three companies in the competition, the Sprague, the Westinghouse, and the General Electric. It is now interesting to note that the Sprague Electric Company have been awarded the contract for controllers for 60 of the cars.

Society of Engineers.—The next meeting of this society is to be held on the 11th inst., when a paper will be read by Mr. A. Hamo Binyon on "Electric Traction." The paper will include notes on London traffic compared with that of other cities, the overhead trolley system, power distribution, sub-stations, combination of electric lighting and traction plant, batteries, engines, motors, etc. The paper is to be illustrated by diagrams, limelight views, and models.

Indo-European Telegraphs. — The report of the India Office on the Indo-European telegraph service shows a profit of 6·03 per cent. on last year's working as compared with 6·57 per cent. for the previous year. It is stated that this decrease is mainly due to the falling off in Indian and Australian traffic, and to the rise in value of the rupee. The number of cases of wilful damage last year shows an improvement over the previous year, the number of cases being 145 and 197 respectively.

Indian Water Power.—Schemes for the utilisation of the water power of the various rivers in India are still making their appearance. The scheme, however, for using the Nerbudda Falls as a source of energy for generating electricity to be used in the Central Gun Carriage Factory at Jubbulpore seems likely to fall to the ground. Arrangements were made to measure the amount of water passing over the falls, but the idea was abandoned owing to the intermittent and unequal quantity and pressure of the water.

Kiel.—Steam power is to be superseded by electricity to a very considerable extent in the Government dockyard at Kiel, Germany. After experimenting with electric power transmission on a comparatively small scale with good results, the Administration have now decided upon a bolder scheme, whereby the whole of the machine tools, etc., installed in the different workshops are to be electrically driven. To this end a power plant having a capacity of 3,500 h.p. is to be put down. This plant will also supply electrical energy for driving the powerful dockyard pumps.

City and South London Extension.—On Sunday last the extension of the City and South London Railway to Clapham Common was opened to the public. There is now a through connection to Moorgate from Clapham, the fare being 8d. return. The trains are to run every three or four minutes, and on Sunday a rather longer interval will come between the trains, while the fare to Moorgate will be 6d. On the north side of the river the City and South London Company is also making extensions, and lines are being constructed to the Angel, Islington, and to the City-road.

Storms Caused by Electric Lighting.—Our contemporary, *Indian Engineering*, states that with reference to the electric lighting of towns in the Himalayas and other similar districts, the question of the safety or otherwise of electric lighting in hill stations has lately been raised, and is of scientific interest. It is alleged that at Darjeeling thunderstorms have been much more frequent and more severe since the introduction of electricity as an illuminant at that station. The theory put forward as to the cause of this is that the electric light attracts the storms. The matter is one for investigation, but we ourselves incline to the opinion that the two things must be regarded as nothing more than a coincidence.

Water Power.—A new power scheme is proposed at South Bend, U.S.A., a corporation having been organised in Indiana for the purpose of supplying South Bend and the neighbouring cities with light and power. One of the principal uses to which the energy will be put will be the operation of an electric railway from South Bend to Michigan City and to Benton Harbour. The horse-power is to be obtained by building a dam across the St. Joseph River, and the plant will have a capacity of 3,000 h.p. Another dam is to be built across the river to the east of South Bend, where it is expected some 6,000 h.p. will be developed. The plant installed in both cases will consist of direct-coupled alternating three-phase generators of 1,500 kw. capacity.

Lightning Arresters.—It is often the case with lightning arresters that, after a considerable period of service, a short-circuit is established between the sparking coils. In a patent issued to Mr. A. J. Wurts, and described in the *Electrical World*, the inventor states that he has found by experiment that if an equal resistance be interposed in the circuit of each of a plurality of spark-gaps, the charge will invariably sub-divide between the several gaps, thus dividing the intensity of the entire discharge by the number of paths. The construction to fulfil this condition is as follows: Resistance is interposed in the circuit in the form of cylindrical rods consisting of a mixture of graphite, kaolin, and some binding material,

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such as starch. These resistance rods have one end joined to a circuit terminal, and their other end respectively connected to the outer ends of terminal strips, the latter being separated from a terminal plate by a spark-gap.

Electrical Trains.—The underground electric line from Earl's Court to Kensington High-street does not seem to be such a great attraction as the District Railway seemed to expect. The ordinary person who happens down on the station at Earl's Court or Kensington does not think that the privilege of riding in an electric train is worth 6d. per mile, while with the ordinary service 1d. is charged. We notice, however, that the fares have been reduced from this high price, and people will no doubt be more ready to patronise the concern. The railway company would, however, appear to wish to keep the passengers select, as the train is run when the average man is at his office, and no chance is given him for forming an opinion as to the merits of this electrical section.

Tasmanian Riches.—We notice in *Feilden's Magazine* for the present month a note which states that large deposits of rare earths, such as zirconia, thurium, ittrium, etc., have been located in the centre of Tasmania. The writer expresses surprise that certain portions of this island are practically unexplored, owing to the mountainous nature and wooded conditions of the country. To those who have visited Tasmania it is not so peculiar as the author of the paragraph evidently thinks, as apart from these special districts, there is an immense amount of good and profitable land, and labour is cheap, and settlers in Tasmania would not be likely to choose the mountainous districts for their farms while such splendid prospects are offered in other parts of the island.

Army Automobiles.—It is stated by the *Globe* that the Signal Corps of the United States army have adopted electric automobiles in the Philippines. The wagons are of two sorts, one for carrying instruments and materials, the other for personal baggage. The first is like a covered ambulance, with rubber-tyred wheels, and is driven by accumulators charged for 30 hours' work with a load of 1,500lb. Two motors, each of 3½ h.p., drive the two rear wheels. The second wagon is a high cart, but in other respects like the first. Both have electric lamps inside and at the sides. Looking to the future before automobilism in war, colonial, and postal work, our contemporary thinks that British makers can safely be advised to turn their efforts in these directions.

Healing by Electricity.—The Vienna correspondent of the *Daily Chronicle* reports that a discovery likely to be of inestimable value to medical science has been made at the hygienic institute at Würzberg University. A dentist named Zierler has found that certain electric currents possess the quality of destroying bacteria, and can be used for healing a number of diseases caused through these. The treatment is said to be very simple and efficient and painless. Successful experiments are said to have been made in the treatment of the roots of decayed teeth. There is every possibility that certain diseases can be cured by the application, but in this case we fail to see why the word "discovery" is used, as it has for a considerable time been known that electricity will have such effects on microbes.

Trolley Wire Joints.—We notice in the *Street Railway Review* for May a description of a trolley wire joint. When a tightly-drawn trolley wire breaks it is, of course, rather difficult to join the severed ends, as there is no slack wire, and the joints must offer no obstruction to the passage of the trolley wheel. The Kisinger Iron Company, of Cincinnati, claim to do this, and have produced a device which consists of a hollow sleeve with tapered ends and a central opening. The interior of the ends of the sleeve are tapered, the small ends of the taper being at the outward ends of the connector, and large enough to admit the trolley wire. The severed ends of the wire are pushed into the holes in the ends of the sleeve, and then locking devices, in the form of toothed wedges, engage upon the side of the ends of the wire and the tapering inner walls of the tube, the wire being thus pinched between one wall of the sleeve and the locking wedges. By this means the makers claim that the harder the pull on the trolley wire the tighter the joint becomes, and the time taken in repairing a trolley wire is very little compared with the old soldering method.

Electricity and Agriculture.—The use of electricity has up to the present not been tried to any extent in connection with agriculture. From *Feilden's Magazine*, however, we gather that an experiment is now being tried in Bavaria, in which state an association of farmers are building large electrical works to supply power for agricultural uses. The current is generated near the village of Schaftersheim, a distance of seven miles from the district of consumption, the prime motive power being partly steam and partly water. From the station the current is to be transmitted at a pressure of 5,000 volts to the surrounding villages, where it will be employed for driving various agricultural machines. The motors used are very simple and compact, so that they can easily be handled by farm hands. If this experiment should prove successful it will probably be imitated in other portions of Germany, as the power, according to the estimates, is far more economical than steam power in separate plants. It is suggested that there might be a very profitable future for such installations also in the United Kingdom.

Improvement in Incandescent Lamps.—A German firm, the Gesellschaft für Elektrische Beleuchtung, Orlow, Berlin, have introduced a new form of incandescent lamp. The lamp is designed to reduce the cost of subsequent renewals. To this end it is constructed in two portions, the socket being detachable from the glass bulb containing the lamp filament, so that either portion may be replaced separately when required. The socket is similar in external appearance to an ordinary socket. The contact pieces are insulated from each other by means of porcelain, as likewise the copper threads which connect through to the lamp filament. In attaching the lamp to the socket holder, the socket is first of all detached from the glass bulb and screwed into the socket holder separately, to facilitate which the socket is somewhat longer than the ordinary pattern. The bulb is then pushed into the socket. Many advantages are claimed for the lamp besides that of economy, the realisation of which seems to depend almost entirely upon the accurate fitting of the several parts, being therefore a question of careful workmanship. Without the latter, the danger of loose contacts is, of course, multiplied relative to the ordinary type of lamp.

Human Energy Increased.—Once again we hear of remarkable inventions and aspirations from Mr. Nikola Tesla. This time the problem which occupies his attention is that of increasing human energy, and his views are published in the *Century Magazine*. He gives three ways in which his problem may be solved—namely, "to increase the human mass," "to reduce the retarding force," and "to increase the impelling force." The first is accomplished by attention to hygiene and good food. Ignorance and stupidity form a retarding force that people are continually endeavouring to improve out of existence, but there are other retarding forces, the greatest being warfare, and to overcome some of these the writer invented the telautomaton, "a machine having all its bodily or translatory

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movements and the operations of the interior mechanism controlled from a distance without wires." The possibilities of this machine are amazing, "and the continuous development in this direction must ultimately make war a mere contest of machines without men and without loss of life." The third problem—"how to increase the force accelerating the human mass"—is to be solved by the application of the power of the sun. Wireless telephony and wireless electrical power transmission are also among the castles which Mr. Tesla has built in the air.

Telegraph Line Protection. — The problem of protecting telegraph and telephone wires from lightning discharges and accidental heavy currents from lighting or power circuits is dealt with in the *Telephone Magazine* of Chicago, which describes an apparatus for protecting the wires from such currents. The device, which is called the Rolfe protector, has given great satisfaction for several years and under the most trying conditions. Laboratory tests have been tried upon it by the American National Board of Fire Undertakers, who have officially recommended it. The protector prevents damage to instruments by opening the circuit and cutting them out on the passage of an unduly large current. This is accomplished by means of a heat coil composed of a mass of fusible material, and a small coil of high resistance wire embedded in the fusible material. When an unduly strong current passes in the circuit, the heat generated by the high-resistance wire melts or softens the mass of fusible material. The operation of the heat coil in this manner is made to cause the circuit to be broken or opened in either one of two different ways—namely, either by effecting a bodily removal of the heat coil from the circuit, or by breaking the high-resistance wire of that coil. In many of the protectors, lightning arresters composed of carbon blocks are also provided.

Japanese Telegraphs.—We notice in the *Journal Telegraphique* an article dealing with the history of the telegraph in Japan. Thus the telegraph was first established in Japan in 1869, the Japanese Government having engaged English engineers to carry out the first line, which connected Tokio and Yokohama. There was, however, so little demand for the service at first that it was practically a failure, until in 1873 the department was reorganised and in 1874 the telegraph law was passed. During what is known as the Satsuma War, however, the Government was awakened to the necessity of developing the telegraphic communication, and during this war many of the most important lines were constructed. In 1879 Japan took her place in the International Telegraphic Union, and the service was gradually extended inland, and a considerable area is at present covered by lines. The Chino-Japanese War of 1894 did a very great deal to forward the progress of telegraphy in Japan. There are now 1,267 exchange stations in Japan itself and 112 in the Isle of Formosa, and in 1899 there were about 134,000 miles of line in Japan and 7,570 miles in Formosa. As against 19,448 telegrams sent in 1871, these being purely in Japan, there were in 1899 about 14,800,000 interior telegrams and 217,000 international telegrams, while in Formosa 475,623 interior telegrams were sent and about 7,000 international messages.

The Riviera Tramways.—From consular reports we gather that the application of electricity to tramways in the French Riviera has not been attended with uninterrupted good fortune. Thus, in the first place, the working of the telephones at Cannes was seriously interfered with, but this interference has been prevented by a system of duplicate wires, which are placed underground. The cost of providing and laying these wires, however, entailed an expense of £2,600, which was wholly borne by the tramway company. In addition to the Cannes line, the Consul-General at Nice reports that electric trams have been substituted for the old horse trams throughout that town by the Thomson-Houston Company, and have been extended to Villefranche with a view to being eventually carried to Monte Carlo. Part of the road is, however, so narrow that it will be necessary to greatly widen it at enormous cost before it can be utilised for electric traction as well as for carriage traffic. The tramway along the Villefranche road has already been the cause of several accidents, but within the town limits the electric is a great improvement on the old system. Sir J. Harris adds, as a curious fact showing the great place the carnival festivities occupies in the minds of the people, that while overhead wires have been generally adopted by the tramway company, these are replaced by an underground system in the streets traversed by the huge carnival cars, with the height of which the overhead wire system would have interfered.

Aerial Telegraphy. — Prof. Bryce, in his recent speech at Aberdeen, speaking of the British Empire, said: "The British nation had not set out to acquire such an empire. It has come to us, not so much by our deliberate purpose as by the natural course of events. . . ." Of course, Mr. Bryce, being somewhat of a Little Englander, has to be taken *cum grano salis*. The words above quoted, however, are admirable in their way, and tell truly, not only what has happened from an Imperial point of view, but what happened, or is happening, from an industrial point of view. Did England pioneer in electric light? Oh, no! In power? Certainly not! These phases of industrial work happened—that is all. Now Dover is up in arms against the removal of the Marconi system from the town and lightship, but gets the reply: It was only an experiment. So idiotic red-tapism can or will do nothing. At the same time we read that Japan is experimenting with aerial telegraphy round her coast. Probably, when Japan—or it may be our red-tapists will wait till China and Timbuctoo have experimented—has tried and achieved the success attained at Dover and adopted an aerial system as suitable under certain conditions, then we may also adopt where suitable. So far as this country is concerned, that is the "natural course of events." Nothing is good enough for red-tapists till proved to be bad—which is a conundrum. The lives of sailors, the value of ships, is as nothing compared to the rules of red-tape.

Electricity in Entertainments.—Those who were fortunate enough to get within St. James's Theatre during the Derby week must have been highly pleased, not only with the excellent performance of that clever modern play, "The Man of Forty," but also with the altered appearance of the house. The lighting of the auditorium is one of the principal features of the recent improvements. The open, objectionable centre piece is entirely done away, and the house is brilliantly lit from above by means of a large number of incandescent lamps, which are set into the gilt arabesques which decorate the ceiling. Thus an unobstructed view of the stage is obtained from all parts, the glare to the eyes is avoided, and the light is more diffused. While on this chapter we must not forget to mention some pretty effects which are obtained at the Empire in "Around the Town Again." There are improved methods of introducing large lamps in wreaths, and other objects carried about by the *danseuse*, apparently quite free and unconnected with dynamo or battery, give some resplendent results. The latest war pictures reproduced are remarkably clear and free from glimmer. Another proof—if it were needed—of the share electricity is bearing in providing the public with entertainment is afforded by the dispatch with which these moving pictures—as, for instance, the Yeomanry marching

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out of Bloemfontein, or the Prince winning the Derby—are placed on the stage. Similar ones are also shown at the Hippodrome, the elaborate electric arrangements of which place deserve a special note. At the Oxford, also, electricity has almost entirely displaced the limelight in the production of pretty scenic effects.

The Central Stations of Chicago.—We notice in the issue of the *Electrical World* for May 19 a description of the position held by the various electric lighting companies in Chicago. The principal portion of the electric lighting in Chicago, with the exception of street illumination, is done by the Edison Company of that city. The central-station work without the city limits is done by the Commonwealth Electric Company, which, under the management of the Edison Company, combined the various franchises owned by other companies, and placed this portion of the work under one direction instead of several. The two companies—the Edison and Commonwealth—as would be expected, are very closely associated, having practically all the same officers. The Edison Company feeds into a 230-volt network at six stations or sub-stations. The largest of these stations contains 10 triple-expansion vertical three-crank engines, each driving two multipolar generators mounted on the end of the engine shaft, the total capacity of the 20 generators being 6,400 kw. The boiler-room contains at present 10 Heine boilers of 500 h.p. each, four more being proposed during the coming year. The boilers are to be fitted with Babcock and Wilcox chain grate stokers. From this large station power is carried by a trunk line to a sub-station containing a battery with a capacity of 2,240 amperes for one hour, or 4,480 ampere-hours at an eight-hour rate of discharge. The other stations are somewhat similarly fitted but with a smaller capacity. To enable the plant at the generating stations to help out another as desired, the adoption of a uniform periodicity of 25 on the system is steadily advancing, and within a year all of the five stations of the company will be working in synchronism with each other on high-tension lines, as well as in parallel with each other on the 230-volt network which is connected through continuously from station to station. Parts of this complete high tension, interconnecting system are already installed and in operation.

Institution of Electrical Engineers.—We have received from the secretary a copy of the circular now being issued to members of the Institution respecting the arrangements which have been made for the railway journeys and accommodation of those visiting the International Electrical Congress and the extraordinary general meeting of the Institution in August. As before stated, the extraordinary general meeting is to be held in Paris on Aug. 16, or two days before the opening of the International Congress. At this meeting on the 16th members of the American Institution will also be present. It is yet too early to state any arrangements definitely, but the Institution committee hope that a formal meeting will be held, and that arrangements may be made for a reception. In order to facilitate the arrangement of the details of the visit, however, the Council ask that members who intend to go should inform the secretary to that effect at an early date, and also as to how many ladies will be in the party. Arrangements have been made with Messrs. T. Cook and Son to attend to the travelling accommodation of the party, and reduced rates will be given if at least 30 members agree to travel by the same train on the outward journey. The arrangements with Messrs. Cook must be made by members personally, but the application form supplied by Messrs. Cook and Son should be sent to the secretary of the Institution for registration purposes and also the remittance, which, with the form, will be forwarded. As regards hotel accommodation, the rooms will be allotted in order of application, providing that a deposit of £1 is sent with the order, and it is advisable that, to ensure accommodation, early application should be made. No extra subscription is required of members attending the joint meeting of the institutions, but for attendance at the International Congress the sum of 20fr. must be paid to the French Committee. Application forms for the congress can be obtained of Mr. W. G. McMillan, secretary of the Institution of Electrical Engineers.

Accumulator Car Construction.—In an article contributed to the *Centralblatt für Accumulatoren und Elementenkunde* Mr. Max R. Zechlin draws attention to the possibility of improving the design of accumulator cars in two important directions. In the first place Mr. Zechlin thinks that considerable economy might with advantage be effected in the weight of the cars, and in the second place strongly advocates the use of ball bearings. A reduction in the weight of the cars would diminish the tractive resistance offered by the same, and also the effect produced by inequalities of the road surfaces on the structure of the cars and of their accumulators. This necessary economy in weight might be obtained by the judicious employment of tubular construction without detriment to the strength and rigidity of the cars, and by paying greater attention to the dimensions required for a given strength. The weight of the car itself is, as Mr. Zechlin points out, of vital importance, since a surplus weight in accumulators, amounting to from 20 to 50 per cent. of the total, has to be carried. This surplus weight, however, ensures the necessary adhesion of the car wheels. Consequently the endeavour of the designer should be to produce a car which, together with its complement of accumulators, is of just sufficient weight to secure the requisite adhesion under given conditions with a proper distribution of the weight. Most of the accumulator cars hitherto constructed leave much to be desired in the direction indicated. There is apparently little room for the further improvement of the driving motors and control of the same. Neither does there seem any immediate prospect of considerable economy being effected in the weight of accumulators. In order to fully establish the practical utility of the accumulator car, improvements in the construction of the cars themselves must therefore be looked to. A further means of improvement than those mentioned above, says Mr. Zechlin, consists in increasing the diameter of the bearing wheels, whereby the tractive resistance of the car may be reduced and other advantages obtained. This does not, of course, apply to all forms of motor-propelled vehicles.

Electrical Tanning.—We notice in *Kuhlow's German Trade Review* a description of a patent recently taken out in Germany by Messrs. Carl Lucknow and Franz Toerisser. The process is one for making hides conductors of electricity by stretching them on a perforated metal plate, of effecting the same result by rubbing them with plumbago, and by precipitating in the inner tissue of the hide, by electrolysis, a metallic substance. In practice, the hides are stretched tightly across a metallic conductor in the form of a plate, so that a perfect contact is assured between the two. The conductors or plates, in order to facilitate the circulation of the electrolytes, should be provided with perforations at intervals, or a wire netting with small meshes may be used. The plates, which serve as cathodes, are of the same material and form. In order to protect the conductors upon which the hide is stretched from being attacked by the anions, they may be polished with plumbago or plated with platinum, or made of certain alloys which

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are little affected by these substances. A similar result may be attained when the hides are coated or impregnated with a metallic substance so that their conductivity is correspondingly increased, and thus they are fitted to act as anodes. The hides must first of all be soaked in a solution of acetate of lead, and then transferred to one of chloride of lead which is deposited in the fibrous tissue. After being thoroughly washed, the hide thus prepared may be suspended as a cathode in a suitable bath, and owing to its metallic properties can then act as an anode. The solutions to be electrolysed principally consist of tannins or salts containing tannins. Where feasible, in order to accelerate the process without injury to the leather, the conductivity of the electrolyte is increased by the addition of certain salts or acids, the anions of which, by acting upon the pores of the hide, also exercise a plumping effect, which facilitates the penetration of the tannin and improves the quality of the leather. Only a very moderate current is employed. The tannage may be commenced with one of from 50 to 100 amperes per square yard of anode surface, and can subsequently be gradually increased. The tension is about three volts. During the process the liquors must be frequently strengthened, and fresh tanning materials added as required. When the tanning is complete, the leather is taken out and finished in the usual way.

The Temperature of Lead Accumulators.—Amongst the abstracts appearing in Mr. Carl Hering's digest in the *Electrical World* is one of a paper contributed by Mr. Dolezalek to the *Zeitschrift fuer Elektrochemie*, on the subject of the temperature coefficient of the lead accumulator. The author states: "Streintz measured the same for concentrations of the acid between 1·144 and 1·173, and always found it to be positive and to have a maximum for a concentration of 1·160 (22 per cent. of sulphuric acid); he found also that the temperature coefficient is independent of the temperature between 10deg. and 70deg. C.—*i.e.*, that the E.M.F. is a linear function of the temperature. Mr. Dolezalek starts from the formula of Helmholtz for the temperature coefficient (deduced from the second principle of thermodynamics) and supposes that the thermo-chemical heat of reaction (of Thomson's law) is independent of the concentration for small concentrations of acid. He thus obtains a formula for the temperature coefficient as a function of the acid concentration, applying to concentrations between 0·1 and 0·0005, which shows that, below the concentrations used in the measurements of Streintz, the temperature coefficient must quickly decrease to zero and become negative for small values of the concentration. He made an experimental investigation, the results of which are in agreement with his theoretical conclusions. The temperature coefficient was found to have positive as well as negative values, according to the concentration of the acid. He found also the maximum observed by Streintz, and that for very dilute acids the E.M.F. is also a linear function of the temperature, which appears from a diagram for an acid 0·0005 normal. He remarks that if a very dilute solution is used, the accumulator may be used as a very effective thermo cell, by connecting in opposite directions two cells filled with such solution, the one being held at, say, 10deg. C., the other at, say, 100deg. C. An E.M.F. of 0 6 volt is thus obtained. When the cold cell is discharged, the warm cell is charged, and it is only necessary to heat the former and to cool the latter in order to enable the system to furnish current again at the expense of the heat supplied. An accumulator filled with such a dilute acid is, of course, no apparatus which can be used in practice. It may be, however, that a high temperature coefficient can be obtained with an electrolyte which can be used in practice. 'The lead-peroxide-lead cell would thus be not only an excellent accumulator, but at the same time a very good generator, which would enable one to dispense with the steam-engine for the generation of current.'"

Power Transmission.—It is stated by our contemporary, the *San Francisco Chronicle*, that considerable interest is felt in the United States as to the practical results of the Standard Electric Company's transmission scheme from the generating plant at the foot of the Sierra to San Francisco and the neighbouring cities and towns. The reason for this is that the voltage will be the highest in the country, and the commercial transmission the longest of any in the world. Amongst the details of interest in connection with this work are the insulators, which are made on a new and complicated system. To overcome the danger of a short-circuit in wet weather, two materials are employed, one being porcelain and the other glass. The upper portion of the insulator is made of porcelain of umbrella form, with a corrugated button at the top in order to receive the wire, with a saucer-like receptacle to catch the water that is led off by means of a spout to beyond the line of the pole. In this connection it is interesting to state that the tests of the working of the insulator demonstrated that the electric current will be of great service in accomplishing this object. When the poles were drenched, the water ran off the insulator in nearly a vertical line; but when the electric current was switched on to the line, the water was propelled horizontally to a greater distance from the poles, first taking the size of large drops, and as the power was increased assuming the condition of spray thrown off so far that no further danger of conduct existed. Just below the insulators is placed an annealed glass skirt, and again below it a sleeve of porcelain, all of these being cemented by a species of flux so as to leave not the slightest opportunity for the water to penetrate and act as a conductor. The top of the insulator is 11in. in diameter, and the exposed portions of the glass skirt and the porcelain sleeve are 11½in., so that by the aid of the spout the danger of transmission of electricity to the poles by water is reduced to a minimum. The current will be transmitted from the power-house by means of aluminium cables ¾in. in thickness, composed of 37 wires laid one over the other in a series of twists in opposite directions, and then bound together. They are constructed to carry current at 60,000 volts, and therefore the tests to which they have been subjected are extraordinary. They proved, however, entirely satisfactory, sustaining 16 times the force to which they will be put in actual transmission. The transmission system will consist of two cross-sections. The first will be from the power-house, for the use of the mines and mining towns, thence to the power-house in Stockton, thence to the Mission San Jose to Oakland, from the Mission San Jose to Alviso, and to South San Francisco. The line from Alviso along the west side of the bay to South San Francisco will be exploited by another company, to which the current will be supplied in bulk by the Standard Electric Company. It is expected that this section of the work will be in working order by July. The second installation will be to San Francisco, and will probably be in operation early next year. The main trunk for transmission will be about 150 miles in length, with numerous branches. The Standard Electric Company has up to the present expended, or contracted to expend, nearly £400,000, but its authorised bond issue is sufficient to enable it to place £1,200,000 in this enterprise should such outlay be deemed necessary or advisable.

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SOUTHAMPTON CORPORATION TRAMWAYS.

The Corporation acquired in 1898 the undertaking then belonging to the Southampton Tramways Company, who owned the whole of the tramways in the borough, which were operated by horse traction. As soon as the Corporation obtained possession, the work of reconstruction and conversion to the overhead system of electric traction was taken in hand.

The tramways consist of the following routes: Prospect-place to Shirley, 1¾ miles; Prospect-place to South-Western Hotel, 1¼ miles; Prospect-place to Portswood, 1⅝ miles. The first of the above routes was reconstructed and opened for electrical working at the beginning of this year. The second route, as far as the South-Western Hotel, and the third route, as far as Stag Gates, have lately been completed and opened for traffic, as reported in these columns.

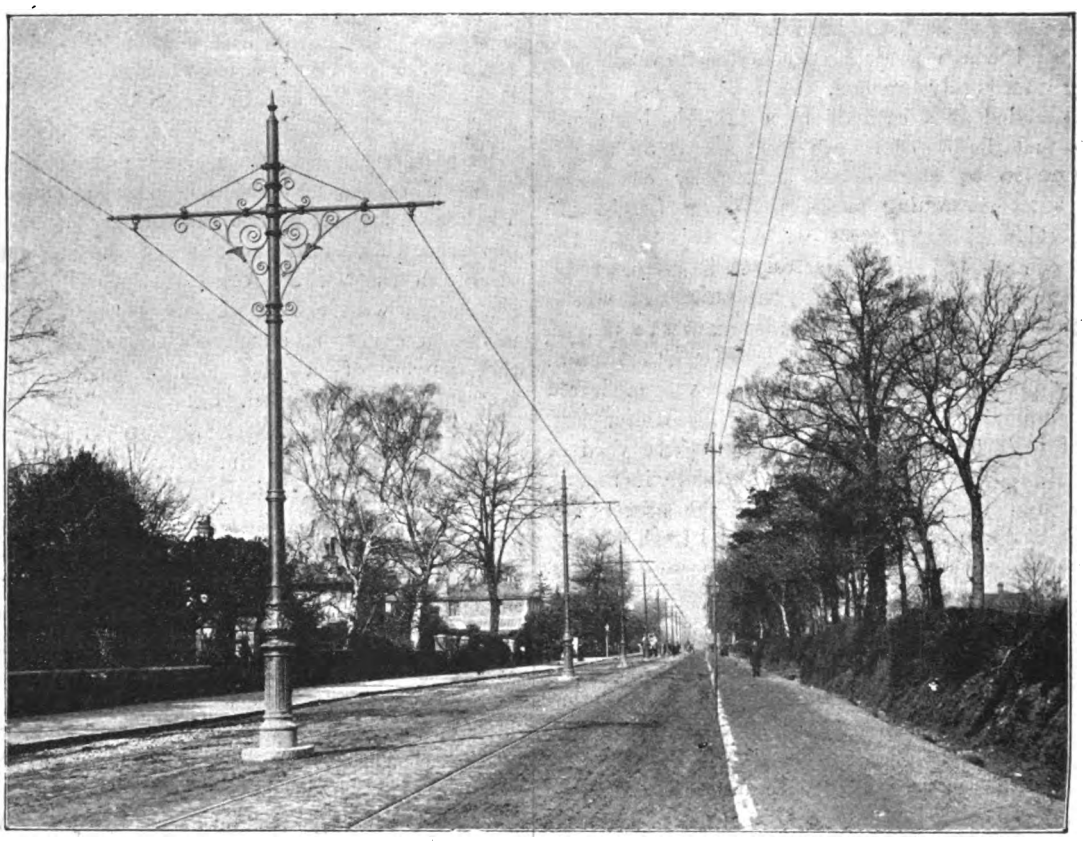

FIG. 1.—View showing Arrangement of Centre Poles, Southampton Tramways.

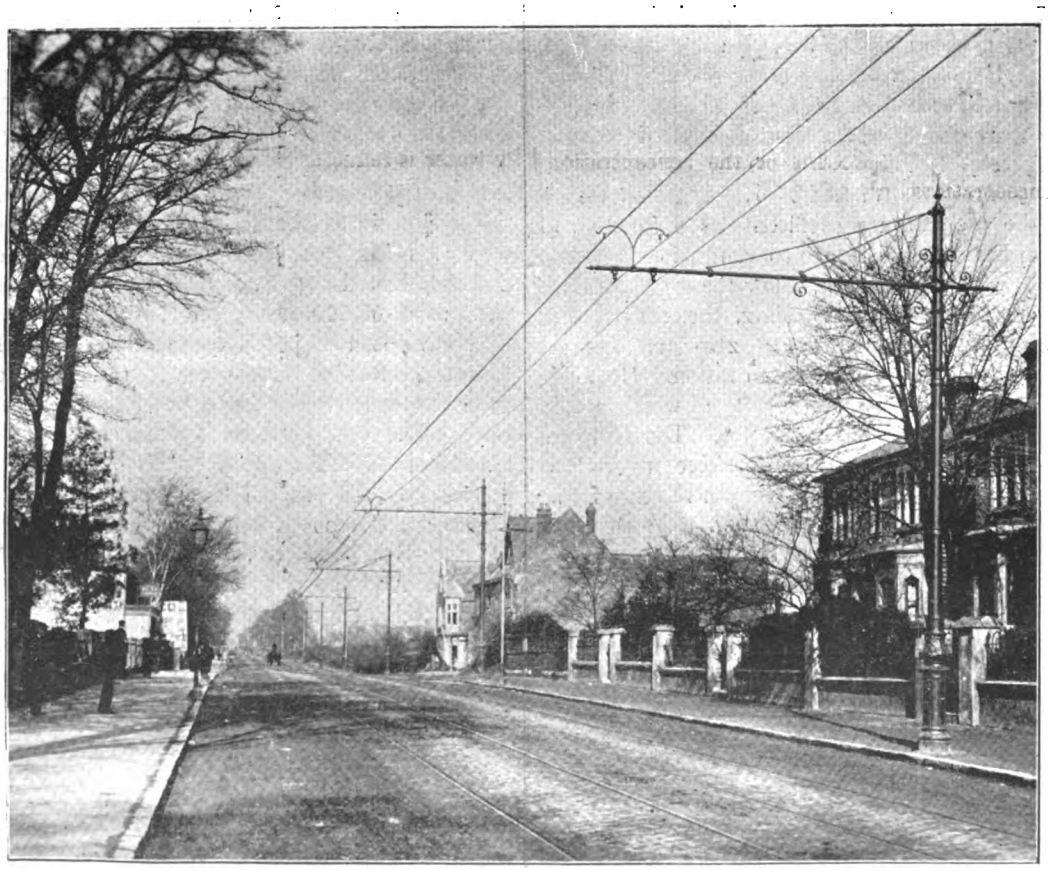

FIG. 2.—View showing Arrangement of Side Poles, Southampton Tramways.

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The remaining portions of these latter routes are now in course of construction.

Permanent Way. — The permanent way throughout consists of new girder rails, laid as double, single, and interlacing lines, to a 4ft. 8½in. gauge, the following being the total length of each form of construction: double line, 3½ miles; single line, 1 mile; and interlacing lines, ¼ mile. The rails are of rolled steel in lengths of 45ft., weighing 86lb. per yard. The fishplates are also of steel, and are bolted together with six 1in. bolts at the joints. The tie-bars are of ⅝in. by 2½in. steel, and average 2½ yards apart. The points, mates, and crossings are steel castings

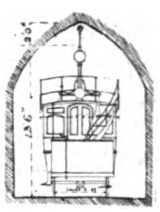


FIG. 4.—End Section of Bar Gate Southampton Tramways.

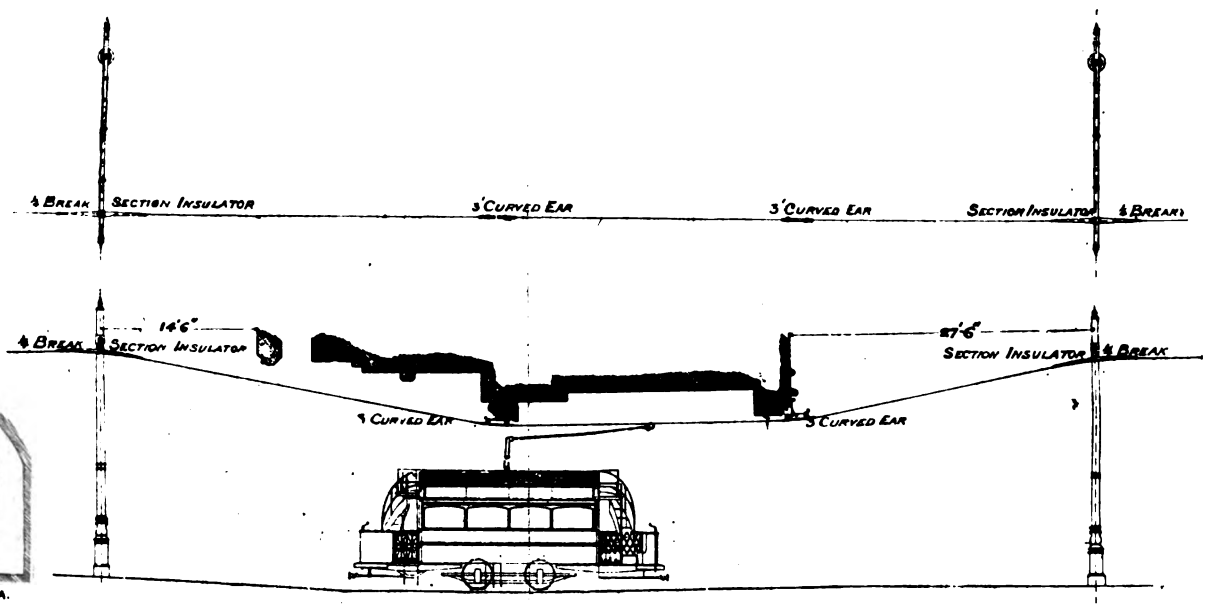
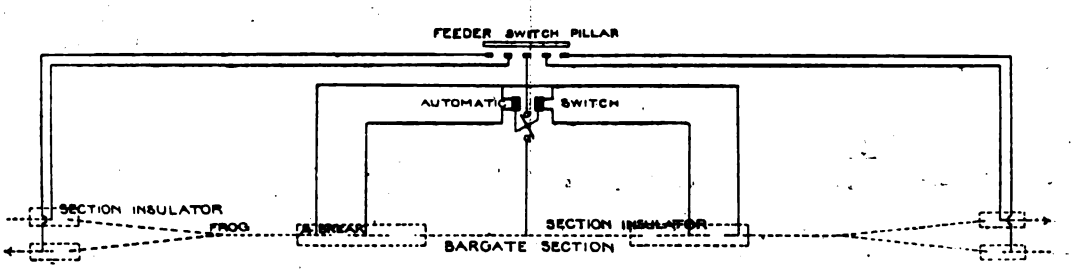
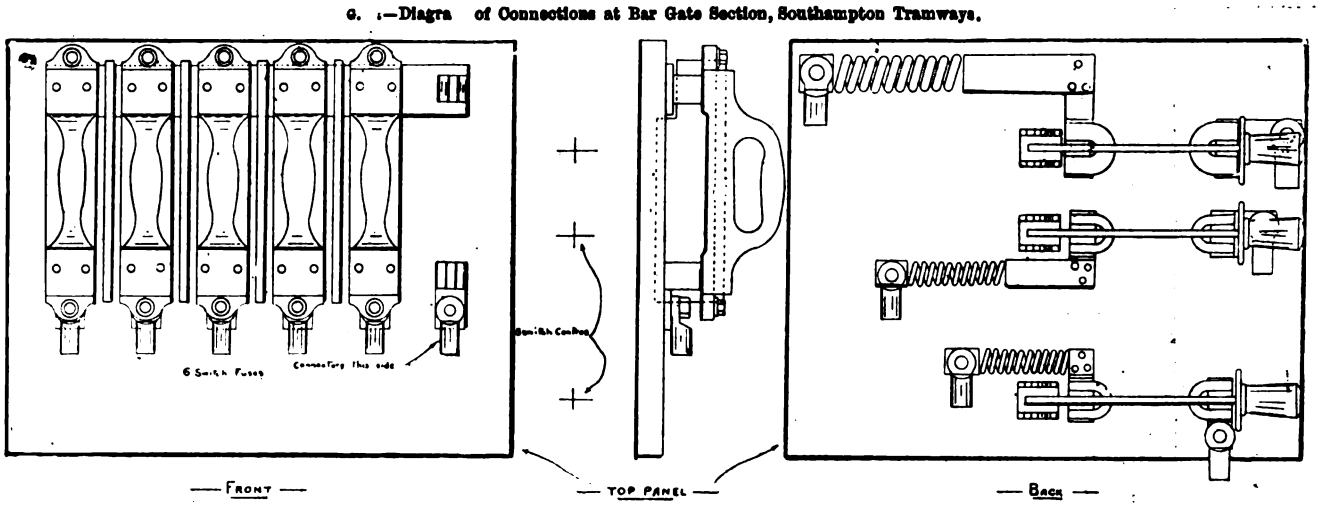


FIG. 3.—Arrangement of Trolley Conductor under Bar Gate, Southampton Tramways.



G. 5.—Diagra of Connections at Bar Gate Section, Southampton Tramways.



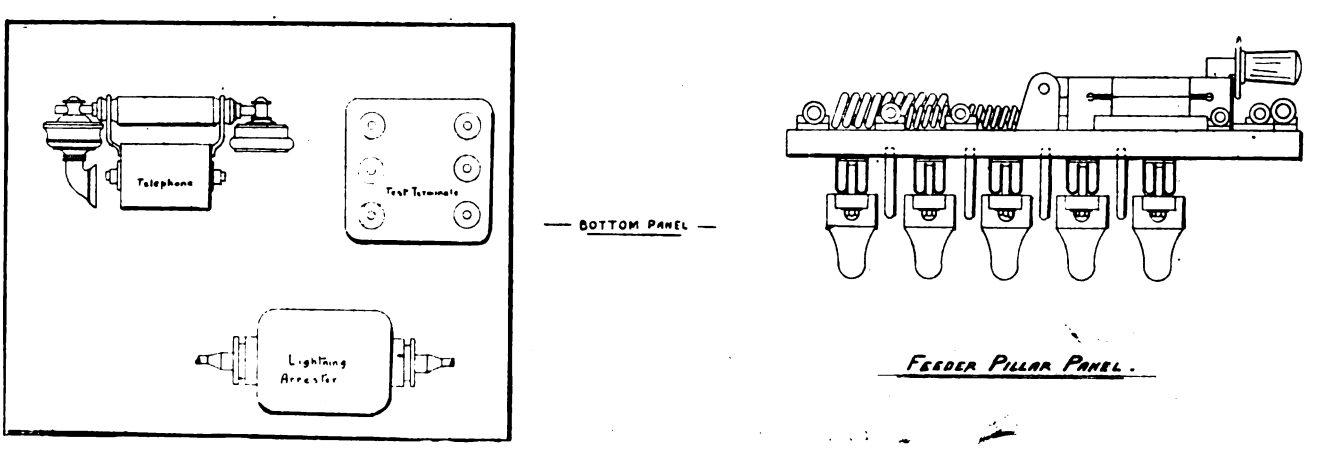


FIG. 6.—Switch Pillar Panels, Southampton Tramways.

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with mild-steel tongues. The rails are laid on a bed of concrete which is 6in. in thickness, and consists of six parts of broken stone to one of cement. The joints

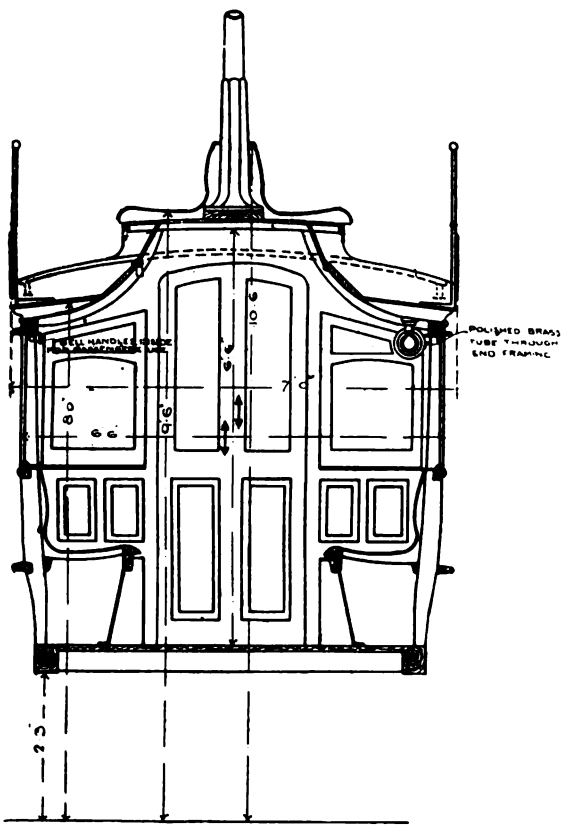

FIG. 7.—Double-Deck Car, showing Longitudinal Arrangement of Top Seats.

between the rail lengths are all double bonded with two No. 4/0 Chicago rail bonds. Cross-bonds are placed at intervals of 120ft., and where double line occurs the lines are bonded together at intervals of 240ft., No. 4/0 Chicago bonds being used in each case.

The contractors for the road construction and laying of track for the first section were Messrs. Krauss and Sons, of Bristol, while the work now in hand is being carried out by Mr. F. Osman, of Southampton. The rails have been supplied by the Leeds Steelworks Company, and the points, etc., by Messrs. Askham Bros. and Wilson.

Overhead Construction. — The overhead construction consists of double trolley wire throughout of $^2/_0$ B. & S. gauge of hard-drawn copper having a conductivity of 98 per cent. of pure copper, carried on steel poles from bracket arms. In places where the roadway is of sufficient width and where double line occurs, the poles are placed in the centre of the road between the two tracks (Fig. 1). Elsewhere they are placed at the edge of the footpaths and side-bracket construction adopted (Fig. 2). The poles are of steel, made in three sections with swaged joints between the sections, and are of two sizes. For ordinary use, poles having the sections 7in., 6in., 5in. diameter respectively are adopted, but where extra strain occurs, as at curves and anchors, poles of 8in., 7in., 6in. sections are used. The bases are of ornamental construction of cast iron. The bracket arms, it will be seen, have ornamental scrollwork of wrought iron, and are suitably stayed from above. Although side swivelling trolleys have been adopted on the cars, the trolley wire has been kept in most places as nearly over the centre of the track as possible in order to ensure easy running.

In the centre of the town the streets are illuminated with arc lamps, incandescent lamps being also placed on the same poles for use after the arc lamps are extinguished at midnight. These lamps, where possible, have been carried on the tramway poles, the arc lamp being supported in an ornamental carrier at the top of the pole, and the two incandescent lamps from wrought-iron brackets about 14ft. from the ground level. The poles carrying arc lamps are provided with larger cast-iron bases of oval section, so as to admit of the automatic switch controlling the arc and incandescent lamps being placed inside the bases.

A special feature in connection with the overhead construction is the method which has been adopted in getting through the Bar Gate, which is a low archway through which the cars have to pass, and is situated on the route from Prospect-place to the South Western Hotel at the lower end of "Above Bar." This archway is of considerable

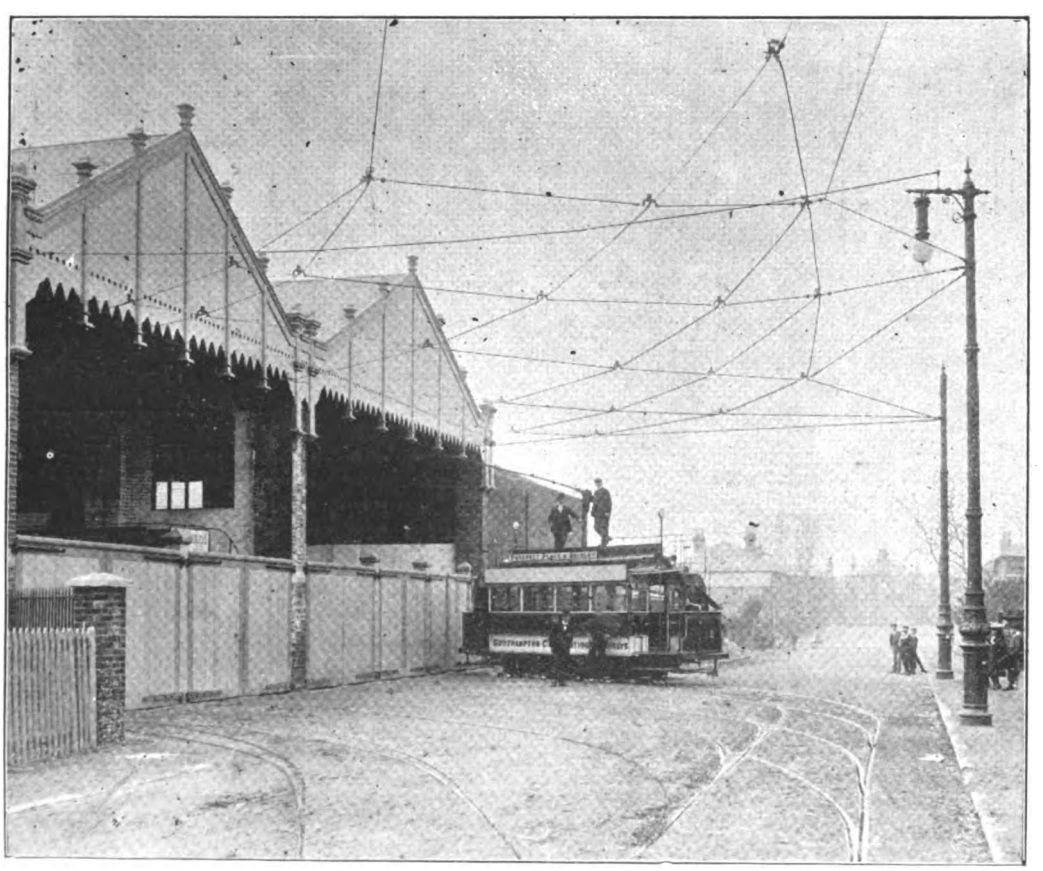

FIG. .—Shirley Car Depot, Southampton Tramways.

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antiquity and of interest from its style of architecture, so that it was decided not to remove it. The headway, however, has been increased by lowering the road at this point from 18in. to 2ft., so that there is now a clearance at the top of the lowest part of the archway of about 15ft. 6in. A single trolley wire has been carried right through the Bar Gate, but in order to prevent any person on the top of high wagons or other vehicles making accidental contact with the wire, the section of trolley wire through this archway is insulated from the remainder of the system, and is only made alive when a car is passing through it. The operation of switching on and off is performed automatically by means of an automatic switch placed in the archway, controlled by an electromagnet, the arrangement being such that on a car entering the section the switch closes, and on leaving opens again. The opening and closing of the switch is so arranged that it takes place at a time when no current is being taken from that section. Figs. 3 and 4 show the arrangement of the trolley wire at this point, while Fig. 5 gives a diagram of the connection.

As is usual, the trolley wires throughout the system are divided up into sections averaging half a mile in length by means of section insulators. The sections are fed from a switch pillar placed at the side of the road at these points. These pillars are all cast iron, with doors back and front for providing access to the switch gear. The switch gear is mounted on a slate panel (Fig. 6), and provides an omnibus bar, to which the feeder is connected through knife switches and the ends of the trolley wire through plug switch fuses. This enables any section of either trolley wire to be disconnected at will, and also permits of the feeders being similarly disconnected. Each of the pillars contains also a lightning arrester, with kicking coils and a telephone instrument of the hand combination type. Terminals are also provided for the test and telephone circuits. The whole of the overhead construction, including the switch pillars, has been carried out by Messrs. Macartney, McElroy, and Co., of Westminster.

Rolling-Stock.—The number of cars in service when the whole of the sections are completed will amount to about 20 in all. The cars are of the double-deck single-truck type, provided with the usual double motor equipment and series-parallel controllers. The cars have a seating capacity for 46 passengers, 22 inside and 24 outside. The length over platforms is 26ft. 6in. and length inside 15ft. 4in. The seats on the upper deck (see Fig. 7) are arranged longitudinally, back to back. This arrangement has been adopted in preference to the more usual garden seats in view of the limited headroom at the Bar Gate. The trucks are of the Brill Company's make, being their 21 E pattern. The wheels are 30in. in diameter, and the wheel base is 6ft. The motor equipment is of the Westinghouse Company's standard type, and the controllers are provided with an emergency rheostatic brake. When braking, the motors act as generators, and the current generated is absorbed in the resistances. This is in addition to the ordinary hand brake. The trolley standards are of somewhat special design, the springs being placed inside the standards so as to be out of the way, and special care has been taken in designing the arrangement of springs so as to ensure as uniform a pressure as possible on the trolley wire when the pole is brought down in view of the lowness of the trolley wire at the Bar Gate. The trolley heads are of the side swivelling pattern. Drawbars are provided for connection to trailer cars if these are afterwards found necessary.

The contractors for the whole of the rolling-stock are the Westinghouse Company, their sub-contractors for the trucks being the Brill Company, and for the car bodies Messrs. Milnes and Co., of Birkenhead.

Car Depôts.—There are two car depôts, the larger one

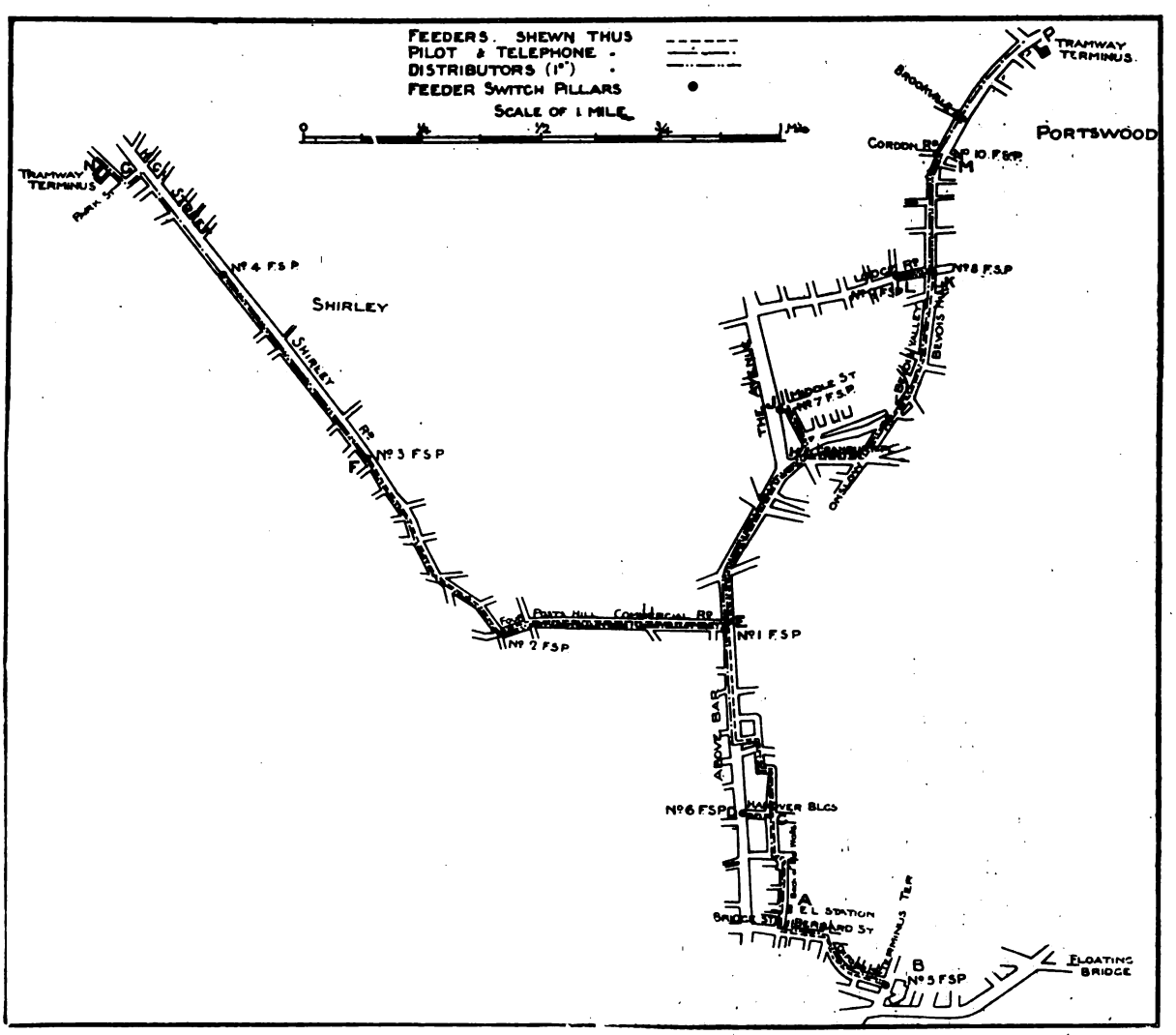

FIG. 9.—Diagram of Feeders, Southampton Tramways. Sections of Feeder Cables—No. 1, A to B, ·100 square inch; No. 2, A to D, ·079 square inch; No. 3, A to E, ·225 square inch; No. 4, A to F, ·300 square inch; No. 5, A to K, ·800 square inch. Pilot and Telephone Cables—Two-core: C to D, H to J, K to L, and G to N; Three Core: A to B, E to G, E to M, and M to P; Four Core: A to E.

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being situated at Portswood and a smaller one at Shirley, each of them being on the site of the old horse-car depôts, which have been reconstructed to suit the electric cars. The Shirley depôt (Fig. 8) has been reconstructed, and in use since the opening of the line at the beginning of this year, but the Portswood depôt is still under reconstruction. The Shirley depôt consists of motorcar shed, providing accommodation for 12 cars, and a trailer-car shed with sufficient room for eight trailers. There is also a small workshop and smithy, with fitter's bench, lathe, etc. The Portswood depôt consists of a car shed with storage for 12 cars. There is also a repairing shed, which will easily hold six cars. A smith and carpenter's shop adjoin the repairing shed. At the end of the repairing shed a full equipment of tools, fitters' benches, etc., is provided for dealing with any repairs which may be necessary. A room for stores and men's room is also provided. Part of the old horse-car depôt at the end of the car shed has been left standing, so that further extensions may be made to the car shed if found necessary.

The contractors for the building work in connection with the Shirley car depôt were Mr. F. Osman, of Southampton, and for the Portswood depôt Messrs. Jenkins and Son, of Southampton.

Feeders.—Power for working the tramways is supplied from the Corporation's electric light station, which is situated in Back-of-the-Walls, in the south end of the town, at 500 to 550 volts. From this point (see Fig. 9) the feeders proceed to the various tramway routes. The feeders consist of insulated lead-covered cables drawn into stoneware ducts by means of drawing-in boxes which are provided at suitable intervals. The feeders are connected up to the switch pillars as previously described. The feeders vary in size from ·30 square inch to ·079 square inch. A three-core pilot and telephone cable is drawn into ducts with the feeders and connected to each of the feeder switch pillars, test wires being continued to the ends of the lines for the purpose of recording the drop in pressure on the rail return on the recording voltmeter at the generating station.

The whole of the cables have been supplied, drawn in, and connected up by Messrs. W. T. Glover and Co., and the conduits and drawing-in boxes put in by Mr. F. Osman, of Southampton.

System of Power Supply.—Power is supplied for working the tramways from the existing plant in the station, which has hitherto been used for supplying the lighting only. Steam is supplied by means of six Babcock and Wilcox water-tube boilers and one Lancashire boiler, which are all fitted with automatic stokers and coal conveyors. The engine-room plant consists of six shunt-wound generators by Messrs. Crompton and Co., five being coupled to Willans and one to a Belliss engine. The generators are of various sizes, the largest sets being about 100 kw. capacity, generating current at 230 volts. When supplying the tramways pairs of these generators will be put in series, and the pressure will then be raised to 500 to 550 volts by means of motor boosters. The boosters are compound wound to give the necessary rise of voltage from 500 at no load to 550 at full load. In order to avoid the necessity of using the generating plant during the hours of the heaviest lighting load, a large battery of accumulators has been installed, of sufficient size to supply power to 20 motorcars for four hours when fully charged. This battery will be charged in the daytime from two of the generators in series, and the pressure will be raised as required by means of boosters. These boosters are each provided with double-wound armatures so as to obtain a wide range of voltage without unduly weakening the fields, and may be used when required to raise the pressure of the current supplied by the battery when discharging.

A 300-kw. combined engine and generator is just now about to be ordered. This generator will also be designed to supply power for the lighting, being provided with a double-wound armature, so that when supplying lighting the two windings on the armature will be in parallel, and when supplying the tramways they will be in series.

The boosters and battery are placed in a building which has recently been erected, the battery-house being in three storeys and the booster-room adjoining. The traction switchboard is also placed in the booster-room and provides the usual feeder panels and panels for the boosters, battery, and for putting any two of the generators in series at will. A Board of Trade test-panel also forms part of this switchboard.

The boosters were supplied by Messrs. Bruce Peebles and Co., of Edirburgh, the battery by the Tudor Accumulator Company, and the traction switchboard by Fowler, Lancaster, and Co., of Birmingham.

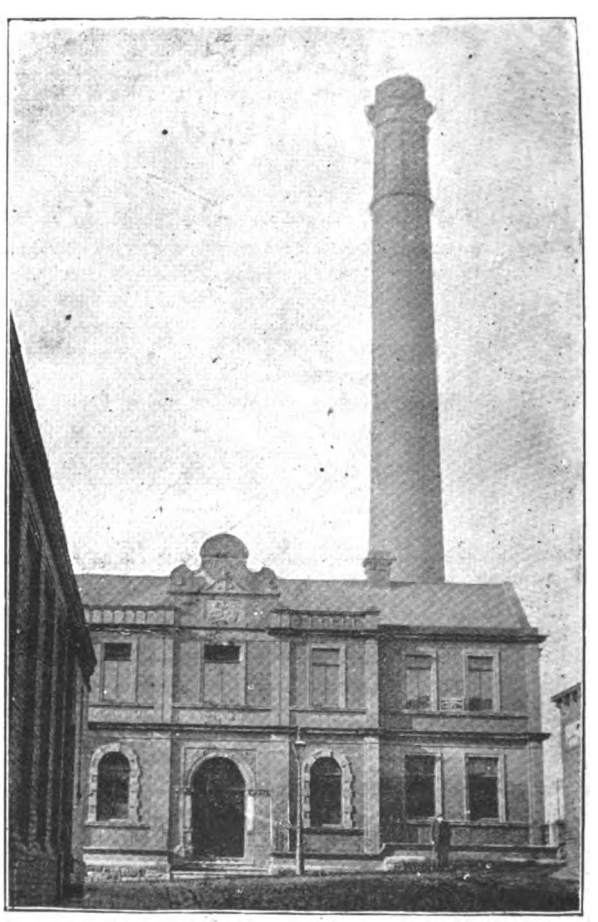
The first section of the tramways opened has been supplied till now, pending completion of the delivery of the plant on order, by a temporary plant furnished by the Westinghouse Company erected in one corner of the engine-room. This plant consists of a vertical Westinghouse engine driving a 100-kw. Westinghouse compound-wound traction generator by means of a belt.

The chairman of the Tramways Committee is Senior Bailiff Dunsford, who has been indefatigable in carrying out the work, the chairman of the Electricity Committee being Alderman Bone, who has also rendered valuable assistance. The engineers for the whole of the scheme have been Messrs. Kincaid, Waller, and Manville, of Westminster, to whom we are indebted for the above particulars.

CARLISLE ELECTRIC LIGHTING.*

BY CHARLES D. BURNET, A.I.E.E., CITY ELECTRICAL ENGINEER.

A provisional order was granted in June, 1895, and in 1897 the Corporation appointed Prof. Alexander B. W. Kennedy, F.R.S., LL.D., M.I.C.E., to be their consulting engineer. A report was submitted by him on March 27, 1897, and being considered satisfactory by the Council, Prof. Kennedy was instructed to prepare the necessary drawings and specifications for the first installation.



Electric Light Station, Carlisle.

Site.—Some little difficulty was experienced in the selection of a suitable site. The present one in James-street was finally decided upon, however, on account of

* Paper read before the district meeting of the Incorporated Association of Municipal and County Engineers at Carlisle on May 26.

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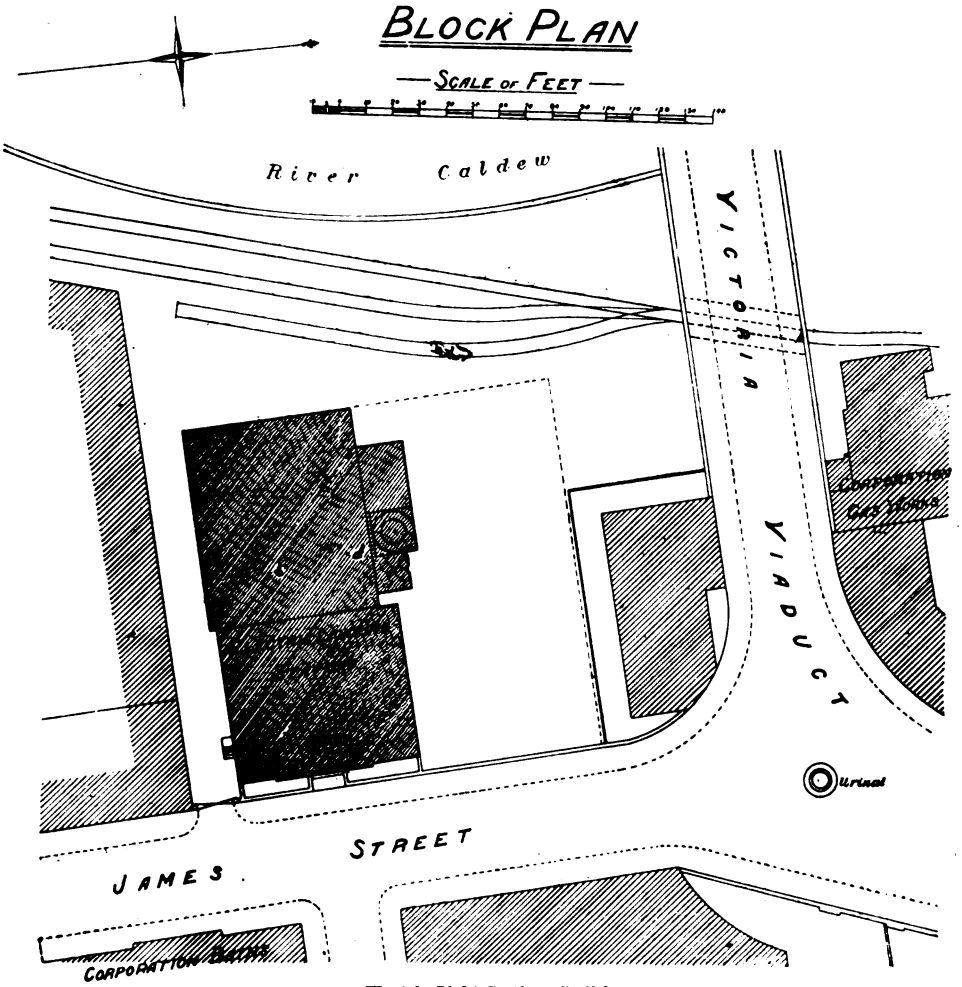
the great facilities for coaling and condensing offered by the proximity of the railway and the river respectively—advantages not possessed by either of the other sites.

System.—Prof. Kennedy recommended a low-tension three-wire direct-current system of supply.

lined for a height of 100ft. with firebrick, an air space having been left between the lining and outer structure.

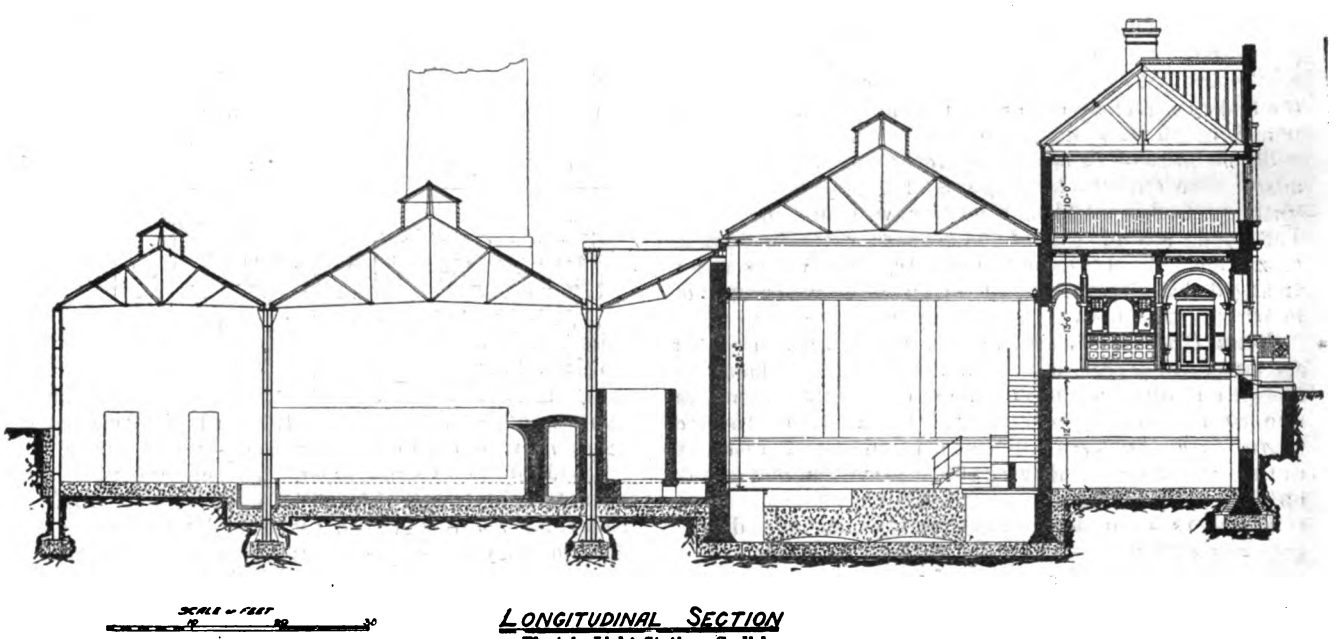
Plant.—The original installation consisted of, in the stokehole, three Lancashire boilers, 28ft. long by 8ft. in diameter, made by the Oldham Boiler Works Company,



Electric Light Station, Carlisle.

Buildings.—The buildings were erected from the designs and under the superintendence of Mr. Henry C. Marks, A.M.I.C.E., the city surveyor. These comprise the offices and storerooms, which are situated over the battery-room

Limited, Oldham, working at 160lb. pressure. Each boiler is capable of evaporating 8,000lb. of water per hour. The boilers are fitted with the patent mechanical "auto-stoker," made by the Union Ironworks Company, Ashton-under-



LONGITUDINAL SECTION

Electric Light Station, Carlisle.

and workshop, facing James-street. Behind this is the engine-room, which is 65ft. 6in. long by 35ft. 6in. wide, lined with white glazed brick. Behind this again is the stokehole, which is 62ft. 3in. by 74ft. 9in. The chimney is 160ft. high, circular, 7ft. in diameter at the top, and is

Lyne. Each boiler is provided with the following fittings: one spring safety valve, one low-water alarm, one lever safety valve, two shut-down feed-check valves, one blow-off cock, one scum cock, one steam-pressure gauge, one fusible plug, two gauge glasses.

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Pump-Room.—The first set of pumps comprised two horizontal, compound, duplex Worthington pumps, each capable of delivering 1,400 gallons of water per hour against 160lb. pressure. The feed water is taken from the town main. The feed tank is situated over the pumps, and is capable of storing 3,300 gallons of water.

Economiser.—The water, after passing through a Kennedy water-meter, is pumped through a Green's economiser of 192 tubes, and from thence through either of the two 'bus pipes which lie in a chase in front of the boilers to the feed-check valves on the boiler fronts. An alternative method is to cut out the economiser altogether, and feed the boilers direct by means of the 'bus pipes before mentioned, which are in duplicate.

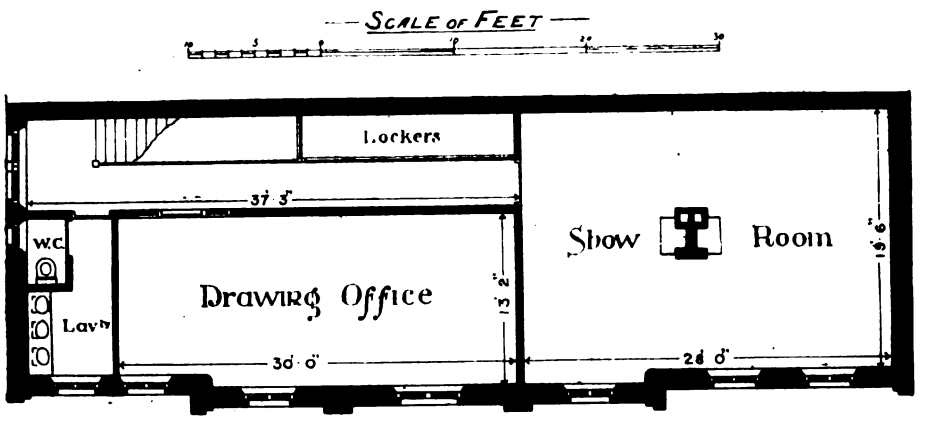
Steam-Main.—The boilers deliver steam into an 8in. ring main. The straight lengths are of lap-welded steel ¼in. thick, with flanges 1⅛in. thick screwed and brazed on. The bends are of solid-drawn copper with steel flanges brazed on. T-pieces are of cast iron. The valves are so arranged that any section of the ring can be cut out without interfering with the running of any of the engines.

Drain Pipes and Separators.—In the boiler-house there are two main separators, which are drained by hand into the pipe leading into the sump or river. Into this pipe are also led other drains from the T-pieces, valves, pumps, etc.

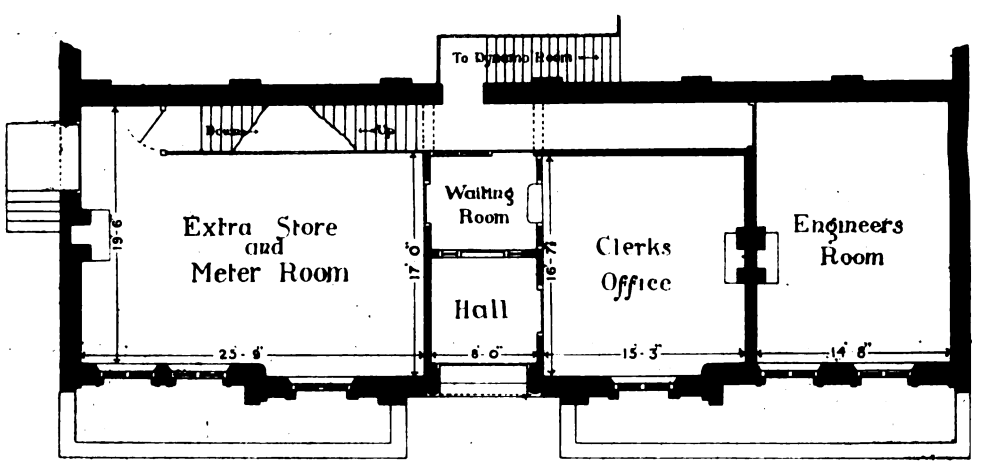
Auxiliary Machinery.—There are two small engines, one in the pump-room for driving the auto-stokers, and another on the economiser for driving the scrapers.

Extensions. — In view of the tramway company's demand for electric energy, and in order to cope with the rapidly-increasing demand for electricity for lighting purposes, extensions had to be considered before the original installation was thoroughly under way. The extensions in the boiler-house consist of two more boilers similar to those already installed, the settings for which are ready to receive the boilers. The economiser has been doubled, and another Worthington pump similar to those already in use has been supplied.

Engine-Room.—The first installation consisted of four Willans engines direct coupled to Siemens dynamos. The two small sets (Nos. 1 and 2) are used as balancers, and run at 460 revolutions per minute. Each engine is 100 i h.p, and drives two 30·2-kw. shunt wound dynamos, one at each end. The E.M.F. of each dynamo can be varied from 230 to 260 volts with a variation of speed not exceeding 5 per cent. from the normal. The two larger sets (Nos. 3 and 4) consist of engines of 200 i.h.p., running at 350 revolutions per minute, coupled to shunt-wound Siemens dynamos having an output of 125 kw. at any E.M.F. from 460 to 520 volts. These machines supply the outers of the three-wire system. Dynamos Nos. 3 and 4 have also a series winding to be used when on a traction load. Herewith will be found a table giving the water consumption and efficiency of these sets on test:



FIRST FLOOR PLAN



GROUND PLAN

Electric Light Station, Carlisle.

Particulars of load.	100-i.h.p. sets. Lbs. of water. I.H.P.	E.H.P.	Effi.	200-i.h.p. sets. Lbs. of water. I.H.P.	E.H.P.	Effi.
Full	17·55	22·46	78·35	16·5	20·32	81·25
Three quarter	18·6	25·23	73·7	17·22	22·27	78·35
Half	18·91	28·68	66·31	18·02	25·16	71·1
Quarter	19·77	38·22	51·73	20·08	34·4	58·37

Each engine is fitted with a Ledward ejector condenser designed to maintain a vacuum equivalent to 26in. of mercury in the exhaust pipes. To supply this, water is taken from a sump in the river a distance of 160ft., by means of a 7in. Bon Accord centrifugal pump driven by a 25-b.h p. shunt-wound Siemens motor running at 750 to 900 revolutions per minute, and is delivered into a large tank situated over the economiser on the boiler-house roof at the rate of 45,000 gallons per hour. The height of the water in this tank is 36ft. above the engine-room floor. The condenser tank is capable of containing 50,000 gallons of water. By means of a system of automatic valves it is not possible for the condensing water to get back into the engines. Should one of the condensers get choked from any cause a valve closes between it and the engine,

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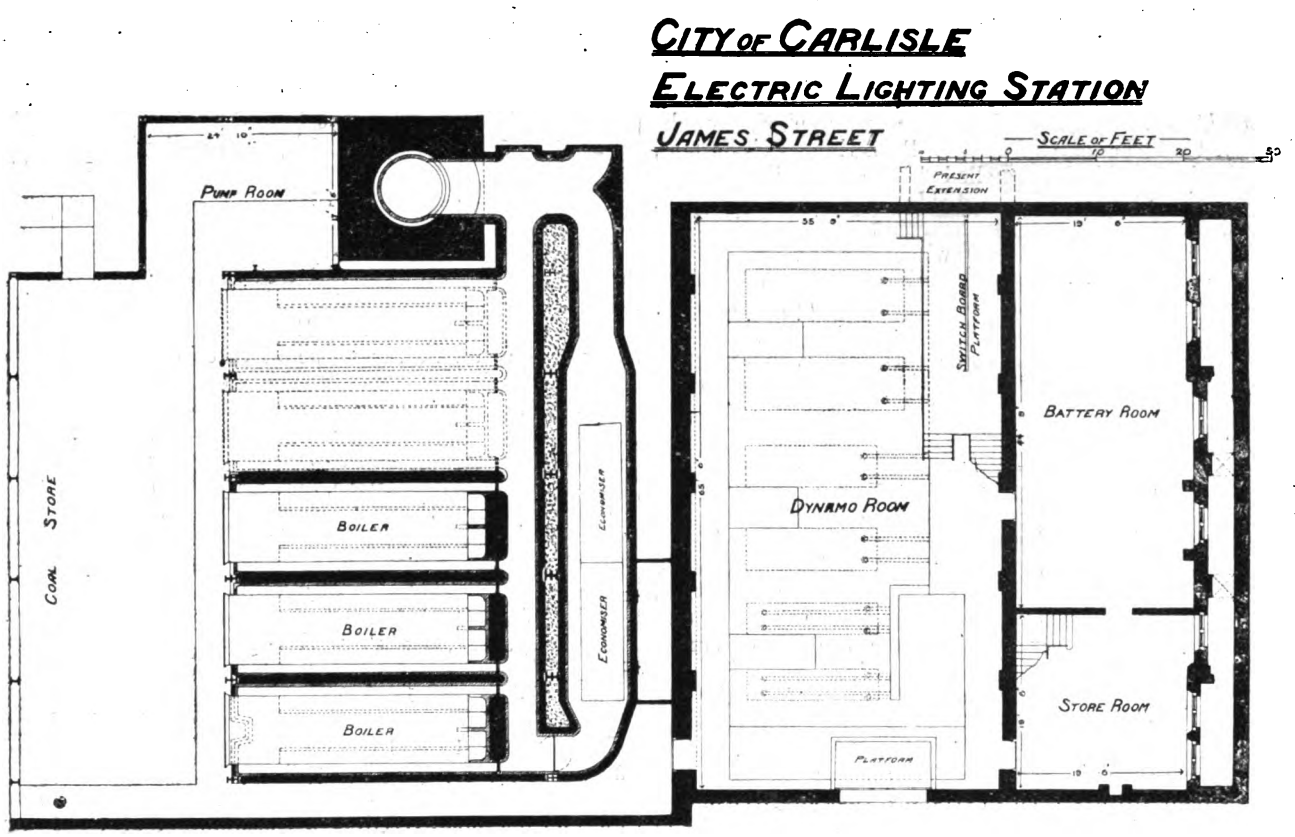
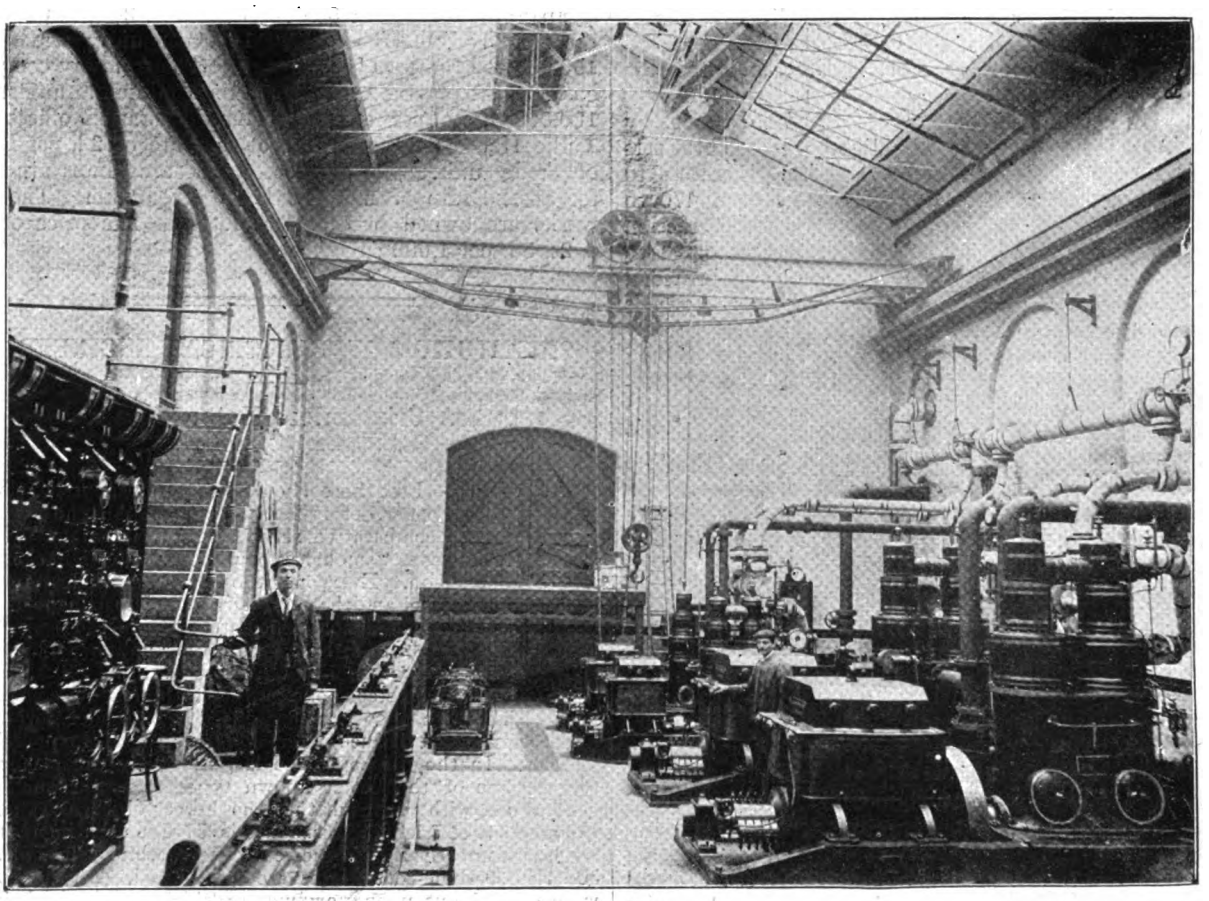
and another opens to the atmospheric exhaust. This pipe lies in a chase by the side of the concrete engine-block,



and terminates in a vertical pipe 12in. in diameter, the top of which is 44ft. above the engine-room floor-level. Overhead there is a 12 ton travelling crane, made by

Construction Company, Limited, Wolverhampton. It consists of two 4·2-kw. generators on either side of a motor mounted on the same base-plate. The motor is shunt wound, and capable of running at any speed from 500 revolutions per minute to 1,050 revolutions per



Interior of Electric Light Station, Carlisle.

Messrs. Carrick and Ritchie, of Edinburgh, spanning the engine-room and manipulated by ropes from the engine-room floor. The booster was supplied by the Electric minute at any voltage from 460 to 520 volts. The normal output of each generator is 0 to 60 amperes at from 10 to 70 volts at whatever voltage or speed (within the

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above limits) the motor may be working. The fields of the generators are separately excited with 230 volts taken from the 'bus bars. The armatures can, without detriment, be doubly loaded for half an hour. The booster is manipulated from the battery panels on the switchboard, and is used for charging and discharging the batteries.

Switchboard.—The switchboard was supplied by the Electric Construction Company to Prof. Kennedy's designs, and consists of black enamelled slates mounted on a metal framework. On the right-hand side are two battery panels, on which the following instruments and switches are mounted: battery emergency switches, battery regulating switches, booster reversing switches, voltmeters and ammeters, booster shunt switches, and motor starting switch. In addition to these, there is a plugging arrangement by which the booster can be connected, so as to (*a*) charge or discharge the batteries, (*b*) link up any particular cells in the batteries, or (*c*) be connected up for meter testing. On the left of these are two panels for the balancing dynamos with ammeters, double-pole automatic switches fitted with carbon sparking contacts, change-over plug bars, and main plugging switches. At the top of each panel are feeder switches and feeder ammeters. In the centre is the lighting voltmeter panel, on which are mounted the feeder, dynamo, and 'bus bar voltmeters and switches, also the middle wire and earth ammeter. At the extreme left on the original switchboard are the main dynamo panels for Nos. 3 and 4 sets, fitted with double-pole automatic switches with carbon sparking contacts of the Electric Construction Company's well-known pattern. The dynamo, ammeter, and main plugging bars are above these, and at the top of the panels are the feeder ammeters and switches. The switchboard has been so arranged that any dynamo or feeder can be plugged direct on to either of the two pairs of 'bus bars. By this means two distinct pressures can be maintained on the network if necessary. On the hand-rail in front of the switchboard the shunt regulating switches for all the dynamos and booster have been placed. The station meters are fixed on the wall in front of the raised platform, and are of the "Aron" type. All the machines are fused on both poles, and the fuses are fixed on the wall at the back of the switchboard.

Extensions.—The extensions for lighting and traction purposes in the engine-room consist of two 400-i.h.p. Willans engines, coupled direct to multipolar dynamos by Messrs. D. Bruce Peebles and Co., Edinburgh. These sets are run at 300 revolutions per minute, the generators to have an output of 250 kw. at any voltage from 470 to 530 volts. They will be run compound on the traction load, and as shunt machines on the lighting load. Two lighting panels for Nos. 5 and 6 sets are being provided by the Electric Construction Company, also traction panels for Nos. 3, 4, 5, and 6 sets. These are placed vertically under their respective lighting panels, and occupy one-half of the total height of the switchboard. A traction voltmeter panel has also been added in the corresponding space left below the lighting voltmeter panel. The balancing dynamo panels have also been altered to enable the two small sets to be used on a traction load, if necessary. The traction feeder-board is being supplied by the Electric Construction Company, and is being placed at right angles to the main switchboard. On the left of this is the Board of Trade testing panel. Beneath are the Corporation and tramway company's meters, to record the total output for traction. To the right provision has been made for three traction feeders, with three automatic switches having a quick and long break, with carbon contacts to take the spark, and corresponding ammeters.

Batteries.—The battery-room adjoins the engine-room, and is 44ft. 6in. long by 19ft. wide. It is situated below the offices. It contains 250 15-plate Chloride cells, in glass boxes arranged in two tiers on four wooden supports running lengthways in the battery-room. The regulating switches are on the battery panels on the switchboard in the engine-room. By means of these the batteries need never be taken off circuit, and the booster can be put in and the batteries charged or discharged without causing any fluctuation in the lights. Interlocked with the regulating switches are the booster reversing switches, by means of which the booster is put in circuit for the purpose, as previously stated, of charging or helping to discharge the batteries. This arrangement was designed by Prof. Kennedy, and works most satisfactorily.

Mains.—The distributors are by Callender's Cable and Construction Company, Limited, Erith, and consist of triple-concentric conductors, ·12, ·06, ·12 square inch jute-insulated, lead-sheathed steel-taped cables. The feeders are ·25, ·25 square inch section, and are similarly insulated and protected. The pilot wires are three-core $^{7}/_{22}$ cables. The arc light cables are ·12 and ·22 square inch section concentric, all insulated and protected as before mentioned. The whole of the above cables are laid direct in the ground, at a distance of 12in. from the surface, except where they cross under the streets. Where this is the case they are laid 2ft. below the surface. Extensions of the network are now being laid in the shape of three single cables, laid on Callender's patent solid system, in cast-iron troughs.

Public Lighting.—Originally 25 10-ampere Crompton arc lamps were erected in the main streets of the city. These are now being increased by the addition of five more lamps of the same pattern, and are run 10 in series across 460 volts. Two Stewart enclosed lamps have been placed outside the town hall, and two Davy enclosed lamps outside the electric lighting station. They take five amperes, and are connected two in series across 230 volts.

General.—The author superintended the erection of the machinery, etc., for Prof. Kennedy, was appointed city electrical engineer by the Council, and commenced his duties in January, 1899. The works were opened by the Mayoress (Mrs. George White) on May 11, 1899. Up to March 25, 1900, 167,032 units were generated; 10,600 8 c.p. lamps, representing 128 consumers, had been connected up. The price charged for electricity is as follows: for lighting, not exceeding a consumption of 1,000 units per annum, 5d. per B.T. unit; 1,000, and not exceeding 3,000, 4½d. per B.T. unit; exceeding 3,000, 4d. per B.T. unit. For motive power not exceeding 50,000 units per annum, 2d. per B.T. unit; exceeding 50,000 units per annum, such terms as may be agreed upon by the Corporation and the consumers. The price charged to the tramway company is as follows: 50,000 B.T. units, 2d. per unit; for the next 100,000 B.T. units, 1¾d. per unit; and above 150,000 B.T. units, 1½d. per unit. The tramway company guarantee to pay the Corporation for a minimum number of 100,000 units per annum. The Corporation offices and Tullie House pay for current at the rate of 2d. per Board of Trade unit. Ten-ampere street arc lamps are paid for at the rate of £23 per lamp per annum. The gas-works are owned by the Corporation. The price of gas is 2s. 3d. per 1,000 cubic feet.

INSTITUTION OF ELECTRICAL ENGINEERS.

A Frictionless Motor Meter.

BY S. EVERSHED, ASSOCIATE-MEMBER.

Preliminary.—Lest there should be any misapprehension of the title of this paper, let it be said at once that the adjective is used in the comparative sense already sanctioned by such analogous phrases as "smokeless powder," "watertight compartment," and so on. Everyone knows that smokeless powder makes some smoke, and that a watertight compartment usually leaks, but the smoke is not sufficient to enable the position of a gun to be seen nor to interfere with other military operations, and the leaks are not sufficient to sink the ship. Similarly, a frictionless motor meter is one in which the friction commonly met with has been so greatly reduced as to render correction unnecessary, and reduce wear and tear to an inappreciable amount. In the course of the last few years the author has tested some of the better known types of motor meter in general use, with the result that the lowest observed value for the moment of frictional resistance is 57 dyne-centimetres and the highest nearly 1,400 dyne-centimetres, while values of from 300 to 500 dyne-centimetres are quite usual. All these tests were carried out upon new meters which had been carefully adjusted by the makers. In the author's meter the friction moments so far observed vary from 1·7 dyne-centimetres in a new meter up to 3·5 dyne-centimetres in one which has run for many million revolutions. These figures will, it is hoped, serve to excuse if not to justify the title "frictionless." Among the many links in the long chain connecting the

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energy locked in the coal store of an electric power station with the work done on the consumer's premises, the supply meter is by no means the least important. Yet it has perhaps received less attention from the Institution of Electrical Engineers than any other essential part of an electric supply. It is difficult to assign any cause for this apparent neglect: electric meters began to be invented in the earliest days of electric lighting, and by the time the industry was on a sound basis there were already a large number, working on a variety of wholly different principles, awaiting the test of practical use. There were motor meters, electrolytic meters, differential clock meters, feeler meters, in addition to a host of nondescript meters. There were many kinds of each of the fundamental types; some of them based on more or less simple laws, others practically lawless, and destined on that account to succumb in the struggle for existence. But the extraordinary activity of the meter inventor and the very wide field he was working in has left scarcely a trace in the *Proceedings* of the Institution. Here are the only papers on meters published from 1885 to 1899: Mr. Hookham, in demonstrating his meter, 1889, vol. xviii., p. 688; Mr. Gibbings, "Registration of Small Currents used for Electric Lighting and other Purposes," 1898, vol. xxvii., p. 547. While we have over and over again discussed every other link—coal, boiler, engines, dynamos, mains, batteries, transformers, lamps, and so on, and devoted a vast amount of learning and experience to efficiencies (reckoned to fractions of 1 per cent.), to load factors, to costs (calculated to minute fractions of a penny)—we have been content to pass the meter over in silence. Is the average meter, then, so good that it needs no attention from us? Far from it; erratic meters are not unknown. One will allow a consumer to run a lamp all day for nothing; another for 30 or 40 per cent. discount. Precious energy after having its cost ascertained to the hundredth of a penny is positively being given away every day by sticky motor meters, unbalanced clock meters, and the like. As a set-off one hears of meters running up a big bill when the consumer is out of town and the main switch off. Bearing all this in mind, the author feels that a paper devoted to the description of an attempt to remove some of the more obvious defects of a particular class of meter—the motor type—together with an exhibition of the outcome of that attempt, will need no apology.

Motor Meters.—The fundamental principle of all motor meters is very simple. The driving moment (torque) of the motor is made proportional to the power (or to the current, in a coulomb or electricity meter) being metered, and the speed of the motor is controlled by a brake whose resisting moment is proportional to the speed. Consequently the speed will be proportional to the power (or to the current), and the number of revolutions made in a given time will be proportional to the energy (or to the electricity) supplied. This was first clearly stated by Profs. Ayrton and Perry in describing their well-known energy meter, the forerunner of nearly all energy meters since invented. Unfortunately, it is easier to lay down the law than it is to make a meter obey it. A motor axle must have bearings; a current has to be led to the rotating armature either by brushes or by means of a mercury bath; and there is a counting train to be driven. All these things involve friction, and a part, often a very considerable fraction, of the available driving torque will be used up to overcome it. There are other minor difficulties, such as the construction of a motor without iron, variations of electrical resistance due to temperature, and so on, but practically friction is the only serious trouble in a motor meter; it limits the accuracy and involves a good deal of wear and tear. If one attempts to design a practicable energy meter of the type described by Ayrton and Perry, one is hampered by certain fairly definite limitations, such as cost of manufacture, drop in the current coils at full load (or power wasted in them if that is the more important item), and, above all, waste of power in pressure circuit. If the full-load drop is fixed at one volt, and the wasted power in the pressure circuit is limited to three or four watts, it will be found that the maximum driving torque obtainable (on the assumption that the meter is to be saleable at present average prices) is something like 20,000 dyne-centimetres, and the friction may be from 300 to 500 dyne-centimetres. A greater driving moment is easily obtained by enlarging the armature, but only at the expense of increased weight of moving parts and a consequent increase in friction. We shall be fairly stating the result of careful designing if we put the driving torque at 15,000 and the moment of frictional resistance at 300 dyne-centimetres—in other words, driving torque at full load amounts to about 50 times the frictional resistance. It will be convenient to reduce these figures to percentages by calling the full load 100, maximum driving moment 100, and the friction moment two arbitrary units. We may also reckon full speed of the meter as 100 revolutions per minute. Our hypothetical meter will obviously not start until the load exceeds 2. Also, it will make 98 revolutions per minute at full load, since of the total driving torque of 100, two units are used up for friction, leaving 98 to work on the brake. Hence a table of corrections can be written down at once, on the assumption, of course, that friction is constant throughout the range of speeds contemplated. If there is no fluid friction, this assumption is correct. The errors of the meter are given in Table I. It will be observed that with such a meter the consumer gets a discount of 16 per cent. when he is taking one-tenth of full load. Through the kindness of Prof. Ayrton, the author has been able to test an actual meter made in the manner described. Its maximum driving torque was 19,000 dyne-centimetres, and its friction 350 dyne-centimetres, the accuracy being therefore rather better than that shown in Table I. But this was dearly purchased at the expenditure of no less than 10 watts in the pressure circuit. The range of a meter within specified limits of error forms the best criterion of comparison as regards accuracy, and the author proposes to call that part of the total range of a meter in which its error is within the limits imposed by the Board of Trade "the standard range." Hence the standard range of the hypothetical meter is 1 to 3·3, when the meter is adjusted to register correctly at full load.

TABLE I.—Errors of Uncorrected Motor Meter. Maximum Driving Torque = 100, Friction = 2. Full speed = 100; Arbitrary Units.

Driving moment, M.	Friction, *f*.	Speed, numerically equal to M − *f*.	Percentage error.
2	2	0	Inf.
4	,,	2	−50
10	,,	8	,, 20
20	,,	18	,, 10
40	,,	38	,, 5
60	,,	58	,, 3·3
80	,,	78	,, 2·5
100	,,	98	,, 2·0

Standard range = 1 to 3·3.

Correction for Friction.—Clearly the simple uncorrected motor meter requires some modifications before it can be considered as a practical instrument. It is well known that friction can be partially corrected by means of a starting coil in the pressure circuit. At first sight this seems a simple and sufficient solution of the problem. If to the hypothetical meter we add a starting coil whose driving moment on the armature equals 2, the errors in Table I. disappear. A new error will, however, have crept in; the meter will almost invariably run when the load is zero, lessen the strength of the starting coil, and the meter, although not quite so immoral, will still occasionally go on running when the load is off. The author was for a long time completely baffled in his efforts to find an explanation of this effect, but a very simple cause was at last discovered, and as others may have been puzzled besides himself he ventures to give the explanation here. Everyone knows how enormously the friction of light mechanism may be reduced by vibration. The reduction is far too large to be accounted for by the vibration causing cohesion to vanish. Now, when a meter is fixed in a town house it is never entirely free from vibration, and the light axle, such as is commonly employed in meters, is alternating between a position in which it is wholly or partially out of contact with its bearings, and one in which it presses on them with more than normal force. In one sense, of course, the average value of friction remains the same as it would be with no vibration, and, in fact, the constant of a meter is hardly altered appreciably by it; but the fact that friction is higher during one half period of the shaking, and the meter therefore at rest (the starting coil is supposed just to balance the average friction—it is obviously insufficient to move the armature while the friction is above the average), does not prevent the starting coil from moving the armature during the half periods when friction is less than the average. The author has found that a meter fixed to the brick wall of the office building at Woodfield Works would go on running all night when the driving moment was reduced to a very small fraction of that required to balance the normal average friction, and this can only be accounted for on the assumption that during what may be called the positive half periods of vibration the meter axle and commutator were to all intents and purposes frictionless. If this is the true explanation of a well-known trouble, then it is obvious that there will always be a difficulty with such meters when they are fixed in buildings subject to vibration.

Elimination of Friction.—Instead of regarding friction as unavoidable and attempting to correct for it, the author has approached the problem from another side and endeavoured to remove the causes of friction and so avoid the necessity for correction. These causes are, as has already been stated (1) friction of axle bearings, (2) friction of brushes on commutator, and (3) friction of counting train and gear connecting it with the motor axle. With an ordinary vertical axle the first is nearly all due to the bottom or step bearing, which is usually a rounded steel point resting in a jewel-cup. In the author's meter the pressure of the axle on the bottom bearing is reduced to a few grammes by magnetically suspending the axle, armature, and brake. A top bearing is entirely dispensed with, the axle being held in position magnetically—"magnetically

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pivoted." The brush friction is enormously reduced by the use of a novel form of commutator having elastic segments, against which the edges of two light and freely pivoted wheels roll to act as brushes. The friction of the train is entirely removed as a source of error. The train is driven by a simple electromagnetic device whose speed of working is controlled by the speed of the motor, although there is absolutely no mechanical connection between them. These means have already sufficed to reduce the friction from a value between 300 and 400 dyne-centimetres to less than 3 dyne-centimetres,

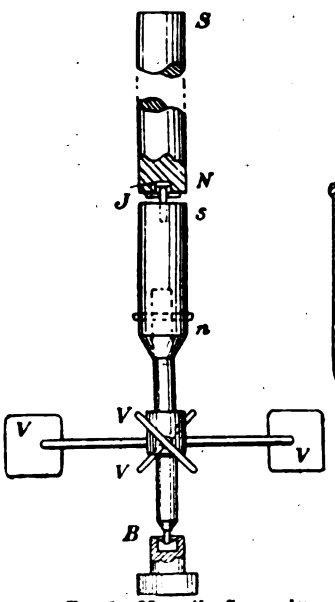

FIG. 1.—Magnetic Suspension applied to Prof. Forbes's Windmill Meter.

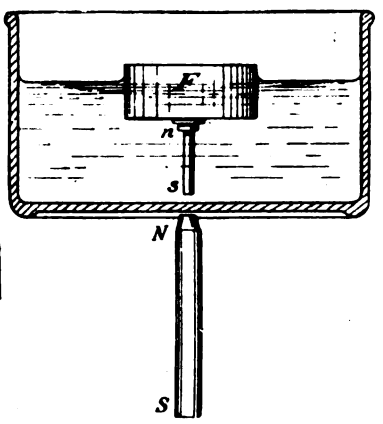

FIG. 2.—Magnetic Pivot applied to the Floating Armature of a Motor Meter.

and there is reason for believing that the limit has not yet been reached.

Early Attempts at Magnetic Suspension.—The possibility of using magnetic force to take the weight of the rotary parts of a motor meter off its bearings has no doubt presented itself to many minds, and probably a good many inventors have made experiments with that object in view. In 1887 Mr. Hookham refers to the subject in one of his meter patents, but he confines himself to the statement that "the magnets may be so disposed as to counteract or partially counteract gravity and thereby lessen friction." A

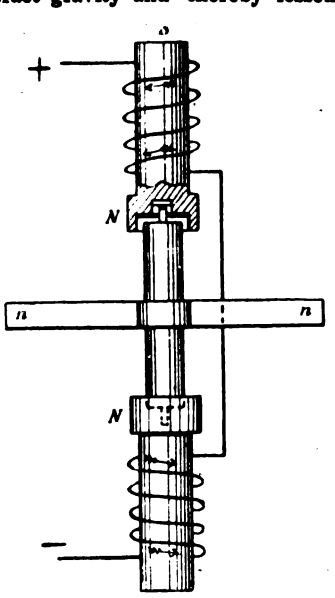

FIG. 3.—Magnetic Suspension applied to the Needle Axle of a Ship's Telegraph.

little later Mr. Ferranti turned his attention to magnetic suspension in connection with alternate-current meters, while quite recently in America Mr. Stanley has brought out a motor meter in which the vertical axle is entirely suspended by means of the attraction of iron discs fixed on the axle and ring poles surrounding them. Pivots at the top and at the bottom of the axle are required to keep it and the discs exactly concentric with the ring poles, the relative position of the discs and ring poles being one of unstable equilibrium laterally, although perfectly stable axially. The author began experimenting with magnetic suspensions a few weeks after the publication of Prof. George Forbes's paper on his "windmill" meter. It occurred to him that the Forbes meter might be made less wasteful of power if it were compounded much in the same way as a steam-turbine, and he proposed to make the compound windmill as nearly frictionless as possible by magnetically suspending the axle and its series of rings and vanes. A meter was made on this plan with a bar magnet placed in line with and immediately above the end of the axle, which was pivoted top and bottom (see Fig. 1); the arrangement proved quite unworkable, and was abandoned. In 1891 the author, in connection with Mr. Vignoles, was working at a motor meter of the Ayrton-Perry type, in which friction was eliminated by floating the armature in water or oil. The armature was held in the centre of the vessel containing the liquid by means of a little iron rod projecting axially below the armature, with its end close to the bottom of the vessel (Fig. 2). A bar magnet was fixed underneath the vessel in line with the iron rod, and with its upper pole as close as possible to the bottom of the vessel. The iron rod was consequently held in the magnetic axis of the bar magnet, and the axis of rotation of the rotary system coincided with the magnetic axis. This "magnetic pivot," as it was called, worked admirably, but the meter itself was a failure. It is worth mentioning that the train of this meter was to be driven by a coil with a vertical axis fixed on top of the armature and alternately attracting and repelling a magnet—an idea which has, after the lapse of nearly 10 years, been tested and proved to be entirely practicable. Another application of magnetic suspension was attempted in 1891-2 in connection with an early form of the Richards-Eversbed ships telegraph. In this apparatus a very powerful magnet is required to be freely pivoted and to have as little inertia as

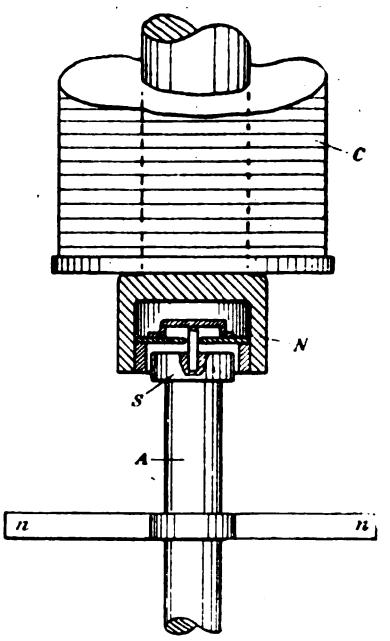

FIG. 4.—Modified Form of Magnetic Suspension for a Ship's Telegraph.

possible. An induced magnet was tried, magnetised by induction from an electromagnet. The induction was led from the fixed to the movable magnet through the ends of the axle, as shown in Fig. 3. The arrangement gave much trouble owing to the magnetic attraction forcing one or other of the pivots against the end of its bearing. In a modified form (see Fig. 4) the induction was led into the axle radially, and at the same time a little axial displacement was given to the enlarged part of the axle with respect to the fixed ring pole in order to relieve the bottom bearing of the weight of the magnet, N N, and its heavy axle. This was accomplished to some extent, but two new difficulties arose: if the axle was not absolutely concentric with the hollow poles of the fixed magnet there was a lateral magnetic pull upon it, causing the pivots to bear with corresponding pressure on their bearings, so that the elimination of one friction had only served to introduce another; the other difficulty arose from want of perfect mechanical truth in either the axle or the ring poles or both. This led to the ring poles having a directing moment on the axle, and gave rise to errors in the indications of the telegraph. In a sense these troubles were due to imperfect workmanship, and were consequently avoidable. But anything requiring great nicety of adjustment was quite out of place in the particular apparatus of which the movable magnet formed a part, and after much fruitless work all idea of magnetic suspension was given up, and the whole magnetic circuit was made to move as one piece. In a renewed attempt to make a frictionless meter of the Ayrton-Perry type, the weight of the rotary part was suspended by the attraction of a fixed solenoid surrounding the upper end of the iron axle (Fig. 5). The magnetic circuit was made as perfect as possible by fixing an iron

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disc on the axle just below the coil, and carrying an iron tube up from the disc so as to partially enclose the coil. It was, however, not found practicable to reduce the waste of power in the solenoid below about five watts, and this was quite sufficient to put this form of suspension out of court so far as motor meters are concerned.

Present Form of Magnetic Suspension.—Finally, the author returned to the first idea (Fig. 1) of a simple magnetic pole fixed above an iron axle. Experience had proved that one of the worst troubles with all forms of suspension was caused by the magnetic axis not being absolutely coincident with the rotational axis, the latter being determined by the pivots. If the top pivot is removed, the axle is free to centre itself in a magnetically symmetrical fashion, and it will then rotate about the magnetic axis (Fig. 6). Any directional moment due to the axle and suspending pole not being perfect figures of revolution will be enormously reduced by diminishing the diameters of axle and pole, and with diameters not much exceeding 5mm., the supporting pole has no measurable directing influence upon the axle. Thus the combination of the suspension shown in Fig. 1 (minus its top pivot) with the magnetic pivot of Fig. 2, has resulted in a perfectly practicable and very simple arrangement for relieving a step bearing of the greater part of the weight of the rotating system. To prevent the axle from accidentally coming into contact with the supporting pole, a thin plate of non-magnetic metal (seen at *e* in Fig. 6) is interposed between

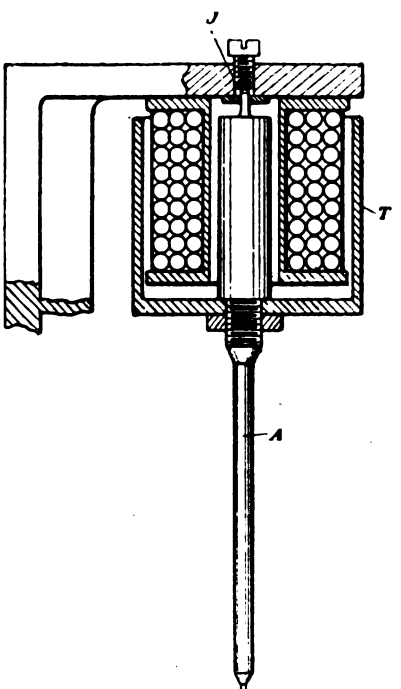

FIG. 5.—Electro-magnetic Suspension applied to a Motor Meter.

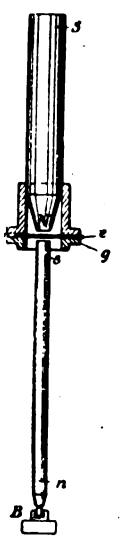

FIG. 6.—Present Form of Magnetic Suspension applied to a Motor Meter.

them. It is fixed immediately above the end of the axle, leaving a very small clearance. The supporting pole is adjusted until nearly the whole of the pressure on the step bearing is relieved. If the pressure is reduced to zero, a slight shake will jerk the axle up until it rests against the plate, where it will remain, since the upward attracting force increases as the space between axle and supporting pole diminishes. It is, therefore, necessary to leave a few grammes weight unbalanced so that there is sufficient gravitational force downwards to pull the axle off the end plate, should it happen to rise into contact with it.

(To be continued.)

LIGHT RAILWAYS.

On the 1st inst. the Earl of Jersey, G.C.B., Colonel Boughey, and the Hon. G. Gathorne Hardy (secretary), Light Railway Commissioners, held an enquiry at the Guildhall, Doncaster, into the scheme for the construction of a light railway to Tickhill and other parts of the districts. Mr. Banks, in explaining the scheme on behalf of the promoters, said the proposed railway would start from the Dearne Valley Railway, which had been authorised by Parliament, and pass near to the village of Wadworth to Tickhill. That was Railway No. 1, and Railway No. 2 would pass from Tickhill eastward to Bawtry. Railway No. 3 would cross over the Great Northern Railway at Bawtry, and go by Misson to Haxey. The whole system of railway was well described in the notice of opposition from the Great Northern and Great Eastern Joint Committee, which says that the proposed light railway would form a continuous line of railway from the South Yorkshire coalfields to the River Trent. It was not merely for that object that the line was promoted. It was promoted by promoters identical with the Isle of Axholme Light Railway, previously sanctioned and promoted by them in consort with the local people. Mr. J. D. Addy, chairman of the Dearne Valley Railway Company, and managing director of the Grimesthorpe and Carlton Collieries, said the Dearne Valley Company were in favour of the proposed system, and attached considerable importance to Railway No. 1. Mr. Banks said the promoters were willing to withdraw the application for that line, and leave themselves open to submit a further scheme to try to meet the wishes of Mr. Foljambe. The No. 1 scheme was then withdrawn. Lord Jersey, in concluding the enquiry, said the Commissioners thought the amount of competition which had been urged on behalf of the Great Northern and Great Eastern Joint Committee was not sufficient to justify them at that stage in stopping the progress of the line. The Railway No. 1 having been struck out there was no question of a through competition. The engineers need not be surprised if some alterations were made. With regard to the objection of the Notts County Council, they would endeavour to arrive at some arrangement by which the width of the road would be kept, and signals provided for warning people on the main roads.

The Westmoreland County Council have evidently not been able to agree with the British Electric Traction Company with reference to the clauses which they required to be inserted in the Windermere light railway order for the protection of the Council.

The Willenhall District Council have forwarded the following memorial to the Board of Trade: "The Willenhall Urban District Council desire to point out that it will be a very great convenience to the inhabitants of this locality if the British Electric Traction Company, who are proposing to make a light railway in their district, can proceed with their work without delay; and they desire respectfully to ask if your department will take such steps as may be necessary to expedite the passing of the Traction Company's Bill." The chairman and clerk were authorised to sign and send same to the secretary, Light Railway Department, Board of Trade.

Notice has been given that application is intended to be made to the Light Railway Commissioners to authorise the following additional loop line, wholly in the parish and urban district of Aldershot, in the county of Southampton, of the Aldershot and Farnborough Light Railway (Extension) sanctioned by the Light Railway Commissioners. Railway No. 1B 1 furlong 0·5 chain in length, wholly situate in the urban district of Aldershot, in the county of Southampton, commencing in Victoria-road at its junction with Station-road by a junction with Railway No. 1 (sanctioned by the Aldershot and Farnborough Light Railway Extension Order, 1899), proceeding along Victoria-road in an easterly direction, thence in a southerly direction into and along Arthur-street, terminating by a junction with a termination of Railway No. 1, sanctioned by the said Aldershot and Farnborough Light Railway Order, 1899.

At the last meeting of the Dartmouth Harbour Commission a letter was read from the solicitor to the promoters of the Devon South Hams Light Railways asking the Commissioners to alter their decision regarding the height of the bridge over the Dart. They had passed a resolution that it should not be less than 100ft., after expressing approval of 80ft. He would be glad to know what reasons there were for such a change of opinion on their part, for the promoters would be able to satisfy them that there was no necessity whatever for a height of 100ft. The Chairman said it was not in order to discuss this matter unless notice was given to rescind the previous resolution.

The Bourne Valley Light Railway Order which the Light Railway Commissioners have submitted to the Board of Trade for confirmation came before Sir Courtenay Boyle at the offices of the Board of Trade on Thursday last week. The Earl of Portsmouth opposed, and was represented by Lord Robert Cecil, Q.C., and Mr. Earle, instructed by Messrs. Nicholson, Paterson, and Freeland, his lordship's solicitors. Sir Douglas Fox was also present to advise as engineer. The proceedings quickly terminated, an agreement being arrived at to the effect that the junction at Hurstbourne Station was not to be taken outside his lordship's land as occupied by the London and South-Western Railway Company. Subject to a clause to this effect being introduced into the order, the same was confirmed by the Board of Trade, and it is expected that before long steps will be taken to at once commence the construction, etc., of the line.

Mr. Charles Chadwell, C.E., of Blackburn, has submitted to the Great Harwood Urban District Council an amended plan showing the proposed light railways from Blackburn, Whalley, and Burnley. There are no less than three firms in the field for the contract, hailing from Blackburn, Accrington, and London respectively, and the Council have resolved to leave the matter in the hands of the Highways Committee, who will watch the progress of the three schemes.

Wireless Telegraphy.—The French Government has, we learn, decided to equip the ships of the Mediterranean Squadron with installations of wireless telegraphy. This decision is the result of a series of experiments lately carried out between the shore forts and a vessel at a distance of 60 miles. The success of these experiments has furnished a further argument for the re-establishment of wireless telegraphy between the Goodwin lightships and the shore.

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WHO IS AT FAULT?

For twenty years, more or less, the papers which deal with sensationalism, sentimentalism, and all other 'isms except right-ism and just-ism, have taken every opportunity to brand electrical work as dangerous. If an accident occurs in any position where electricity is used, the accounts given tend to indicate that the accident was due to the use of electricity. They do not always deliberately say so, but leave the matter in such a way that no other inference is possible. In 50 per cent. of cases the inference is wrong, and the method of stating the accident an euphemistic manner of deliberately uttering a lie. There is no other hypothesis conceivable. The uninitiated pressman takes the information given him and only hopes to make a sensational paragraph. The latest sample of this kind of work is headed, "Electric Train Smash," and then follows another heading about the killed and wounded. In these days when people are satisfied with news in homœopathic doses and in headlines, that is about as far as the majority will read, and they will go away with the impression that that cursed thing, electricity, is once more in fault. But a careful instead of a cursory examination of the paragraph will show that electricity had about as much to do with the accident as steam has to do with the failure of a brake. Here is a car, in holiday time, standing at the top of an exceedingly steep gradient, requiring, therefore, no power except gravity to set it going, and kept from going too fast only by the use of powerful brakes. It happens to be an electrical car—only current is not used on this down grade. Some fool of an excursionist among the crowd is supposed to have interfered with the brakes, the car jumps the rails, and thus damage to life and limb arises. The fault is not in the electricity, yet it bears the blame; the fault is not in the brakes, nor in gravity. The fault is just as it is in the so many instances of the after-the-event, I-didn't-think, or I-didn't-know person; in the idiocy of the human, the frailty, if you like that term better, of the untrained, who will always touch and dabble with what does not concern them, and whose acts so often lead to loss of life or limb. The gun or pistol is not at fault when the playful fool points it at his fellow-man and pulls the trigger. If you wish for a day of nervous tension, go shooting with a party of men some of whom know not how to shoot or how to carry a gun. Our words have a far wider application than merely to electrical matters. In many of these so-called accidents laid to the door of gas, electricity, steam, etc., these things are free from fault, and the blame should be placed upon other shoulders. As regards electrical work, every effort has been made to give it a bad name, and in many quarters nothing that is good is ever said of it. Such a fate is undeserved. Not quite on all-fours with the mawkish reports above referred to, but still reports of a character we have often condemned, yet they recrudesce again and again, are the "Arabian Nights" tales headed "Tesla goes one better than Marconi" or "Wonderful Developments of Telegraphy from Poland," etc. Someone long since

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correctly said, "Give a lie twenty-four hours' start and you will never overtake it." The information given in these paragraphs is read by the man in the street, and he, having thus obtained a wholly erroneous idea of what is possible and what is not, fails altogether to give credit to those honest, hard workers who are continually introducing small but not sensational improvements in all directions. The progress of any industry is largely due to these small constant improvements, and it is only after many decades that these schemes, evolved more or less crudely and put forward sensationally, become at all—if ever they do—practical. There is a moral to all this sermonising. Men who are workers need money. If the public is misled as to what is dangerous and what is practicable, it is more difficult to touch the pockets of the moneyed class than if the real truth was known. To harp upon these things to our technical readers is perhaps useless; but what of the many who seek our guidance? The latter look to the technical Press to guide them aright, hence it is a duty of those who know to do what they can to counteract the absurd stories and misleading reports so prevalent.

ON THE INTRINSIC BRILLIANCY OF THE CRATER OF THE ARC.*

BY J. E PATEVAL.

The following is a portion of a paper on "An Experimental Research on Some Standards of Light." In discussing the arc lamp the author says that for many years it had been noticed that the area of the crater of an electric arc when burning between carbon poles increased about in proportion to the current; also that the light emitted increased in the same ratio as the area of the crater. These and other facts led to the conclusion that the temperature of the crater remained constant. The hypothesis was put forward that this temperature was the boiling point of carbon, this theory being supported by the experiments made in 1892 by J. Violle. In the same year it was proposed simultaneously by Swinburne, S. P. Thompson, and Blondel that the crater of the arc should be used as a standard of light, Blondel publishing a series of experiments illustrating the way in which the new standard might be used.

In 1894 A. Trotter proved that when the arc is not silent the crater is formed by a point or line of very high intrinsic brilliancy rotating at a speed of from 50 to 450 revolutions per second. The existence of the above-mentioned phenomenon forms a serious objection to the use of the electric arc as a primary standard, but it does not, *per se*, render its use impossible. Finally, the variation of the intrinsic brilliancy of the crater is a question which in itself offers considerable interest.

The points on which the present work bears are threefold: (1) What is the average intrinsic brilliancy of a normal (silent) arc; (2) when the conditions are carefully specified, are the variations still too great to allow of the use of this source of light as a standard? (3) what variations can be obtained by the use of excessive currents and current densities, and by surrounding the arc with an enclosure maintained at a very high temperature?

To obtain consistent results the observations must be made on a very small area selected from the central portion of the crater. The diaphragm used for this purpose is shown in Fig. 3. The opening, *d*, is 1·47 square millimetre in cross-section. The diaphragm is shaped much like the tuyere of a blast furnace, and being kept cool by a water circulation it can be placed within a very short distance of the crater of the arc.

* From the *Proceedings* of the Royal Society.

The next question involved was the determination of the best relative position of the carbons. In the usual arrangement of the arc the centre of the crater is hidden by the negative carbon. A modification of this arrangement, used by Blondel, which consists in slanting the carbons and placing the positive slightly behind the negative, was found not to be entirely satisfactory. An attempt was made to take the observations through a hole drilled out of the negative carbon (see Fig. 1), but when the arc was started

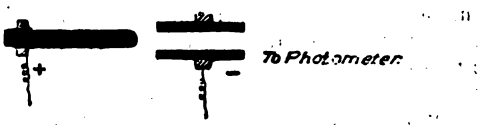

FIG. 1.

this hole became filled with mist, and the plan had to be given up. Fig. 2 shows diagrammatically the next arrangement which was tried. The carbons, n_1, n_2, n_3, are negative, and form the edges of an equilateral pyramid, the axis of which is in the prolongation of the positive carbon, P. The summit of the pyramid is at the point P. The crater formed on the positive carbon by these three arcs is in full view, and good results might have been obtained in

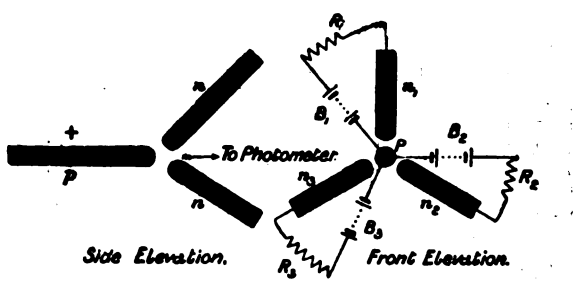

FIG. 2.—P, positive pole; n_1, n_2 n_3, negative poles; R_1, R_2, R_3, variable resistances; B_1, B_2, B_3, batteries.

this manner. Unfortunately, this disposition had to be abandoned, as it soon became evident that it was impossible for one observer to adjust the currents in the three independent electrical circuits, to feed up the four carbons, and to make all the electrical and photometric readings. The disposition which was finally adopted is shown in Fig. 3.

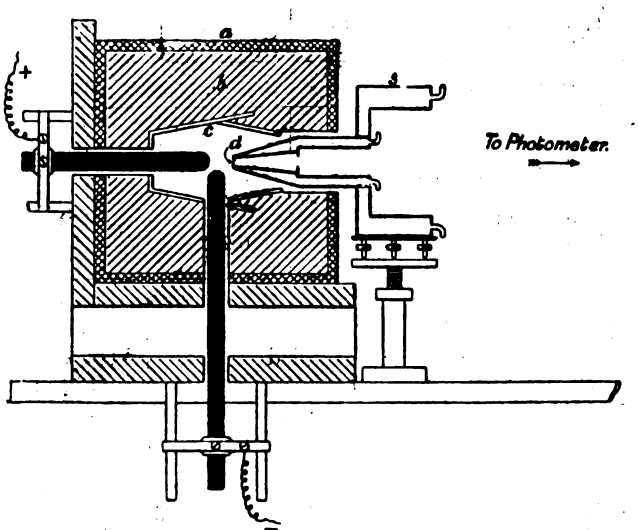

FIG. 3.—*a*, asbestos box; *b*, lining of refractory bricks; *c*, graphite crucible; *d*, diaphragm; *s*, screen.

The diaphragm, *d*, screws into a screen, *s*. This screen is supported on a system of pivots and levelling screws, so that it can be raised, lowered, or turned round a vertical or horizontal axis. The opening, *d*, can thus be directed to any portion of the crater. The positive carbon is horizontal, and so placed that its axis coincides with the axis of the photometer.

Two distinct series of experiments were carried out: one with the arc placed in a metallic enclosure kept at about 20deg. C. by a water circulation, the other in the enclosure shown in Fig. 3. The temperature of this enclosure varied from the melting point of silver to near the melting point

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of platinum, according to the amount of power expended in the arc. Referring to Fig. 3, *c* is a carbon crucible surrounded by a thick layer, *b*, of firebricks and refractory clay. The outer covering, *a*, is of asbestos. Both the high and low temperature enclosures were provided with a small camera obscura (not shown in the figure), by aid of which the relative positions of the carbons could be adjusted and the length of the arc measured. "Apostle" carbons were used in all the experiments. The size of the positive carbon varied from 6mm. to 25mm. in diameter. To obtain reliable results a sufficient current density must be used to give a fairly large crater. The arc must also be sufficiently stable for the crater to remain some considerable time without shifting its position. Finally, it is desirable that the arc should be burning in a normal manner, and therefore neither hissing nor roaring. Given these conditions, it is impossible to vary either the current, the E.M.F., or the length of arc, within very wide limits.

TABLE I.—"Silent" Arcs. Enclosure at about 20deg. C.

E.M.F. in volts.	Current in amperes	Power in watts.	Diameter of the positive carbon in mm.	Current density in amperes per sq mm. of cross-sectional area of positive carbon.	Length of arc in mm	Intrinsic brilliancy of the crater in candle-power per sq. mm.*
65·0	8·1	526	8	0·161	4·8	136
64 5	7 0	452	8	0·139	—	141
72·0	10·3	742	8	0·205	6·0	143
70·3	7 3	513	6	0 258	—	147
61·7	6·0	370	6	0·212	5·1	154
62·0	9 1	564	6	0·322	6 0	160

TABLE II.—"Silent" Arcs. Enclosure above 900deg. C.

83·0	11 0	913	8	0·219	—	136
57·0	10·9	621	15	0·061	—	142
61·0	8·6	525	8	0 171	6 0	152

TABLE III.—"Hissing" Arcs. Enclosure at 20deg. C.

70·0	15·8	1,106	8	0·314	4·8	136
42·0	21·6	907	8	0·410	1·2	143
53·0	25·8	1,367	8	0·514	2 9	157
44 0	50 0	2 200	15	0 283	—	160

TABLE IV.—"Hissing" Arcs. Enclosure above 900deg. C.

79 0	18·0	1,422	15	0·102	—	119
45·6	42·0	1,915	15	0·238	—	121
60·3	18·6	1.122	25	0·038	—	130
52·0	55 0	2,860	25	0·112	—	133
41·0	43·4	1,779	25	0·088	—	137
50·0	39·3	1,965	15	0 222	—	142

* Each of the figures in this column is the mean of a number of photometric observations.

In the experiments recorded in Table I., the mean intrinsic brilliancy is 147 c p. per square millimetre; the variations from the mean amounted to 10 per cent. Table II. gives experiments made under similar conditions, but with the enclosure in which the arc was burning at a temperature of over 900deg. C. The average intrinsic brilliancy calculated from this table is 143, or about 3 per cent. lower than when the enclosure was at the ordinary temperature. It would, however, be unwise to attach too much importance to this change. The difficulty of obtaining consistent results is considerable, and a 3 per cent. variation is well within the experimental error.

The conclusions we have reached may be summed up as follows: (1) The intrinsic brilliancy of the crater of a silent arc is about 147 c.p. per square millimetre. (2) Even when the most favourable conditions are selected, and the intensity of current and the length of the arc are maintained constant it is difficult to obtain consistent results, variations of over 5 per cent. being by no means unfrequent. The crater of the arc does not, therefore, possess the qualities required of a standard. (3) Variations in the size of the carbons, in the intensity and density of the current, in the length of the arc, and in the total power expended (as long as the arc is kept silent), will not cause the intrinsic brilliancy to vary more than 10 per cent. on either side of the mean. (4) No sensible variation in the intrinsic brilliancy, and therefore in the temperature of the crater, is produced by placing the carbons in an enclosure maintained at over 900deg. C.

With regard to the constancy of the temperature of the crater, these results are not without importance. Having this question in view, it was necessary to determine what were the effects of extreme variations of current density and power. In Tables III. and IV. will be found the results of observations taken when the arc was hissing. The word "hissing" is used here as being the generally accepted term. It is only when the current density is small that it is actually descriptive of the sound made; as the current increases the pitch rises, until with a very short arc and a current density of about one ampere per square millimetre, the sound is between a whistle and a scream. The arc then assumes a very peculiar aspect, a pointed blue flame, like the flame of a blow-pipe, being sent out from the crater. This effect was most marked when the high-temperature enclosure was used. With the above current density the entire carbon becomes white hot and burns away with great rapidity; an increase in the intrinsic brilliancy seems also to take place. Unfortunately, it was not found possible under these circumstances to obtain reliable photometric observations.

It will be seen that the current varied from 6 to 50 amperes, the current density from 0·03 to 0·51 amperes per square millimetre, and the power from 370 to 2,800 watts. The lowest photometric readings gave 119 c.p. and the highest 160 c.p. per square millimetre.

If we assume that the formula

$$t - 400 = 889 \cdot 6^{\frac{2}{3}} \sqrt{b}$$

(t = temperature in degrees C., b = intrinsic brilliancy in candle-power per square centimetre) holds good for carbon at these high temperatures, the above change in candle-power corresponds to a variation of temperature of from 3,866deg. to 4,018deg. C. The total alteration in absolute temperature thus works out at 4 per cent. Observations made on silent arcs (Tables I. and II.) reduced in the same manner give the extreme limits of temperature, as 3,935deg. and 4,018deg. C., or a change of 2 per cent. in the absolute temperature.

These variations are somewhat greater than we should meet with in the case of substances boiling at ordinary temperatures. It must, however, be borne in mind that even in the case of a silent arc the crater is the seat of several secondary phenomena, which under certain circumstances may affect the boiling point. The term boiling point is in itself misleading, as it seems possible, if not probable, that at atmospheric pressure carbon does not become liquid, but, like carbon dioxide, passes direct from the solid to the gaseous state. It has frequently been stated that impurities cannot affect the temperature of the crater, as all known bodies become gaseous at a lower temperature. The experimental data to substantiate this are entirely wanting; silica, lime, alumina, magnesia, and other substances are solid at the temperature of melting platinum, and it is difficult to predict at what temperature they volatilise. Taking everything into consideration, it may therefore be said that the present experiments confirm the theory that the crater of the arc is at the temperature of volatilisation of carbon.

The earliest determinations of the intrinsic brilliancy of the crater were made in 1878 at Chatham under the direction of the Royal Engineers' Committee. The results varied from 39 c.p. to 442 c.p. per square millimetre, the mean value being 110. With regard to more recent researches, Trotter gives the intrinsic brilliancy as 64 c.p., Weber as 70 c.p., and Blondel as 158 c.p. per square millimetre. With the exception of those of Blondel all previous results are very much lower than the values I have obtained. The discrepancy may be attributed to the fact that instead of using a diaphragm to select the rays from the centre of the crater, the first-named observers estimated the total area of the crater, and compared it with the total amount of light.

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NEWCASTLE-ON-TYNE LOCAL SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

The following is the address delivered at the Durham College of Physical Science, May 15, 1900, by the first chairman, Mr. A. W. Heaviside, M.I.E.E., superintending engineer of the North-East (North) District of the British Postal Telegraphs:

Gentlemen,—In addressing you at this the first meeting of the Newcastle Section of the Institute of Electrical Engineers, I have, in the first place, to thank you for the unexpected honour you have bestowed upon me in electing me your first chairman. There are other members of this worshipful company worthier than I whose modesty has thrust the unaccustomed duties upon me, but having accepted the position I will do what I can to further the success of this section of the Institute, whose interests are those of the fascinating industry in which we are all engaged, in such fashion as my slender attainments will permit. I have thought that as the establishment of a section of the Institute in the ancient city of Newcastle-on-Tyne earmarks both the place and the time, that, perhaps, it would not be altogether uninteresting to the members if an effort was made to locate in some degree the position held by the district, of which this city is the centre, in the electrical industry. To do this, by way of historical introduction, it is not necessary to go back to Thales of Miletus and his excited amber, but only to a more recent period which is scored all over with the honourable marks of discoveries and inventions which have mainly assisted in making electricity the servant of man.

As we all know, the pioneer industry is that of the electric telegraph, which knits the world together and is both the oldest and at present the most indispensable of all the applications of electricity. Like our venerable Queen, it came to the throne in 1837, where, similarly, it has reigned with ever-increasing beneficence ever since. In the circumstances, and out of reverence for those who have done so much to aid present successes, a few moments can be well spared for just a glance at the discoveries and inventions needed for the evolution of the electric telegraph in its simplest form. All that is needed to signal the thoughts of the community from one place to another is the combined use of three things, built up of many parts—a source of electricity, a conductor of electricity, and an indicator of electricity. Simple enough in these modern days, every electric bellhanger knows that, and sometimes knows how to do it. But consider what a mountain of labour and patient investigation over more than a century, from 1729 to 1837, before the discoveries of great men were combined by the invention in the production of a practical electric telegraph. Just look askance over one's shoulder down the back entry of Time. There are always the shadowy forms, looming largely on the horizon, of Gray, an Englishman, who, in 1729, discovered the difference between conductors and insulators, using moistened packthread for the former and silk loops for the latter; of our great Anglo-American Franklin, who, in 1752, with his kite in the sky, conducted the lightning to the earth, thus establishing its identity with electricity; of Galvani and Volta, the eminent Italians, who, from 1786 to 1789, developed one source of electricity—namely, the chemical battery.

Here we may pause for a moment, having learnt in 70 years how to produce and how to conduct electricity in an elemental manner. Then comes the achievement of a practical indicator of electricity—How to get it? a somewhat complex problem. A needle, or armature of steel or iron, magnetised permanently, or temporarily from any source, and responsive to every change in its electrical environment, yet controlled by man—a thing that no one at that time knew anything about practically, in a combined sense, though many lent wings to their imaginations in the effort to mentally satisfy the problem. The magnetic needle—I promised not to go so far back as Thales of Miletus, but, again, reverence for the past unexpectedly commands that I should go back farther still, but just for one moment, if only to say that the ancient Chinese in past ages apparently knew all about its properties. So, to start fair, we find that Oersted, the Dane, in 1819, with the magnetic needle ready to his hand, made the first step. He deflected his needle by means of a current in a wire parallel with it, proving that currents and magnets have similar properties, whilst Ampère, the renowned Frenchman, in 1820, made another step by discovering that a suspended coil of wire carrying a current was a magnet. Then Italy, in the same year, in illustrious Arago, provided another link by temporarily magnetising soft iron during the presence of the current. Finally, Sturgeon, the sturdy Englishman, in 1825, made a last elemental step—by placing Arago's soft iron into Ampère's coil produced the electromagnet of to-day, which, in conjunction with a needle or armature, is the basis of telegraphy and many other things.

The mental activity of the 12 years following, which gave a clearer grasp of the laws of electrical action, is marked by the mere mention of the names of such giants in science as Gauss, Weber, Coulomb, Faraday, Henry, Neuman, who also, in one way or another, contributed to the almost simultaneous invention of practical electric telegraphs in three great countries—viz., England, Germany, and the United States of America—in the year 1837. June of that year gave the world Cooke and Wheatstone's five-needle telegraph; July, Steinheil's needle, Bell, and printed marks telegraphs; and October, Morse's marks embossed on paper. With many apologies to the names of the unnamed illustrious ones, I must conclude this stride over a century, and endeavour to show Newcastle's place in telegraphy and kindred things. But, in passing, I would beg you to observe, incomplete though the list may be, how suggestive is the array of names and countries to which the contributors belong. How ubiquitous is science and its votaries. What a true cosmopolitanism and universal brotherhood exists, which took the Institute to Switzerland last year, and will certainly take most electrical engineers, including myself, to Paris this year. Forgetful of yellow-press politicians and their narrow statesmanship, which contract the humanities and tend to embitter one nation against another, I am sure that my audience is with me in crying away with all such narrow and sordid feelings; let us breathe a purer atmosphere on a higher platform.

In 1837, as I have said, a practical five-needle telegraph was invented, which was soon simplified to two needles only. This invention was slow of appreciation, for seven years elapsed before a joint-stock company was established to exploit it. However, in 1844, the Electric Telegraph Company started the combined railway and public service, and in two years their operations extended to this neighbourhood, where they established a double-needle circuit from Gateshead to York. At that time 13s. 4d. was charged for a message of 20 words from Gateshead to London *via* York. The basis of this charge needs to be placed on record: 1d. per mile for the first 50 miles, ½d. per mile for the second 50 miles, and ¼d. for every addititnal mile, with certain extras for porterage and addresses. Now, as is well known, since 1885, 12 words cost 6d. to anywhere within Great Britain and Ireland. The nimble 6d. is the key to the carriage of lightning thoughts throughout the land. In 1849 the high-level bridge across the Tyne was completed, and with it came the establishment of an office on the Sandhill, about the site of Gosmas's Restaurant. Newcastle's first direct connection with the Metropolis was in 1851, when it was temporarily established with the first International Exhibition in Hyde Park. The double-needle now began to give way to the single-needle and the Bain chemical recorder, which were succeeded by the Morse embosser in 1858. In 1853-4 the Magnetic Telegraph Company using Highton's single-needle and Bright's acoustic bell system, a forecast of the American sounder came to Newcastle, with transmitting centres at Leeds and Carlisle, competitively reducing the before-named 13s. 4d. to 3s. as the Newcastle-to-London rate. Another 10 years, and 1864 saw the shilling, or United Kingdom Telegraph Company, in local existence, using the Morse printer and the beautiful Hughes typewriter, invented in 1853-4-5, which brought Prof. Hughes honourable distinction in every civilised country but his own. But in 1867 a great jump was made. Up to this time the usual controlling force in all signalling by battery contact, or interruption, was the hand of the operator, which limited the speed of working on any wire to 30 or 40 words per minute at most. Wheatstone knew that the speed of electric travel and the carrying power of the wire were beyond the needs of man, whilst the work then got out of the wires was below man's needs. His problem was both to save new wires and time by the introduction of a mechanical device by which an electric battery contact could be made, broken, or reversed with great speed. These battery contacts represented signals, the familiar dot and dash of the Morse alphabet, which were recorded on a paper tape at one or more places simultaneously. He achieved this by first punching through a paper tape a series of contact holes to correspond with the dots and dashes which form the alphabet, and by passing this tape through a clock-work reversing battery contact maker, transmitted long or short currents along the conductor, which entered an electro-magnetic receiver at the distant end, whose responses were recorded in dot-and-dash inkmarks. This invention was worked out by the aid of that most estimable gentleman, Mr. Augustus Stroh, a veteran pioneer in the scientific construction of all philosophical and electrical apparatus, whose understanding of means to an end in electrical mechanisms stands pre-eminent. This Wheatstone automatic apparatus was first introduced for practical work in this country between Newcastle-on-Tyne and London, Edinburgh and Glasgow following after. Daily practical work is carried on with it at a normal speed of 330 words per minute on the local wires of this district, and between London and Birmingham 600 per minute; of course, if duplexed, these figures become about 550 and 1,000 respectively. In 1870 the Post Office acquired the telegraphs and introduced universal 1s. telegrams, followed in 1885 by 6d. telegrams. By the kindness of Mr. T. Stevenson and Mr. A. Mellersh, the Post Office surveyors of this district, I am able to give the following

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figures of the traffic of this district for the year ending March 31, 1900 :

Telegrams forwarded	3,034,030
Telegrams received	3,193,890
Telegrams transmitted	2,523,971
Total	8,751,891

The first line is the money-earning one, and shows that, taking the population of the district at 2,000,000, rather more than 1½ messages per head of the population originated in the district per annum ; but taking the forwarded and received, the traffic of the district is rather more than three per head of the population. The wires provided in the district by the engineers' department amount to 14,889 miles carried along 1,794 miles of route ; 287 post offices absorb 823 sets of telegraph apparatus, and 1,244 private offices absorb 1,418. The National Telephone Company's amount to about 5,000 exchange connections, using 6,657 miles of wire serving 32 exchanges. Fig. 2 shows the telegraph offices in direct communication with Newcastle at the present time, equalling 155 served by 104 wires, exclusive of wires that pass through Newcastle *en route* for other places.

To continue our story, of course duplex and quadruplex telegraphy is largely employed. Gintl, in 1853, invented duplex telegraphy, but it did not come into practical use until Stearns applied a counter kick condenser to it in 1873. Mr. O. Heaviside suggested quadruplex telegraphy, which was developed by Edison and others, and was followed by the multiplex of La Cour and Delaney. In duplex telegraphy, as we all know, the outgoing current divides equally upon the apparatus, nullifying local responses, consequently it is left free to respond to currents from the distant end only. Quadruplex is the addition to the latter of currents of two strengths, with selective apparatus at each end, which responds only to the current suited to it. In multiplex telegraphy, six or more instruments are synchronously and successively connected to one wire, with such short intervals between each connection that practically each operator has an independent use of the wire. Newcastle has not risen to the dignity of the use of this apparatus at present. The search for various methods of multiplex telegraphy led to the use of vibrating reeds of different responses. A reed may be a tongue of iron before an electro-magnet. Here we have the magnetic telephone *in nubibus*. The tongue may respond to vocal vibrations and be developed into a membrane of disc shape still more responsive. It is remarkable that there is a mysterious connection between the search for multiplex telegraphy and telephony which just proceeded the invention of the telephone.

It may be usefully mentioned here that in 1868 the importance of Newcastle-on-Tyne telegraphically was greatly increased in consequence of the Anglo-Danish, now Great Northern, Telegraph Company commencing operations. Their first cable was laid in 1868 by Mr. R. S. Newall, between Newbiggin-by-the-Sea and Sondervig, on the west coast of Jutland, 335 nautical miles. The second cable was laid in 1873 between Newbiggin and Hirtsholson on the same coast, 430 nautical miles. The third cable was laid in 1880 between Newbiggin and Arendal, in Norway—520 nautical miles ; and their fourth and last cable was laid in 1890 between Newbiggin and Marstrand, in Sweden—509¾ nautical miles. In addition, this company have two land lines to London, and one to Peterhead, in Scotland, in connection with another submarine cable to Norway. The apparatus employed is one of remarkable delicacy (a first cousin to Lord Kelvin's siphon recorder, which is still more sensitive) called the undulator. Indeed, so sensitive is the arrangement which works through the cables and the land lines to Scandinavia at a normal speed of 80 words per minute simplex and 120 duplex, that great care has to be taken to avoid lateral inductive effects. Mr. John Mygind, who has ably locally administered the affairs of this company since 1868, can only view the introduction of electric traction with apprehension. The Commercial Cable Company and the Anglo-American Cable Company have each land wires to Newcastle to feed their cables.

Going back to 1859-60, at this time the Universal Private Telegraph Company exploited the Wheatstone A B C telegraph for private conversation at a rental. This was introduced into Newcastle in 1863. Out of it developed the A B C exchange system (Fig. 1), by which private circuits converging on a centre were joined together for conversational purposes. This was the forerunner of all telephone exchanges. Printing Court Building is the historic spot where this was first done in this country in 1864. Sir William Armstrong and Co., Thompson and Boyd, and Charles Mitchell and Co., were the first to keenly realise its advantages. This magneto-electric telegraph took 18 years to develop, from 1840 to 1858, and again the hand of Stroh helped Wheatstone. This instrument is really the baby of the alternating inductor dynamo of Mordey and others of to-day. But in 1877 came the epoch-making telephone : the receiver perfect from the hand of Bell, our Anglo-American, at a bound—Alexander Graham Bell somehow stepped in front of Elisha Gray, who was first in the field—the instrument that has appealed more powerfully to the mind of the thinker as a physical demonstrator of the existence of electrical vibrations than anything before and up to the time of Herz in 1887. This instrument made the detection of long-distance induction practical for telegraph purposes, and preceded the no less extraordinary detector of Branly and others, called the coherer. So great was the interest excited by the invention of the telephone, that in May, 1877, two of my staff—Mr. Frank Reid and Mr. W. R. Smith—needed no initiative to make the first telephones in this district from parts of the A B C telegraph. In September of the same year Alexander Graham Bell paid a stimulating visit to Newcastle, where already with all our might we were trying to understand the sometime called "philosophical toy." What to do with it, the pesky thing, with its marvellous sensitiveness ? How to get it under control ? It was such a libertine in tapping all hitherto invisible and unknowable electrical procedures, showing that beneath the outward calm the heavens, the earth, and the whole cosmos, were in ceaseless activity of vibration, partly nature's and partly that part of nature man's. A little bit of soft iron encircled with wire, and a wee ferrotype iron diaphragm fixed in a case, became the revealer of the mysteries until then only deductively dreamed of by the physicists, such as Maxwell, Lord Kelvin, and, perhaps I may be permitted, Oliver Heaviside, and others—running riot with the imagination of all investigators, and forecasting that in the long run there is no articulate secret that may be unknown, the irrepressible telephone picking up all vagrant sounds of mechanical or electrical origin, like the sleepless fury Tisiphone at the gate, always on the watch to record, not to avenge.

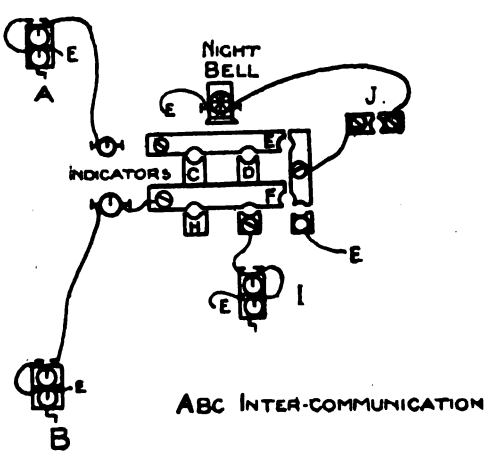

FIG. 1.

Then Hughes, in 1878, crowned the telephonic edifice with the invention of the pencil microphone, nearly as we now have it, making a gift of it to the world, thus paying tribute to humanity, as he has since done, by bequeathing his great wealth to the London hospitals. Of course, from the first the days of the A B C were numbered, and the problem, how to get the telephone under control, stared one in the face. Just let us consider the place the telephone has in the world.

Electric telegraphy is the transmission and reception by electrical agency of inarticulate thoughts by a prearranged code of signals representing the alphabet, say five signals per word. It involves eight elemental steps : (1) the thought ; (2) its writing out ; (3) its conveyance by messenger to the telegraph office ; (4) its transmission by dots and dashes over the wires ; (5) its reception by dots and dashes over the wires ; (6) its rewriting out ; (7) its conveyance by messenger to the recipient ; (8) the understanding of the written thought by the recipient. Nos. 4, 5, and 6 may be, and are, multiplied enormously by repetition where the service is indirect. Though clumsy, it has done and does good work, is interesting in its complexity, and limited in application. Electric telephony is the instantaneous interchange by electrical agency of vocalised thoughts, charming in its simplicity. It sufficeth not in this country, through the greed of monopolists and imperfections in exploitation. This, time will cure, as in application it is unlimited. The house-to-house telephone, nay, the room-to-room telephone, is its inevitable goal.

From May, 1877, to Dec. 24, 1880, much telephonic research work, that would take too long in the telling, was done at Newcastle, as well as elsewhere. As it is with Newcastle we are mostly concerned in this address, it behoves one to touch—alas, too lightly—in this lightning survey on what was locally done as the result of the midnight oil. We can only stop to record one observation, which, though it attracted little attention at the time, was eventually more far-reaching in its consequences than any other. In May, 1877, a local circuit was made up of four lines converging on an Umschalter switch. When conversation was held with the pegs inserted, as in Fig. 2, better speech was obtained between the mechanics' shop and the

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battery-room than when the pegs were inserted as in Fig. 3. That it was so, we knew; why it was so only revealed itself as time disclosed its importance. On Dec. 24, 1880, judgment was given that a telephone was a telegraph. This opened the

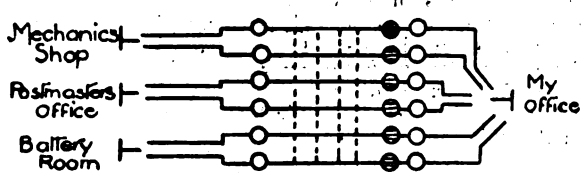

FIG. 2.

door of the Department for its exploitation. In 1881, a Post Office exchange was opened at Sunderland. It was joined up on the usual plan with the intermediate apparatus in sequence, upon double-wire twisted loops, as first suggested by Prof. Hughes. The apparatus in sequence choked

tained in Fig. 2, which, if drawn out straight, threw off its disguise and gave the intermediate apparatus (Fig. 4) in bridge across the line. Savants looked askance; it abrogated Ohm's law—why, it short-circuited the line! However, its efficiency was drastically put to the proof by partial use in 1881; it survived the whips and scorns of time, and was finally adopted *in toto*. Stockton was the first exchange entirely joined up in this manner—a new post office involving new construction was

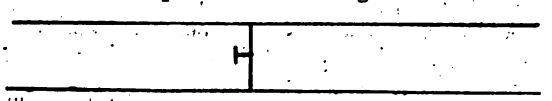

FIG. 4

the opportunity. This exchange was opened on Jan. 26, 1885. The kernel of the system is that by putting apparatus of great impedance at the intermediate points, vocal high-frequency telephonic undulations gave the short-circuit the go-by, whilst low-frequency call-signal currents operated the signalling indi-

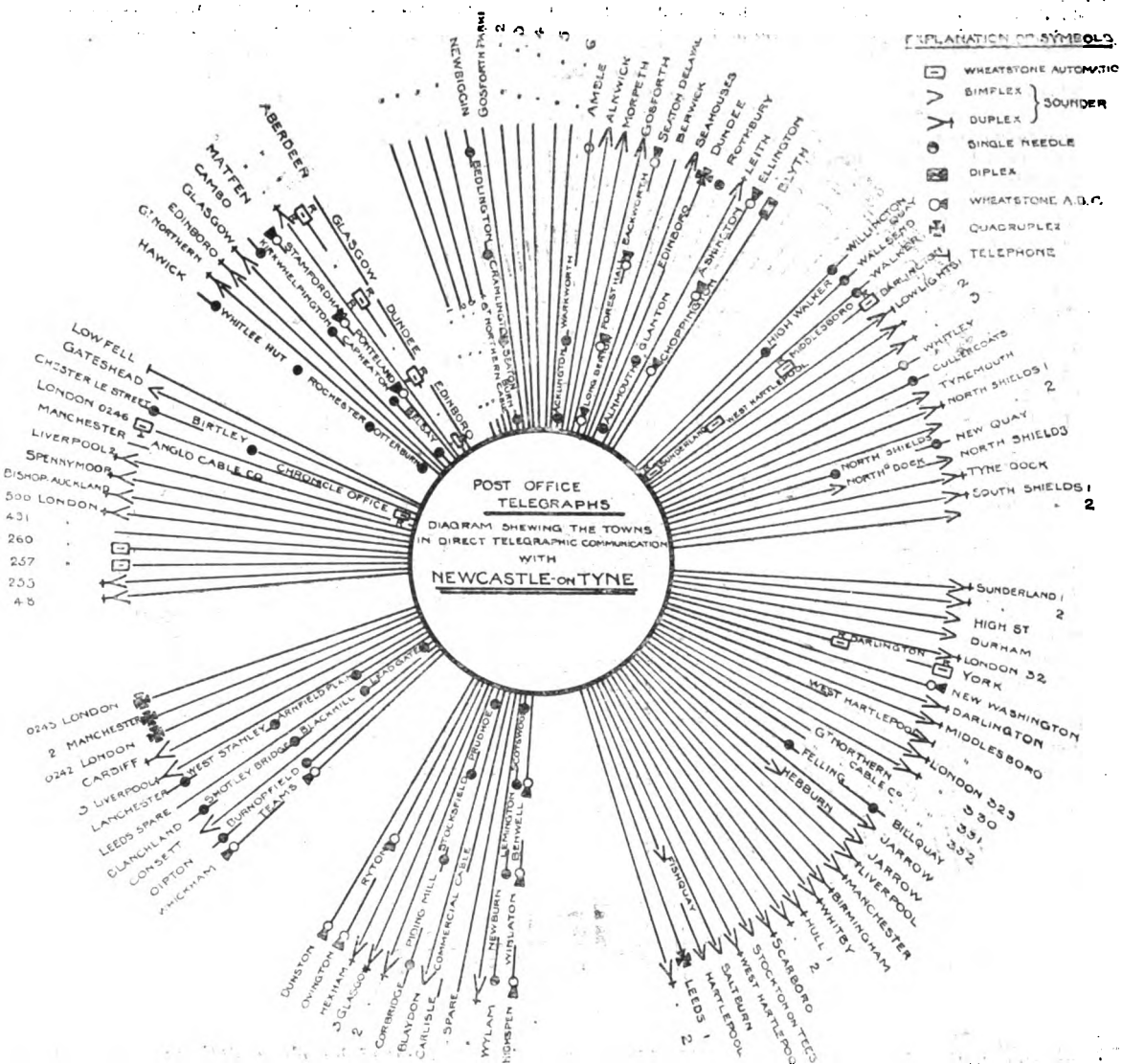

FIG. 5.

the speech, threw the line out of balance, let in lateral induction, undoing the benefit of Hughes's twist. Shift was made in this district, as all over the world, with this arrangement, its imperfections being condoned. With underground work it died at four miles length; by putting one

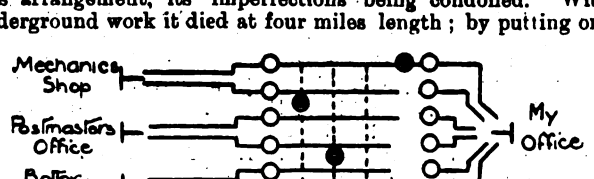

FIG. 3.

intermediate on one side of the loop and another on the other side its life was resuscitated to eight miles of underground work, and there speech stopped dead. But, as had already been proved, there was one, and one way only, to secure telephonic speech unlimited as to distance and free from vagrant sounds. That way was hidden in the elemental principle con-

cators at the bridges *con amore*. The operating in the Post Office system is arrauged so that overhearing on the part of the switch clerks is unnecessary—a system of automatic block signalling by means of needle deflections telling the operators all they need to know; hence all the conversations are heard only by those whose property they are, the principals in the transaction. The clever application of hard-earned prior knowledge ensures business success, but if it leaks by the way, what then?

Telephone trunk wires were early introduced in this district, the first being between Newcastle and Sunderland, erected in 1883. In October, 1896, when the National trunk wires became the property of the State, the Newcastle service had already reached 33, to which had to be added the National, giving a total of 68. Now they reach 72, and Fig. 6 shows to what towns (14 in number) direct communication exists. If to this is added all the towns now served by telephone trunk wires, the total is 303. In the Tees-to-Tweed district, for the year ending March 31 the number of trunk calls reached 3,127,689, and local exchange calls reach about 12,000,000 per annum.

Then came 1886. As already referred to, the telephone's

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detection of inductive effects at long distances is marked. This is the so-called wireless telegraphy of the electromagnetic order. It was always there—most people knew of it from the days of Faraday and Henry in 1831; but what they did not know was its extent, which, after all, depends upon the force of the source, the delicacy of the detector, and, to some extent, on the opacity or transparency of the medium. The telephone always asserted itself unblushingly in responding impartially to vagrant electrical effects. In pursuit of this will-o'-the-wisp, most people's trouble was to find time to step on one side from the busy humdrum of life to follow, much less exhaust, any one of the many avenues that revealed fascinating horizons that led to the joys of finding out Nature's secrets and gave beauty of understanding. In the Newcastle battery-room, as recorded in the *Journal* of the Society of Telegraph Engineers, vol. x., p. 21, Jan. 26, 1881, in December, 1880, one had only to walk about the room with a telephone and a coil of wire to read the Morse signalling from every battery in use. This work was resumed in 1886 by a series of experiments which had for their object four things: (1) at what distance from a primary parallel could these effects be detected on the telephone; (2) how much of the effect was conductive; (3) how much was induction; (4) were

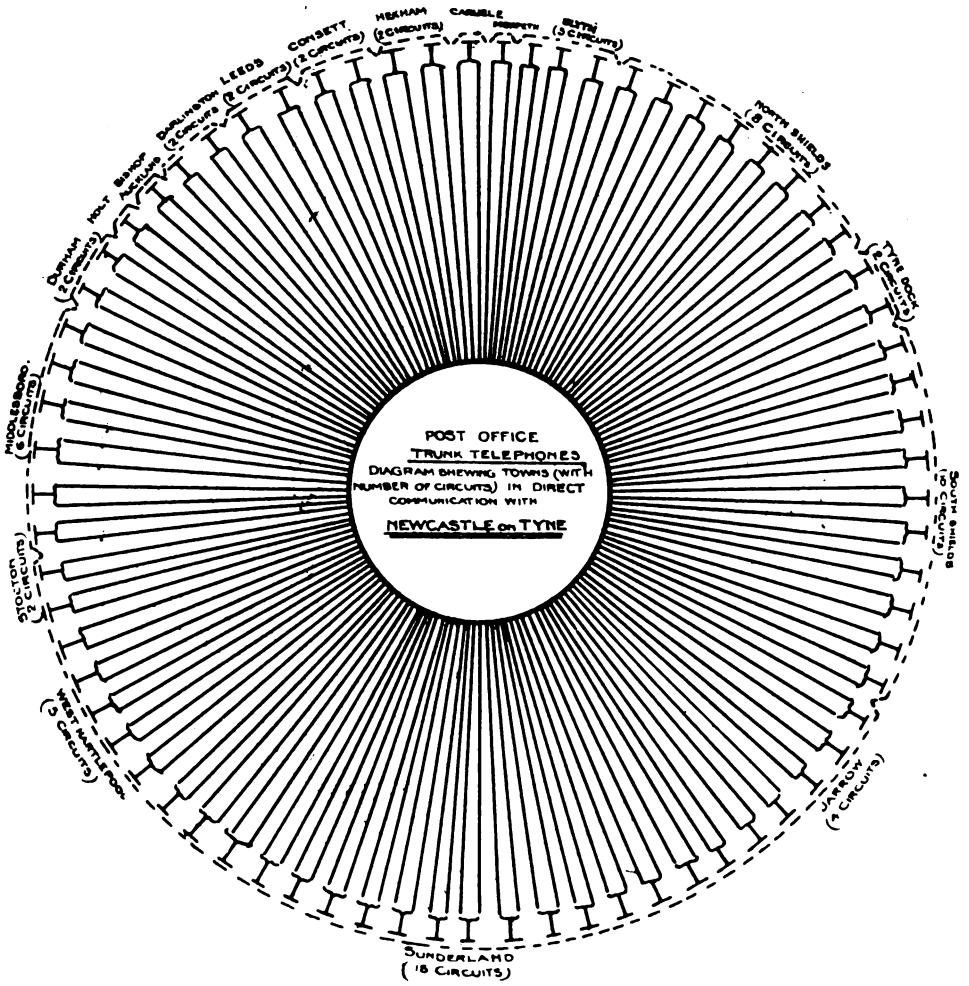

FIG. 6.

came to the rescue, and placed his estate at my disposal. Here it was, in the last week of August, 1886, that with two miles of insulated wire laid out as two squares of quarter-mile sides and a quarter of a mile apart, or half-mile centres, that articulate telephonic talk was inductively held between one square and the other—hearable with closed circuits, difficult to hear, but present with open circuits. Of course, this test was with undulatory currents of microscopic value, and forms the highest testimony of the extraordinary sensitiveness of the telephone. This was followed up by telephonically speaking from the workings of Broomhill Colliery to a triangle of insulated wire, three-quarters of a mile each side, laid roughly parallel over the colliery workings, the medium for the waves to travel being 360ft. of the crust of the earth. Of course, as everyone knows, with the all-important addition of Evershed's call, this electromagnetic system has been developed and applied practically by Sir William H. Preece, and is in use between Flatholm and Lavernock in the Bristol Channel.

But in 1897-8-9 Marconi has, by combining the labours of Branly, Righi, Oliver Lodge, and others, coupled with his own clever insight into the subject, signalled over great distances, truly without wires, for really what wire he does use may be

all bodies transparent to them? On April 14 and 15, 1886, 14 years ago, on the Newcastle Town Moor, I proved, with 120 reversals per second and half an ampere of current, that it might be both or whichever you pleased, inductive or conductive, dependent upon whether earth returns or insulated metallic returns were employed; also, that where earth returns were used, the earth could be tapped by driving the two ends of four yards of wire with a telephone in circuit into the earth. It was also proved that with a secondary or with a primary only connected to earth at one point static effects could be easily detected, though diminished in loudness. Further, it was proved that if the distance from the primary was more than the length of the primary, the effects diminished in loudness very rapidly.

From this time until Aug. 15, 1886, the changes upon the above experiments were rung in many ways, always extending the distances, ending in Morse speaking across 40 miles of country, between Shap and Gretna on the West and Newcastle and Jedburgh on the East, produced by interrupting the vibrations with a Morse key. Up to this time the primary wires were usually single wires put to earth at each end and the secondaries insulated squares or rectangles, and the difficulty was to get a space large enough to lay out insulated wires on the surface without exciting the hostility of the tenants of the Northumberland moors. However, Mr. Hugh Andrews, of Swarland Park, considered as part of his electrostatic apparatus. Of Marconi and his system much may be expected, and all present must rise in admiration of the persistency and pluck of this young Italian in experimenting and experimenting in every possible way to achieve long-distance speaking and practical success by focussing, so that nothing shall leak out to the wrong person. In connection with the coherer, which coheres in response to an electric flash, it is singular that Mr. Augustus Stroh has observed something akin in the adhesion of surfaces when traversed by an electric current (see *Journal* of Society of Electrical Engineers, vol. ix., p. 182), and it is sad that, misguided by the savants, Prof. Hughes, the cruelly-neglected scientist, did not go further in anticipating wireless telegraphy than as brought to light last year. Like Cavendish, it is a pity he did not publish his researches at the time.

We must now hurry forward to see where we stand with the other great electrical industries, better known than telegraphs and telephones in one sense, arising out of their control not being that of the State, or of the monopolist, but everybody's business. Let us ask what is Newcastle famous for in original work? Well, first we have Lord Armstrong's hydro-electrical frictional machine of 50 to 60 years ago, showing the electrification produced by steam rushing through an orifice, and then we have Lord Armstrong's *magnum opus* of 1897, on the "Electrical

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Movements in Air and Water." Who, in Newcastle, is not justly proud of this venerable citizen, mathematician, scientist, engineer, and, above all, one who does not live for himself alone—the giver of parks and gardens, and the creator of the greatest private arsenal in this and many other countries? Second in the order of date comes Joseph Wilson Swan, F.R.S., of Newcastle-on-Tyne, the inventor of the Swan lamp, which assumed practical form in the autumn of 1880. From the days of King, in 1845, to the days of Swan, in 1878-80, many tried their hands at getting light from incandescent platinum, or carbon in vacua. But whilst all they did established the soundness of the principle, nothing they did brought more than disappointment from a practical point of view. Mr. Swan himself laboured and experimented with the incandescent lamp in the decade 1850-60, with like result. He used carbon strips in loops and spirals carbonised in Wallace's Forth Banks pottery kilns in crucibles filled with powdered charcoal, but the available mechanical air-pumps gave a bad vacuum for such a purpose. Yet at this early date Mr. Swan had grasped the necessities of the case—a cheap source of electricity, an excellent filament, and a good vacuum.

By 1877-8 the dynamo was entering upon a vigorous life. Arc lamps were being introduced daily, Jablochkoff, the unrewarded, being the first. In 1864 and 1870 Pacinnotti and Gramme produced direct currents from ring armatures; Wilde's of 1866 and Wheatstone's and Siemens's dynamo self-excitation of 1867 was beginning to bear fruit. The telephone was invented. Planté batteries were coming to the front. In 1873-6 Crookes had shown how to produce high vacua with the Sprengel pump in his beautiful radiometer. Electricity was in the air, sparkling and iridescent as any sunrise. In fact, hopes ran high, and the electricians of the day felt how beautiful was the world if only rightly taken. In these stimulating circumstances Mr. Swan resumed his researches in incandescent lighting, determined to solve the problem of the hour—viz., the sub-division of the electric light—by the production of a lamp for domestic use that would, as it did, outrival Aladdin's lamp in the riches it has brought its explciters. Early in 1879, Mr. Swan, whose acquaintance the charming telephone introduced, brought some lamps to the historic Post Office battery-room for measurement of current and resistance, when it was at once apparent that filaments made from cardboard parchmentised and carbonised were unsatisfactory, their resistance was low, the current absorbed was high, and the bulbs quickly blackened. At these interesting and never-to-be-forgotten tests Ohm's law and multiple arc were much in evidence, all theory and experiments pointing to low-resistance conductors and high-resistance filaments as the solution of the domestic lighting problem. The filament was the crux of the problem, and as late as April 3, 1880, after much work in the meantime, taking four lamps as samples, their cold resistance was only 38, 45, 47, and 65 ohms, and 3½ amperes only made them red hot, or a little more. But on June 15, 1880, Mr. Swan gave me the pleasure of testing one of 120 ohms and another of 118 ohms resistance. This happier result was brought about by carbonising crochet cotton, a true filament. (In the meantime, it is interesting to note that Edison was more successful in his world-wide search for a vegetable fibre as a filament than Diogones was in his search for an honest man. But then, he did not use candles.) After this, Mr. Swan made such progress that by the autumn Lord Armstrong's Craigside house was installed with 20 lamps, and on Nov. 24, 1880, Mr. Swan brilliantly illuminated the auditorium of the Institute of Civil Engineers in Great George-street, Westminster, to the delight of a distinguished audience of the members of the Institute of Telegraph Engineers and Electricians. Mr. Swan, during these three years of labour, was running a neck-and-neck race with Edison and Lane-Fox, each on independent lines—none the less, honour to each of them; and all Newcastle men are proud of the distinction that in their city one of the most valuable inventions of the Victorian era was conceived and developed to a practical issue by Joseph Wilson Swan. Since then, at Bromley, in 1885, Mr. Swan invented the cellulose, or nitro-cellulose filament squirted into a coagulating medium, such as alcohol, without which the high-voltage copper-saving lamps of to-day would not be. This material is also the basis of the artificial silk of to-day. It is now produced in a viscous form that can be moulded, enormously increasing its use in the arts. It is worthy of remark that Swan foreshadowed the Faure pasted plate (which Lord Kelvin brought in a box from Paris containing a million foot-pounds of energy). At his lecture before the Literary and Philosophical Society of Newcastle-on-Tyne, on Feb. 2, 1879, when exhibiting a crude lamp, he spoke of the need for storage, and showed a modification of the Planté cell, in which there was the novel feature of spongy lead having been deposited around the frillings of the peroxide element previous to oxidation, to form what is now called the + or positive element. Swan's domestic lamp suggested a large incandescent lamp as a rival to the arc, and early in 1887 Mr. T. W. Edmondson, a disciple of Mr. Swan's, succeeded in making the Sunbeam lamp, of from 100 c.p. to 500 c.p., or even up to 2,000 c.p., which as a survival of the fittest has managed to more than hold its own with its rivals. It is deserving of honourable mention as a Tyneside development, and, as in other lamps, the filament was the crux of the problem.

But to the Hon. Chas. F. Parsons the district has earned distinction by his invention in 1876-1884 of the turbo-generator—a far more original work than the last-named. For the horse-power developed it is perhaps the lightest machine in existence, occupying little space, perfectly elastic, dancing in its bearings, and said to cost little to mechanically maintain. It is idle for me to attempt to describe what is done so much better by its inventor, who I shall now ask permission to quote: "The first condensing turbine of the radial-flow type was of 200 h.p., and at a speed of 4,800 revolutions per minute drove an alternator of 150 kw. output. It was tested by Prof. Ewing, and the general result of the trials was to demonstrate that the condensing steam-turbine was an exceptionally economical heat engine. With a steam pressure of 100lb., the steam being moderately superheated, and a vacuum of 28in. of mercury, the consumption was 27lb. per kilowatt-hour, which is equivalent to about 16lb. of steam per indicated horse-power. This result marked an era in the development of the steam-turbine, and opened for it a wide field, including some of the chief applications of motive power from steam. At this period (1892) turbine-alternators of the condensing type were placed in the Newcastle, Cambridge, and Scarborough Electric Supply Companies' stations, and soon afterwards several 600 h.p. of the non-condensing parallel-flow type were set to work in the Metropolitan Company's stations, where the comparative absence of vibration was an important factor. Turbine-alternators and turbine-dynamos of 2,500 h.p. are now in course of construction in England and the United States, and larger sizes are in prospect. A turbo-alternator manufactured at Heaton Works, Newcastle-on-Tyne, for the Corporation of Elberfeld, in Germany, was tested a few days ago by a committee of experts from Germany, Prof. Ewing being also present, with the following remarkable results: at the full load of 1,200 kw., and with a steam pressure of 130lb. at the engine, and 10deg. C. of superheat, the engine driving its own air-pumps, the consumption of steam was found to be at the rate of 18·8lb. per kilowatt-hour. To compare this figure with those obtained with ordinary piston engines of the highest record with which I am acquainted of the ratio of electrical output to the power indicated in the steam-engine—namely, 85 per cent.—the figure of 18·8lb. per kilowatt in the turbine plant is equivalent to a consumption of 11·9lb. per indicated horse-power, a result surpassing the records of the best steam-engines in the production of electricity from steam."

The remarkable feature of the modern turbo-generator is its utilisation of the expansive force of steam in a series of steps, by which its initial velocity of 2,462ft. per second is reduced to a final velocity of 405ft. per second, or one-sixth. Take a waterfall; it is theoretically possible to utilise the head without loss. Well, similarly, the fall could be used in a series of steps, the water losing its potential energy with each step. So it is with the turbo-generator. Take steam at a given pressure, with a corresponding velocity, provide, as in the turbo-generator, a series of steam guide blades, and a corresponding series of interposed blades for the steam to impinge upon, the diminution of pressure with each step being probably but ½lb., the resultant circumferential velocity is one that is easily dealt with in practice, say 2,400 revolutions per minute, which allows direct coupling. On the other hand, if all the energy is absorbed in one wheel, the resultant circumferential velocity gets beyond practical control. In the Laval turbine, its 30,000 revolutions per minute must be reduced by gearing when practically applied; this limits security from breakdown to machines within and up to 100 h.p., beyond that disaster follows. In the Parsons turbo-generator the centre of gravity of the moving mass coincides with the centre of the figure or the geometrical centre of gravity on account of the provision made for lateral displacement.

At the present time 10 large towns in this district, including Newcastle, Gateshead, Sunderland, South Shields, Tynemouth, Wallsend, Middlesbrough, Stockton, Darlington, and West Hartlepool, have either electric power-houses in active operation or in course of rapid construction. But I cannot stop to say much of them except the pioneer ones of Newcastle-on-Tyne. In this city we have two services—that of the Newcastle and District Electric Lighting Company, projected by the Hon. C. A. Parsons late in 1888, and that of the Newcastle-on-Tyne Electric Supply Company, projected by Dr. Robert Spence Watson in 1881, but not brought to a practical issue until 1888. Taking Parsons's Company first, the original turbo-generators are employed at a speed of 4,800 revolutions, the later machines only 2,400 revolutions with a pressure of 1,050 volts and a frequency of 80 periods. Last year the company generated 1,571,650 units, sold 963,622 units, and the peak reached 756 amperes upon an installation of 1,490,130 watts, the number of consumers being about 400. The Newcastle-on-Tyne Electric Supply Company's plant is the very antithesis of that of its companion company, the "District," where, as described, it is light, having velocity and elasticity in lieu of momentum or inertia of mass. That of the "Supply" is slow moving and heavy—

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horizontal compound long-stroke Corliss engines of 70 to 80 revolutions and Mordey dynamos up to 150 kw. each. The engines, which are by Robey and Co.'s well-known make and fitted with their triple-expansion gear, have performed admirably, as it will be acknowledged by all present when I state the following facts: That during the 11 years' working no main bearing cap on any engine has been lifted and no new part has been supplied, excepting piston rings, and all the engines are now in first-rate working condition. The steam consumption may be said to average 16lb. with the low vacuum of under 20in., the larger units, of course, giving the best results. Similarly, the Mordey uniphase dynamos (2,100 volts) have been equally successful. They are nearly self-regulating, the larger units being the most satisfactory. As is well known, they are remarkably efficient, having the characteristic of steadiness under all loads. In 1899 the company generated 1,517,311 units for the supply of an installation of 1,924,680 watts, reaching a peak of 416 amperes upon a sale of 990,551 units, the number of consumers being nearly 1,000. Both companies use rubber cables, the "District" using a complete network of high-tension single cables in iron pipes, and the "Supply" a network of concentric cables in iron pipes. Rubber-insulated cables, if not starved and treated properly, either wholly concentric or wholly single pairs, in a uniform atmosphere and a uniform mechanically protective environment give little trouble. Both companies have cable 10 years old still doing excellent service. Both companies are developing direct low-tension services in congested places. Dr. Watson's company has two accumulator sub-stations—one in operation, another on the eve of practical employment. They are experimental. If successful, both technically and commercially, they will mark an important step. Accumulators may be charged when there is no other use for the machinery and employed to take the peak off, and above all, during use, the running machinery possible troubles are absent. The transformation losses are roughly comparable with the transformation losses in central distributing power-house schemes. Though so divergent in system, both companies' commercial success is nearly the same.

What is the public to think who do not look below the surface when they observe, however wide the variations in the electrical means to an end, the results are apparently the same. Like Max O'Rell, when speaking of nations, we must not at present say that one system of electric lighting is better than another, but that they are different. Clearly, a variety of conditions demands a variety of applications; nevertheless, it is only a question of time—the fittest will survive eventually, and standard methods will crystallise. 'Twas said of fascinating Cleopatra, "Age cannot wither her, nor custom stale her infinite variety." So it is with fascinating Electricity, with a difference—disaster does not follow her lovers; the British public pay the bill. Nowadays, when electric supply is an assured success, everyone can go to work with confidence, if only over-capitalisation is avoided. This is in the first degree the active danger of municipal undertakings governed by committees—all experts, of course. The need for dividends acts as the check in company undertakings; it tends to ensure both economy in capital, in production, and in maintenance. Production to serve a wide area of many needs assures continuity of load. This assures economy of production. An average of less than two hours' daily use of all the machinery in established pioneer stations brings 8 per cent. dividend. But suppose we build anew on the experience gained. Cease to put down what now may be considered toy machines all in a row, and tobacco-pipe chimneys, jealously watched by vigilant smoke inspectors catching the specks upon sheets of white blotting paper. Emulate the courage of the Americans, the Swiss, and the Continent generally. Don't adopt expediency, either as to site or anything else; then that peace of mind which belongs to solid far-seeing work overtakes the engineer and his friend the capitalist. They may smoke the pipe of peace with the imperturbability of a Turk, and wait. It must come. Every house will eventually have its electric light as it will have its telephone. Purity, steadiness, and convenience save its extra nominal cost over other illuminants now, and continuous production will reduce gas companies' dividends from lighting alone to something exceeding small by-and-by. Hence the future of the electrical engineer augurs happily—he, the maker of this good thing, who only the other day, and, alas! even now, is so lowly rewarded for his labours as not to be lauded by his neighbours.

On the distribution side of the question there is a danger. A large central power-house, if there is to be economy, means high-pressure alternate-current transmission of, say, 50 periods uniphase, if it will do (by no means improbable in the near future), and more phases if it will not, to as near the point of consumption as possible. Large low-tension services are to be deprecated, especially where coal is cheap. The fewer the transformations the better, and preferably of the static than of the dynamic order. In other words, do not have moving parts demanding human watchfulness, except where it is imperative, as for straight currents for electro-chemical work. Alternating currents needing no brushes will do all the rest. This may be rank wickedness to some trade interests, but it is the goal. Simplicity is what is wanted, not complication. There must be a point where the cost of long-distance transmission overtakes the economy of centralised production. That point has to be determined; our grandmother, the Board of Trade, will have something to say about that. We are not as free as the winds as in Switzerland, where a dab of red paint on an insulator on a pole supporting multitudinous services marks sudden death if disregarded, locating as it does the extra high-pressure service, and where magistrates rightly treat the idle breaking of an insulator as a crime, thus acting for the public interest as the British Post Office does when a penny letter is stolen. But the great unpaid treat insulator breaking as a pastime: "Oh, you playful boy, don't do it again," or a nominal fine, is all that happens. Motive power by electrical agency is as convenient as going to the poulterer for your ducks, instead of keeping your own duckpond. It is this principle that makes for success with power work. Nothing can stop it. What so cleanly, so simple, as getting all that is needed by turning on a tap. No space is occupied by a steam plant, no capital locked up in its purchase, and no standing charges in its maintenance. There is no waste during holidays or strikes, and one care the less is borne by the user. This is the age of specialists, another name for the division of labour—without them the work of the world would not go on. Scatteration of effort is dissipation of energy. The user with the specialist at his elbow is relieved mentally, thus brain power is released for concentration on his own speciality. What stands in the way is the loss at parting with a still useful old friend in favour of the new. It is the house-wiring question over again. Credit wiring in the latter case at an enhanced cost in current to the user until the capital is recouped is one solution. Similarly the development of good motors has reached that stage that their hire and subsequent purchase will accelerate their adoption and eventual universal use. To produce confidence, all that is needed is wise selection and judicious application.

Of electric traction one can speak as eulogistically as of the bicycle. It is the cheapest, pleasantest, and most healthy in its effects of all road locomotion. No loss of time at terminals, a travelling station that passes one's door. One halfpenny per mile in general and one farthing for workmen's cars. Happily, now it is booming in this country, and one sighs with relief that at last our conservatism has been broken down, and we shall soon be as our colonies and other civilised nations are. Only build strongly, make a good sightly workmanlike structure, looking as if it fitted its purpose, then the cry of the æsthetic will cease and the cloud of the benighted disappear. I would like to express my unqualified condemnation of the extremely short-sighted policy of not starting with a double track right away in the busy towns of this district. It is only excusable when there is a lack of width, and that is rare. The imperturbability of the Turk will not overtake the exploiters or running engineers of that class of work. If they think so, as remarked in effect by the *Times* when prompted by Lord Salisbury's criticism of Treasury control of the War Office, they must be possessed of that incurable self-complacency that overtakes the public services of Great Britain.

Another word and this retrospect is done. The result of a circular I sent out to ascertain the number of persons employed on electrical work in this district gives the following approximate figures: telegraphs and telephones, 3,900; electric supply companies, 335; manufacturers, 2,400; installers, 219; sundry employment, 146—total, 7,000.

DEVONPORT.

The following are the wiring regulations issued by the Devonport Corporation:

Save as hereinafter provided, all the work upon consumers' premises to be carried out in accordance with the rules of the Institution of Electrical Engineers, and of the company in whose office the building is insured.

Service Mains.—Provided that the length of line is not more than 60ft., the Corporation will at its own expense lay the necessary electric service mains to the premises of any consumer entitled to be supplied with energy up to a cut-out box to be fixed in a position suitable for the insertion of the consumer's house mains.

Cut-Out Box.—The cut-out box will be fixed at a point on the consumer's premises nearest the Corporation service manhole, and will remain the property of the Corporation and in their sole charge.

House Mains.—The mains from the Corporation cut-out box into the house, when passing through damp walls or out in the open, must have an insulation resistance of 2,000 megohms per mile for rubber insulation, and 800 megohms for compound or other special insulation, and must be laid in metal casting or other approved manner. Sufficient length of cable in the house mains must be left for the insertion of the meter.

Circuits.—The house mains after passing through the meter are to be taken to the distribution boards, and there divided into such branch circuits that each pair of fuses do not carry more than the equivalent of 10 8-c.p. lamps.

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Main Service Switch.—Main service switch at the entrance of each house of the service cable. A main double or treble pole quick-break switch (of a type to be approved by the borough electrical engineer) to be provided and fixed at the cost of the consumer. Switches of the single-pole type cross-connected by means of an insulating bar and handle, and mounted on separate basis, make the best arrangement for main switch. Where main switches are protected by one cover, a dividing slip must be fixed between the insulating bases.

Conductors.—Conductors to be of pure copper and of such sectional area that the current in them shall not exceed 1,000 amperes per square inch, the area of conductors to be so proportioned to their length that the fall of pressure between the service mains and the furthest lamp shall not at times of full load exceed two volts. All conductors larger in sectional area than No. 18 S.W.G. to be stranded. No conductor at a less total area than No. 18 S.W.G. to be used except in the case of flexible cords, which may be equal in section to No. 20 S.W.G. Flexible cords to have waterproof insulations. All copper conductors must be tinned if the insulation is vulcanised.

Insulation Wiring and Fitting for High-Voltage Supply.—The insulation resistance of wire used not to be less than 1,000 megohms per mile for rubber insulation, and 600 megohms per mile for conductors insulated with compound or other special insulation. Wires fixed in such positions as to be liable to damp to be placed in metal casing or other approved protecting medium. The covers of all casings to be screwed and not nailed down. Conductors must not be fixed by means of metal staples unless the wires are insulated and sheathed with lead or other metal covering throughout their length. Joints will not be allowed in wires which are to be buried in casings or walls. Throughout the system one main or wire to be coloured black and the other red. No disused circuit is to be allowed to be left with the current on the wires, but must be cut off close to the mains or at the distribution board. The wiring of gas fittings is expressly prohibited unless the gas supply pipe is absolutely cut away from the gas fitting.

Fuses.—Fuse boxes, except under special circumstances, must not be fixed on the consumer's premises at any other points in the system than on the distributing boards, near the ceiling roses and switches, branch fuses in all cases to be of the single-pole pattern, one to be fixed on each lead, and no type of fuse having less than 1½in. clear break will in any case be permitted. (The types of fuses having small round close-fitting covers must not be used, as at a pressure of 230 volts, when a fuse thus enclosed is melted by a short-circuit, the cover is blown to pieces; fuses therefore must be used that give a large air-space between the fuse wire and its cover.) Double-pole fuses will not be permitted under any circumstances. All fuses and distribution boards must be fixed in perfectly accessible positions. All fuses to be of pure tin wire with metal terminals soldered to the fuse wire. Fuses composed of copper will not be allowed. Every fuse must be carefully adjusted so that it will melt at 50 per cent. above the normal current it has to carry. Each wall plug installed shall form one independent circuit from the distribution board, and no plug shall carry current for more than six 8-c.p. lamps or their equivalent.

Switches.—No double-pole switches on one base will be allowed. All switches employed should be of the double-break pattern. Switches having metal covers or metal handles must have special precautions taken to insulate both these parts from any portion of the circuit. Key sockets or switches attached to lampholders will not be allowed. Ceiling roses, lampholders, etc., must have a projecting slip to divide the terminals of opposite polarity. Installations requiring a supply of 50 amperes and upwards to be wired on two circuits for connection to a treble-pole service with supply through two meters.

Motor Circuits.—Motor circuits must be wired quite independent of the lighting circuits in all installations, and special arrangements made for connection to the supply mains.

Final Tests.—When the wiring of premises has been completed the Corporation will test the insulation at full working pressure of 230 volts, and the current will not be turned on if the insulation resistance is below the following standard: for 12 lamps, 5·0 megohms; for 25 lamps, 2·5 megohms; for 50 lamps, 1·5 megohms; for 75 lamps, 1·25 megohms; for 100 lamps, 1·0 megohm; for 150 lamps, 0·75 megohm; for 200 lamps, 0·5 megohm. Previous to a test being made by the Corporation every fuse in the whole installation must be inserted, all switches turned on, and the lamps removed. A test for insulation between the wires will then be made, and in no case must this installation fall below 7,500 ohms. The Corporation may refuse to supply current to any installation if the above tests are not complied with, or through any temporary wires or fittings, or if the work be not carried out in accordance with the conditions and regulations herewith.

Leakage.—In the event of the insulation resistance of an installation falling below 5,000 ohms after a supply has been turned on, and if the Corporation's servants are not allowed to find or remedy the fault, the whole of the installation will be cut off until the fault has been put right. Any expenses the Corporation are put to in finding and remedying such fault are to be repaid to the Corporation by the consumer.

Increase of Lighting.—In the event of an increase in the lighting of an installation after a supply has commenced, necessitating alterations or additions to the wiring, notice in writing to the Corporation must be given, and all such work will be tested by the Corporation when finished prior to turning on the increased supply. Failure of such notice may render it necessary for the Corporation to cut off the whole installation.

Note.—The Corporation will make one test only free of charge. If it is found that the work is not ready, or if it fails to pass the test, a fee of 10s. 6d. must be paid at the Corporation engineer's office before a second visit can be made. The above tests and inspection are for the purposes of the Corporation supply only, and does not attach any responsibility for the efficient and proper carrying out of the installation on a consumer's premises whether tested and passed or not.

Notice to Test must be made in writing to the borough electrical engineer on the contractor's completion form supplied by the Corporation at least 24 hours before such test is required, and the installation contractor must be represented during such test, to prevent any delay or trouble in obtaining a supply. Contractors are recommended to satisfy themselves by testing the installation before applying to the Corporation. No date for supply should be given by contractors without first referring to the Corporation. All communications and appointments should be made in writing to the borough electrical engineer, who will give all information respecting the supply of electricity and the position of the meter on the consumer's premises.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

277. What are the general principles that should guide in the selection of units for a central station?—B.

278. How would you proceed to work out the sizes of feeder cable required for a tramway route, the furthest point of which was four miles in a straight line from the power station, the drop in voltage not to exceed 20 volts, two trolley wires 00 size being used, and a car service of 10 minutes, using 70 amperes at 500 volts per car?—MAGNET.

ANSWERS.

Question No. 271.—What is the most convenient and practical method of carrying out tests on the heating, voltage drop, and insulation of a transformer with the usual apparatus available in a central station?

[The first two answers to this question are considered of equal value.—ED. *E. E.*]

Answer to No. 271 (*awarded 7s. 6d.*).—The following tests on transformers can be carried out with the usual apparatus available in a central station.

A. *For Heating.*—Small transformers can be run directly off the high-tension mains, their secondaries being loaded to their full capacity by means of a bank of incandescent lamps or a water resistance. An ammeter should be placed in circuit with the secondary winding, and a voltmeter across the secondary terminals. The bank of lamps or resistance should be adjusted so that the current multiplied by the secondary voltage equals the maximum output. A thermometer with flat bulb should be placed as far in the transformer as possible. A second thermometer, previously compared with the transformer thermometer, should be hung in the room. The difference between the two readings after running for the prescribed time gives the temperature rise of the transformer, which should be compared with the rise guaranteed. For large transformers this method is unsuitable, as too much current would be wasted. A good plan is to put the primary of the transformer on the station lighting (secondary) circuit. The transformer secondary should have an adjustable resistance in series similar to that described above. The secondary current should be adjusted to the same value that it would have if the transformer were giving its full output running on the high-tension mains. If anything, the current should be slightly excessive. Comparative readings are taken of the thermometers in the transformer and room. It will be seen that this method only takes into account the C^2R

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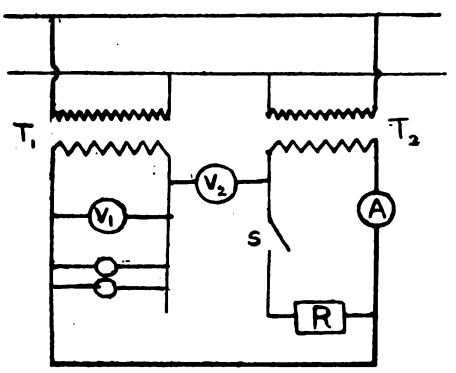
losses in the copper, the iron heat being practically nil owing to the greatly reduced voltage of supply. This can be allowed for (*a*) by comparing the temperature rise obtained in this test with that given by a similar test on a transformer of the same size and type which is known to be within the heating limits. (A reference table of values to be added to obtained temperatures can be constructed from a series of such tests on different sized transformers.) (*b*) By running the transformers first for, say, two hours with an excess current as above, then for another two hours on full primary volts and open secondary, and so on till the time of test is completed, closely approximating to actual running conditions. The transformer should not, of course, be exposed to draughts.

B. *For Voltage Drop.*—It is useful to know this (*a*) on a non-inductive load, (*b*) on an inductive load. For the first a neat method is shown diagrammatically. T_1 is the station lighting transformer. The test should be performed in the day, when no station lights are on and full secondary volts are on T_1. T_2 is the transformer to be tested. Its primary is run from the high-tension 'bus bars. V_1 is a



voltmeter showing voltage of station supply, which must be kept constant. V_2 is a low-reading voltmeter. The ends of T_1 and T_2 in phase with one another are connected through this voltmeter, the other ends are connected by a thick cable. R is an adjustable non-inductive resistance. S is a main breaking switch; A is an ammeter. With S open adjust needle on V_2 to zero, or else note any deflection shown. Close switch, and note the steady deflection on V_2 after adjusting R to obtain the required reading on A. This will give the potential difference between the terminals of the voltmeter, and show the voltage drop on the transformer at that load. This is a more sensitive method than that of having a full-range voltmeter on the transformer terminals. The same method is adopted for an inductive load, such as arc lamps, in place of R, the drop being, of course, greater.

C. *For Insulation.*—Some engineers pin their faith to some definite value of insulation resistance between primary and earth (or transformer case), secondary and earth, and primary and secondary. If the engineer be of this persuasion, the insulation test can be carried out with a cable-testing set, either Silvertown or Kelvin or with an ohmmeter and generator set. Of the three sets the last mentioned is probably the most convenient for ordinary work, as it is very portable. If accuracy is desired, a Silvertown set arranged for insulation resistance test can be used. The test should be taken while the transformer is hot—say, just after the heating test—in order to have a normal working condition. Insulation resistance, however, varies unaccountably and within wide limits in a transformer, without endangering its reliability. Hence an insulation resistance test on any particular transformer is only useful taken in conjunction with a series of other periodic tests on the same transformer, preferably plotted as a curve. The best test to employ previous to setting a transformer to work is to subject the insulation round the windings to an alternating pressure of, say, four times the working pressure. For this purpose it is worth while buying a small transformer of, say, 2 kw. capacity with a transforming ratio of 1 : 4, and capable of standing a voltage in its low-tension winding equal to the high-tension station voltage. This can then be used with its low-tension coil on the station primary or secondary bars, and its high-tension coil on the transformer primary or secondary coil to be tested. A 10 minutes' test in this fashion is usually quite long enough.—J. A. S.

Answer to No. 271 (*awarded* 7*s.* 6*d.*).—The different tests can best be treated under separate heads:

1. *Heating.*—The transformer should be run at full load—*i.e.*, full secondary amperes and volts—at the correct periodicity for a period varying from about three hours for a 1-kw. transformer to six hours for a 20-kw. or 30-kw. one. The temperature should then be measured by thermometers placed at various points on the transformer and held in position (covered by a pad of waste) for several minutes, until the maximum temperature is reached and the thermometer commences to fall again. Sometimes it is considered better to measure the temperature by means of the change in resistance. The average temperature of the winding can be obtained by measuring the resistance of, say, the primary winding when cold (= R ohms), and again when hot after the test (= R′ ohms). Then, if T deg. F. be the temperature of the room when the measurement, R, was made, the final average temperature of the winding will be given by $T + \left(\frac{R' - R}{R} \times \frac{100}{\cdot 21}\right)$ in degrees Fahrenheit, the term within the bracket being the temperature *rise*, allowing the usual temperature coefficient for copper of ·21 per cent. increase per 1deg. F. rise. The temperature rise of a good transformer should not exceed 70deg. F. or 80deg. F. if measured by thermometer, or 90deg. F. to 100deg. F. if measured by resistance. There is no reason why the heating test should involve any serious waste of energy, for instead of loading the transformer up on a resistance frame, or on a water resistance, the output can be taken up as a highly inductive load by means of a choking coil without in any way affecting the accuracy of the test. The necessary choking coil can be readily made up of a core of a bundle of straight lengths of iron wire, or of thin sheet-iron strips, with a coil of wire or cable wound about the central part of the core, leaving several inches of core projecting out at each end. The cable should be of sufficient section to carry the full output current of the transformer under test at a current density of 1,000 to 1,500 amperes per square inch, and the number of turns can be best adjusted by experiment. Such a coil in series with a small water resistance for adjustment, will be found most convenient.

2. *Voltage Drop.*—This can be roughly measured by taking simultaneous readings of primary and secondary volts, first at no load and then at full load. The difference between the no-load and full-load secondary volts, both reduced to the same primary voltage, is, of course, the drop, but from the nature of the test (two large quantities being measured in order to obtain their difference, which is, relatively, a very small quantity) no great accuracy is obtainable. When any considerable number of transformers has to be dealt with, it is by far the best plan to keep a small standard transformer—of, say, 1 kw. or 2 kw. output—in the station, and to determine its curve of voltage drop accurately once for all, either by repeated independent measurements of terminal voltage as above, or, better, by means of the short-circuit test described in the answers to Question 125 in the *Electrical Engineer* for Jan. 6, 1899. This transformer can then be run in parallel with the transformer whose drop is to be determined, and the load (taken upon a water resistance or resistance frame) can be increased until the new transformer is giving its full load. The current then given by the standard transformer corresponds to a certain drop, read off its drop curve, and this drop is also the drop of the new transformer from no load to full load. The drop on transformers of all sizes should not exceed 2½ to 3 per cent.

3. *Insulation.*—The only reliable insulation test is a high-volt one. Transformers should stand a pressure of at least double the primary voltage from primary winding to core and from primary to secondary winding, and the secondary winding should be tested with at least double the secondary voltage to the core. To obtain the high-test voltage of, say, 4,000 volts, a special high-pressure transformer of 5 kw. or 10 kw. capacity is usually employed, this large

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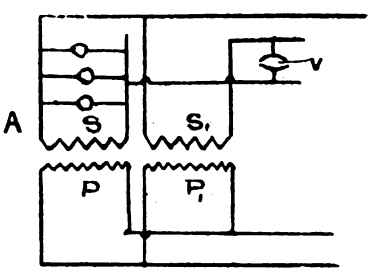
capacity being necessary in order to ensure the full pressure being maintained even when a small current passes through the insulation.

4. *No-Load Loss.*—Though not mentioned in the question, this is an important point, and its amount should be measured on all transformers before putting them to work on the circuit. For this purpose a wattmeter of some description is necessary, a reading of the primary watts with the secondary on open circuit giving the required amount, which should not exceed about 35 watts on a 1-kw. and 300 watts on a 30-kw. transformer.—Q.

Answer to No. 271 (*awarded* 5*s.*).—The most satisfactory way of measuring the voltage drop in a transformer is by comparison with a standard transformer whose drop curve has been carefully determined. Under conditions specified such a method is probably out of the question. The method which remains to be adopted is the following: A voltmeter—electrostatic by preference—is connected across the secondary circuit, and a reading is taken when the voltage in the primary circuit is known. This primary voltage is kept constant. Meanwhile, the load on the secondary side is brought up from nothing to full load, frequent readings of the voltage across the secondary circuit being taken. This process is repeated several times, and a curve of the mean values is plotted out. This curve will show with sufficient accuracy the performance of the transformer under varying conditions of load.

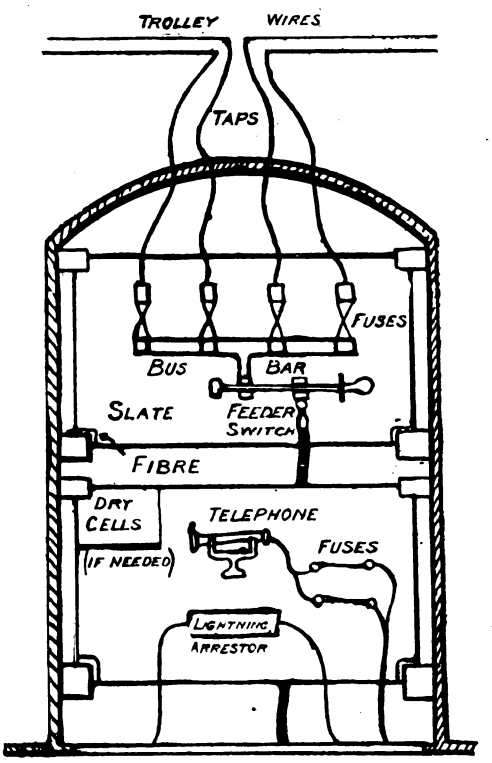
If two identical transformers and a low-reading electrostatic voltmeter are available, the above results may be checked as follows. Connections as shown in diagram: A is transformer under test; V, low-reading electrostatic



voltmeter. Readings are taken, as before, on voltmeter, V, during the increase of the load on the transformer. These readings give the difference between the pressures of the unloaded and loaded transformers, which is the secondary drop As the relative values are not affected by any variation which might occur in the applied primary voltage, a likely source of error is thus eliminated. To measure the heating, a thermometer should be suspended inside the case, with the bulb resting against the coils. The lid is then fixed in position, and the transformer given a run of about two hours under full load. At the end of this time the temperature should not have risen above 150deg. F. There is no hard-and-fast temperature limit, as that depends upon the durability of different classes of insulation under conditions of heat. It is usual, however, when ordering transformers to specify the permissible losses, which, of course, must get away as heat. The insulation may be tested by the portable testing set used on the mains, etc. The generator should give at least 500 volts. Insulation resistance should be taken between primary and secondary coils, and also from coils to case. As high insulation resistance is not always a guarantee of ability to withstand disruption, the transformer should be subjected to a maintained pressure of at least double the working value from coil to coil and between coils and case. This double pressure may be stepped up by means of two of the ordinary transformers having their secondaries in parallel off the low-tension mains and their primaries in series.—P. S. T.

Question No. 272.—Give sketch and detailed description of a good form of "section" street pillar for tramway work.

Best Answer to No. 272 (*awarded* 10*s.*).—The appended sketch shows a simple form of cast-iron pillar for connecting a traction feeder with a double trolley wire system on each side. The pillar has two doors—one for access to each panel. These and the ornamental beadings are not shown. Brackets are cast on the inside to hold the slate panels, and vulcanised fibre is used to bed them. The trolley taps come in at the bottom, and are fed through separate fuse terminals to a 'bus bar. There is a switch between this 'bus bar and the feeder terminal, and a separate contact piece for each of these ensures that no current passes through the switch pivot. A quick break is obtained by having a spiral spring between the handle lever and the contact lever. The fuses are preferably enclosed in porcelain handles with contact pieces each end,



so that any fuse can be replaced with safety without switching off the lot. The lower panel contains a lightning arrester and a telephone set for communication with the works when fuses blow, etc.—J. H. C. B.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Shoreditch.—The Vestry invite tenders for various plant at Whiston-street station. Tenders by 19th inst.

Newington.—The Vestry invite tenders for the supply and laying of electric mains, etc. Tenders by 15th inst.

Dudley.—The Corporation invite tenders for Section H, free wiring contract. Tenders by June 15. Details in our advertisement columns.

Stockport.—The Gas and Electricity Committee invite tenders for the supply of two water-tube boilers for their electricity station at Millgate. Tenders by 13th inst.

Blackpool.—The Corporation invite tenders for the electrical equipment of 15 single-truck tramcars. Tenders by June 18. Details in our advertisement columns.

Larne.—The Urban District Council invite tenders for lighting their district by coal or acetylene gas or electricity for three years from Aug. 1. Tenders by June 18.

Manchester.—The Tramways Committee invite tenders for the overhead equipment of three routes of tramways. Tenders by June 9. Details in our advertisement columns.

Nelson.—The Corporation invite tenders for the supply of storage battery and switchboard for their electricity works. Tenders by June 12. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the supply of two sets of switchboards and instruments for 4,000 amperes each. Tenders by June 12. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the excavator work required in the construction of Section No. 2 (north) of the new generating station at Port Dundas. Tenders by June 11.

Egremont.—The Wallasey Urban District Council invite tenders for the maintenance of the electric installation on their steamers for 12 months from July. Tenders by noon on June 12.

Croydon.—The County Council invite tenders for engine foundations and for joists and flooring at the electric light station, Factory-lane, Croydon; also for the supply of coal. Tenders by 14th inst.

Bury.—The Art Gallery Committee invite tenders for the electric wiring of the art gallery and free library situate within

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the borough. Tenders by 18th inst. Details in our advertisement columns.

London, S.E.—The Bermondsey Vestry invite tenders for the supply and laying of insulated electric mains, conduits, junction boxes, etc. Tenders by noon on June 18. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for outside coal storage and steel structure for coal handling, and locomotive travelling cranes for outside coal handling. Tenders by June 21. Details in our advertisement columns.

Bootle.—The Corporation invite tenders for the supply and laying of underground electric cables, the erection of arc lamps, and the supply of mechanical stokers. Tenders by June 16. Details in our advertisement columns.

Newcastle-on-Tyne.—The New Tramways Committee invite tenders for the erection of new generating station and tall chimney at Melbourne-street. Tenders by 10th inst.

Crewe.—The Town Council invite tenders for the wiring of the municipal offices, market hall, and corn exchange, and for supplying lamps and fittings for electrically lighting the same. Tenders by June 11. Details in our advertisement columns.

Bradford.—The Corporation invite tenders for the supply and erection of a switchboard for a pressure of 500 volts, or for alterations to existing switchboard, at their electricity works, Valley-road. Tenders by June 14. Details in our advertisement columns.

Wolverhampton.—The Tramways Committee invite tenders for the construction of tramway track and contingent work in Dudley-road, Cleveland-road, Bilston-street, Piper's-row, and Fiveways, amounting to a route length of about one mile seven furlongs, mainly double track. Tenders by June 26.

London, S.W.—The Asylums Committee of the London County Council invite tenders for (1) the installation of electric lighting and power (except generating plant); (2) the installation of telephones, tell-tale clocks, fire-alarms, and call bells at the Horton Asylum, near Epsom, Surrey. Tenders, endorsed "Tender for Electric Lighting. Horton Asylum," or "Tender for Telephone, &c., Installation, Horton Asylum," by 10 a.m. on June 16. Details will be found in our advertisement columns.

Sutton Coldfield.—The Corporation invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, etc., pipework, etc., in engine and boiler house, three steam dynamos (vertical enclosed high-speed engines) and motor boosters, storage batteries, main switchboard and connections, eight-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed) and posts, and station lighting. Tenders by June 21. Details in our advertisement columns.

Alexandria.—Tenders will be received at the Central Office of the Administration of Ports and Lighthouses, up to 12 noon on July 1, for supply of the whole or part of an electric generating machine for the Port Said lighthouse, and the tools for the lighthouses workshop at Alexandria. Persons wishing to tender can consult the conditions of tender and the specification, on all days on which public offices are open, from 9 a.m. to 1 p.m., at the office of the Administration of Ports and Lighthouses, Alexandria. Copies of conditions and specification can also be had on application to the Controller-General of Ports and Lighthouses, Alexandria. Tenders must be submitted on stamped paper and addressed to the Controller-General of Ports and Lighthouses, Alexandria, in sealed envelopes, bearing the inscription "Tender for the Supply of Electric Generating Machinery for Port Said Lighthouse," or "Tender for the Supply of Tools for the Lighthouses' Workshop, Alexandria."

Durban.—The Corporation invite tenders for supply, delivery, and erection of materials under the three following sections: (Part A) comprising the supply, delivery, and erection of the entire overhead equipment for about 16 miles of equivalent single track, including poles, overhead trolley wire, distribution boxes, etc.; (B) comprising the supply, delivery, and erection of 22 double-deck motorcars, complete; (C) comprising the supply and putting into working order of a complete steam and electric generating plant in a power station to be built by the Corporation, including three 250-kw. direct-coupled generators, boilers, condensers, cooling tower, switchboard, etc. Parts A and B will not be separated, but will be let to one contractor. Part C may be let separately. Preference will, however, be given to a contractor who will undertake all three sections, and a separate form of tender for all three sections will be supplied. Specifications, bills of quantities, forms of tender, and lithographic drawings may be obtained on application to Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation, on and after 29th inst. A deposit of £10. 10s. must accompany application for specifications and forms of tender. The deposit will be returned on the receipt of a bona fide tender. Sealed tenders, in duplicate, under separate cover, in specially-provided envelopes, to be delivered to Messrs. Webster, Steel, and Co., by June 29, or to the Town Clerk of Durban by mail delivery on or about July 23. The successful tender will be accepted by cable from Durban.

RESULTS OF TENDERS.

Dundee.—The Town Council have accepted the tender of R. W. Blackwell and Co., Limited, at £583. 7s. 4d., for the supply of copper bonds.

Gloucester.—The furniture required for the offices at the electricity works is to be obtained from Matthews and Co., Limited, the cost being estimated at about £96.

Burnley.—The Corporation have accepted the tender of the Callender's Cable and Construction Company, Limited, 90, Cannon-street, London, E.C., for cables, at £352. 2s. 1d.

Aberdeen.—The contract for painting the centre and side poles and span and guard wire rosettes on the Woodside section of the tramways has been given to A. Brown and Son, at £66. 15s.

Dundee.—The Town Council have accepted the tender of Lowdon Bros. and Co., Dundee, at £1,063. 5s., for supply and erection at the electric station of a traction switchboard and equipments.

Dundee.—The Town Council have accepted the tender of the Callender's Cable and Construction Company, Limited, London, at £3,695. 18s. 1d., for the supply and delivery of feeder mains, joint-boxes, and underground conduits for tramway purposes.

Heywood.—The Town Council have accepted the following tenders: C. Dennis, Bury, Lancs., construction and erection of chimney shaft, 120ft.; D. Diggle, Bamford-road, Heywood, electric light station, comprising engine-house, boiler-house, battery-room, offices, and stores.

Dundee.—The Gas Commissioners have accepted the following tenders for supplying cables and laying down a system of distribution mains on the "solid system" within the burgh: British Insulated Wire Company, Limited, Prescot, material and laying, £8,523 18s. 1d.; Callender's Cable and Construction Company, Limited, London, vulcanised bitumen cables, £2,415. 8s.

Heywood.—The Corporation have accepted the tender of Crompton and Co., Limited, Mansion House-buildings, London, E.C., for the supply and erection of Lancashire boilers, economiser, pipe work, feed pumps, two steam dynamos, balancer booster, travelling crane, storage batteries, switchboard connections and station lighting, underground mains and feeders, and meters.

BUSINESS NOTES.

TRACTION.

Colchester.—The Town Council have decided to apply for a tramway provisional order.

Leicester.—The tramways deputation's Continental tour gave rise to a stormy discussion last week. The amount of the bill for expenses was nearly £900.

Glasgow.—At a meeting of the Tramways Committee it was agreed to recommend an increase of salary of £150 to Mr. Young, the tramway manager, making his salary £1,400.

Farringdon-street Tramways.—The Court of Common Council on Thursday week decided not to assent to the London County Council's scheme for conduit tramways in Farringdon-road and Farringdon-street.

Halifax.—Mr. A. P. Trotter on the 6th inst. inspected the new section of the Corporation electric tramways to Stump Cross, *vid* New Bank. The inspection proved satisfactory, and a service of cars was commenced.

Durham.—At a meeting of the City Council on the 6th inst. the clerk reported the receipt of the usual parliamentary notices given by the British Electric Traction Company, who propose to run trams through certain parts of Durham. The matter was referred to a committee.

Aberdeen.—At the meeting of the Town Council on Monday the Tramways Committee reported that one horse car was being electrically equipped from spare parts belonging to the Corporation, and that two other cars were being electrically equipped by the Glasgow Corporation. The report was adopted.

Staines and Egham Light Railway Co.—This Company has been registered with a capital of £1,000 in £1 shares, the objects being to carry on the business of constructors and proprietors of light and other railways and tramways, electrical and general engineers, electricians, suppliers of electricity, etc.

Hoyland.—The District Council have agreed to give their consent to a scheme proposed by the British Electric Traction Company, whereby the tramways are to be brought into the township. The intended line will be an extension from Worsborough Dale, and will run *vid* Birdwell and Hoyland Common into Hoyland as far as the town hall.

Hull.—The Spring Bank section of the Hull Corporation electric tramways was opened on Saturday morning. When the connection over the North-Eastern level crossing at Botanic Gardens Station is made, the section will form with Beverley-road (which has just been commenced) almost a complete circle covering a very large area of the city.

Blackpool.—The tramway extension through Claremont Park to the Gynn was inspected on the 28th ult. by Colonel Yorke, R.E., and Mr. Trotter, who gave their permission for the Corporation to work the trams until the usual order came from the Board of Trade. The new line has since been most extensively patronised. Penny stages have been introduced.

Crewe.—The tramways question was discussed at Wednesday's meeting of the Town Council. It was resolved to make application to the Light Railway Commissioners for an order, and that the County Council and the Nantwich Rural Council be consulted in reference to the application. The borough surveyor was instructed to submit to the Council a scheme or line of route of the proposed tramway.

Derby.—The Tramways Committee of the Corporation have reported against the desirability of discontinuing the running of

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tramcars and omnibuses on Sundays. They also state that they cannot support either the suggestion that the drivers and conductors should be granted Good Fridays and Christmas Days as annual holidays. The committee have under consideration a petition from the drivers and conductors for a reduction of hours.

Fulwood.—The Urban District Council are prepared to lease the tramways to the Preston Corporation on the following terms—viz., that the Corporation pay as a rental therefor a sum equivalent to 8 per cent. on the cost of the present tramways in Fulwood, excluding the length in Victoria-road if so desired, and a further sum of 8 per cent. on the cost of the new tramway of tramways. The same matter with regard to Walton was also discussed at the last meeting of that Urban District Council, but nothing definite was arrived at.

Lincoln.—An agreement has been sealed between the Great Northern Railway Company and the Corporation, whereby the company abandon their opposition to the Corporation's Tramway Bill. We understand that the Corporation will have to pay £4,000, for which they obtain the widening of a street and a certain amount of land, the total of which was valued by one of the speakers at Tuesday's meeting at £1,000. On the other hand, it was pointed out that the railway company, in addition to handing over 661 yards of land, would allow the Corporation the right of crossing their level crossing by electric traction, and had agreed to remove the chapel standing on the land and erect another on a suitable site in the city.

Kinver.—The delay in the completion of the electric railway is coming to an end, the matters in dispute between the British Electric Traction Company and the Staffordshire County Council having been settled. The principal matter at issue was as to the track followed on the road between the Ridge, Wollaston, and the Stewpony. But there were also collateral matters to be adjusted. An appeal was made to the Board of Trade to pronounce on the matters that could not be arranged, and Colonel Yorke has been down this week and met representatives of the Staffordshire County Council and of the company, and also of Mr. P. H. Foley. Colonel York has stated what is to be done, and the line will probably be finished in two months' time.

Southport.—We learn from the *Southport Guardian* that the work of laying the lines and fixing the electrical equipment is rapidly approaching completion. With the exception of short isolated lengths the work is nearly completed, and the system should be ready for traffic in the course of six weeks, or even less. The work of building the cars is well forward, but the car sheds are barely commenced. The poles and overhead wires have proved to be far less unsightly than people had reason to expect. Manchester-road, however, where there is a complete double track, and posts on each side, has a somewhat busy appearance, and the network of wires at the junction of Hartwood-road is not exactly decorative in its effect.

Heckmondwike.—At the last meeting of the Council a letter was read from the British Electric Traction Company, Limited, pointing out that the Board of Trade had granted to the Batley Corporation an order, subject to confirmation by Parliament, to construct a tramline along Halifax-road in the borough of Batley. A proviso had been inserted providing for running powers being obtained by the company over the Halifax-road. The company intended petitioning against the confirmation of the Batley Corporation's order, and they asked the Heckmondwike Council to authorise the chairman and clerk to give evidence before the House in support of their proposed action. The Council decided to comply with the request of the company on the same terms as those agreed upon by Dewsbury.

Leeds.—On Wednesday a regular service of electric tramcars was instituted on the York-road route. The *Yorkshire Post* says: "The great increase of Whitsuntide tramway receipts in Leeds does more than indicate a fine holiday. It speaks of good management under an electric system. The greatest recommendation of such a system from the point of view of its earning power is that cars can be rapidly put upon a busy route at any moment, with little addition to the cost of working. The £3,000 earned by the Leeds tramways during four days is much more largely profit than it could have been a year ago, and what is more, a year ago the tramways were unequal to the task of earning it. The increases day by day were above 34 per cent. upon last year's record on Saturday, 66 per cent. on Sunday, 138 per cent. on Monday, and 84 per cent. on Tuesday."

Paddington.—The Vestry have adopted a report of the Works Committee recommending that the London County Council be informed that in so far as their tramway scheme is in accord with the consent given by the Vestry in 1891 to the tramway scheme of the Harrow-road and Paddington Tramways Company for extending their tramway from Lock Bridge to Edgware-road (involving the widening of the Harrow-road by Dudley-grove), the Vestry offer no opposition. Further, that the Council be informed that the Vestry is strongly opposed to the laying of the following tramways, as suggested in their scheme for 1900-1—viz.: (*a*) Edgware-road and Maida-vale; (*b*) Bishop's-road, from Dudley-grove to Queen's-road; (*c*) Inverness-terrace (single line); (*d*) Queen's-road (single line); (*e*) Uxbridge road, from Inverness-terrace to the western boundary.

Isle of Man Tramways.—Last week we gave a detailed account of the affairs of the Isle of Man Tramways Company. The committee of investigation met again last Tuesday, and we learn from the *Manchester Guardian* that something of a deadlock has occurred. At the opening of the meeting the minute of the resolution of the previous meeting was read, and its accuracy was challenged by the mover and others of the committee of investigation. The minute recorded that the resolution was to the effect that the time had arrived for the debenture holders to be called in, it being considered necessary that they should take action. The minute of the resolution was amended to meet the views of the proposer. A long discussion ensued as to the course to be recommended to the shareholders. The course advocated by the directors was opposed throughout by several members of the committee, who finally quitted the meeting without a resolution having been adopted.

Association of Municipal Corporations.—The conference of delegates of the Association of Municipal Corporations opened on the 2nd inst. in the Royal University Buildings, Dublin. The Right Hon. the Lord Mayor of Dublin presided at the opening. The Town Clerk of Huddersfield proposed: "That, in the opinion of this association, it is expedient that the Tramways Act, 1870, be amended so as to empower the Board of Trade, on the application of local authorities, to settle and make provisional orders for the construction and working of tramways beyond the districts of such authorities, provided that such tramways will form a connection with any tramways of such local authorities within or beyond their districts; that a copy of this resolution be forwarded to the Joint Committee on Municipal Trading and to the President of the Board of Trade." He said there was no sufficient reason why this procedure should not be extended to outside tramways. The Mayor of Southport seconded the resolution, which was supported by a number of speakers, and adopted.

Accidents.—The Vienna correspondent of the *Daily News* telegraphed on Tuesday night as follows: "A terrible accident is reported from Budapest to have happened to an electric excursion train near there on Monday. Auwinkel, in the Buda hills, is a favourite place with Budapest trippers. Where the electric railway starts from the station there is a steep descent, which cannot be taken unless all brakes are on. Between eight and nine on Monday evening the crowd of people, eager to get home, was so great that the guards could not keep up any kind of order. The rush to the carriages was terrible, and a passenger, it is thought, must inadvertently have taken the brake off. The train on being started flew down the rails for about a mile, when a sharp curve caused it to jump the metals and fall over on one side. When the unfortunate passengers were dragged out, four were quite dead, one died on the way to the hospital, and seven more are so much injured as to make death likely. Nearly all were more or less hurt." At Leeds during the holidays a child was run over and killed by an electric car. As it was supposed that the car was travelling at an excessive speed, the crowd vigorously hooted the driver and conductor.

LIGHTING AND GENERAL.

Epsom.—Ten thousand telegrams were dealt with at Epsom Post Office on Derby Day.

Cardiff.—The subway under the Ely, which was opened on Monday, is lighted by electricity.

New Address.—Messrs. W. T. Glover and Co., Limited, have removed to Trafford Park, Manchester.

Leith.—There is being fitted up at the Council-chambers, Charlotte-street, a recording voltmeter.

Fenton.—The Urban District Council have resolved to defer for the present the question of electric lighting and supply.

Mexborough.—Messrs. Hudson, Epworth, Barron, Gothwaite, and Platt have been added to the Electric Lighting Committee of the Urban District Council.

Kirkburton.—The scheme prepared by the Yorkshire Electric Power Company also embraces this district. No action has been taken by the Council in the matter.

Kendal.—The Electricity Committee have instructed Messrs. Handcock and Dykes to proceed with the preparation of plans, specifications, and estimates for the electric works.

Commercial Cable Co.—The directors have declared a quarterly dividend of 1¾ per cent., payable 2nd prox. The transfer books will be closed at 2.30 p.m. on 20th inst. until 3rd prox.

Wood Green.—The Light Railway Committee of the Urban District Council have been instructed to enquire into the question of electric light for the district with a view to an early report to the Council.

Fires.—Two fires broke out in Reading about four o'clock on the 31st ult. on the premises of Mr. Dewes, electrical engineer, and Mr. Jackson, general merchant. The damage done is estimated at many thousand pounds.

Beckenham.—A plot of land near Church-road, Shortlands, is to be purchased by the Urban District Council for the sum of £275. A small portion of it will be used for the erection of a transformer station, the remainder to be sold.

Greenock.—The Electricity Committee of the Police Board have selected the following short leet for the post of electrical engineer: H. R. Forbes Mackay, Edinburgh; W. M. Nelson, Greenock; and R. W. L. Phillips, Bristol.

Appointment Vacant.—In another column will be found a notice from the University College of North Wales stating that a Drapers' Company's assistant lecturer and demonstrator in electrical engineering is to be appointed at once.

Malton.—With regard to the difficulties between the promoters of the Malton electric lighting provisional order and the Urban District Council, we learn that the promoters have agreed to the Council's requirement to erect their works within the district.

Bangor.—Prof. Taylor Jones will begin in October next a systematic course of instruction in electrical measurement and

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practical electricity for students proposing to enter the profession of electrical engineer at the University College of North Wales.

Scothill Upper.—The District Council have received a letter from the Yorkshire Electric Power Company with respect to their proposal to supply electric lighting, power, etc., throughout Yorkshire, asking for the Council's support, but nothing has been done in the matter.

Hereford.—From the last report of the Electric Lighting Committee it appears that the loss on the working during the past quarter was £36, while the demand was so satisfactory that further machinery will soon be required. Moreover, the demand for gas had not suffered.

Stourport.—The Kidderminster and District Electric Lighting and Traction Company have asked the views of the Council as to supporting an application by the company for a lighting order for Stourport. The subject has been referred to the General Purposes Committee to report on.

Personal.—Messrs. Johnson and Phillips's Electric Cable Works inform us that Mr. T. M. Harvey has rejoined their staff.—We also learn that the office of Mr. G. R Peers, 96, Deansgate, Manchester, is now connected with the National Telephone Company's system, the number being 08507.

Electric Construction Co.—At a meeting of the first mortgage debenture-holders on Wednesday the International Assets Company, Limited, were appointed trustees in the place of the International Trustees Corporation, which latter company has been wound up and reconstructed as above.

Wear Electrical Engineering Company, Limited.—This Company has been registered with a capital of £5,000 in £1 shares, and the object is to carry on the businesses of electricians, electrical and mechanical engineers, makers of electrical apparatus and appliances, suppliers of electricity, etc.

Newington.—The recent failure of the electric light in several of the main thoroughfares was alluded to at the last Vestry meeting. Mr. Edwards (chairman of the Electric Lighting Committee) said the incident was one of those which were almost inevitable in the early days of a new electric lighting undertaking.

Kidderminster.—The Guardians have referred to the House Committee a suggestion of the electric lighting company asking the Guardians if they would be willing to arrange for an electric lighting installation at the workhouse. It appears that the gas bill is very heavy at the workhouse, and comes to over £265 a year.

Middleton.—At the meeting of the Council on June 1 a discussion took place upon the recommendation of the General Purposes Committee to spend £100 in fitting the old Council-chamber with the electric light. Ultimately the recommendation was adopted by a majority of six. A further amendment that only £20 be spent was lost.

The Pacific Cable.—We learn from Reuter's Sydney correspondent that, in reply to a cable from Mr. Chamberlain, Mr. Lee, the Colonial Secretary, has cabled that the Government of New South Wales agreed to the recommendations of the Pacific Cable Committee, and urged that the work should be pushed on as expeditiously as possible.

Dick, Kerr, and Co.—We have received from this firm their circular (No. 102) illustrating top-seat and single-decked motor-cars, as used at Liverpool, Bolton, the Potteries, and Blackpool and Fleetwood, and also circular 103 giving an illustrated description of the new rolling-stock for the Waterloo and City Railway. Views, sections, and curves are given.

Tunbridge Wells.—The Postmaster-General has issued a license authorising the Corporation to establish and carry on a municipal telephone exchange. In order to obtain authority to borrow a little more than is absolutely required for present necessities, the Town Council will apply to the Local Government Board for sanction to a loan of a sum of £10,000.

Edinburgh.—At the meeting of the Town Council on the 5th inst. it was resolved to disapprove of the minutes of May 22, which fixed the price of the electric light for next year at 3¾d. per unit. The Treasurer held that it should have been 4d., as he did not think 3¾d. left a sufficient margin. On a division 25 voted for the approval of the minutes and 11 against.

London Gazette.—A receiving order has been made out *re* A. W. Hirst, trading as Hirst and Co., St. Michael's-road, West Croydon, Surrey, on debtor's petition.—The first meeting in the estate of G. H. Bentley, 63, Cross-lane, Earlestown, Lancaster, will be held on June 15, at 3 p.m., at the Official Receiver's Offices, Byrom-street, Manchester; an adjudication order has been made.

Wellingborough.—At the last meeting of the Urban District Council a letter was read from the Local Government Board stating that it would be necessary for the Wellingborough Urban Council to obtain a provisional order from Parliament to enable them to generate electricity for public lighting purposes. The Clerk was empowered to take the necessary steps to obtain the provisional order.

Aberdeen.—At Monday's meeting of the Town Council it was proposed that it be remitted to the Watching, Lighting, and Fires Committee to consider and report as to the lighting of Union-street west of Union Bridge with electricity, so that the amount required for the purpose may be included in the estimates for the financial year now current. The motion was rejected by 24 votes to 4.

Pemberton.—At a meeting of the ratepayers convened by the District Council the schemes for electric lighting and tramways were laid before them. The Chairman stated that they expected in a short time to obtain borrowing powers for electric lighting, and they wished to consider whether it would be advisable to have the house wiring done by a free wiring company. Many ratepayers gave their opinions, but no resolutions were passed.

Accidents.—Two men were killed by electric shock at Messrs. Adams's Ironworks, Wolverhampton, yesterday week. It is not known exactly how the accident occurred, but it is reported that the men came in contact with a live wire.—On Saturday night an explosion occurred in an electric light manhole in Jamaica-street, Glasgow. A girl who was passing at the time was knocked down by the explosion, and the flame ignited her clothes. She was not injured, but was greatly frightened.

Uxbridge.—The Council have received a letter from the Board of Trade *re* the Uxbridge and district electricity supply provisional order and the agreement entered into by the District Council and the promoters, stating that the Board have inserted in the order all the provisions of the agreement which they are advised can be inserted; also that the Board have no power to express any opinion with respect to any arrangements made between the District Council and the promoters outside their order.

British Thomson-Houston Co.—We have received from this Company an extremely well-got-up price-list (No. 33) for overhead line material. The frontispiece gives an excellent view of the overhead wire construction at Fitzalan-square, Sheffield, while various trolley cars, automatic and clamping ears, frogs and crossings, etc., are also illustrated. Prices are given in every instance. We have also received from the same Company an illustrated pamphlet (No. 65) for automatic circuit breakers, form C D, for 125 and 250 volt direct-current circuits.

John Turner and Sons.—We have received a tabulated list, with lithograph, giving full particulars of the enclosed dustproof motors made by this firm at Denton, near Manchester. These machines may be used as dynamos or motors, and they are supplied either totally or only partly enclosed. Our attention has been drawn to the exceptionally low speeds at which these machines are designed to run. It is claimed that this is a desirable and important feature in an enclosed dynamo or motor, which, however, cannot be attained without a considerable increase in cost of manufacture. The circular contains a detailed list of prices.

Nuneaton.—Recently the *Atherstone Observer* published some comments on the Nuneaton electric lighting undertaking by the consulting engineer, Mr. Hawtayne, who had come down at the request of the Council to inspect and report on the Coton-road works. Last week the matter was mentioned in the Council-chamber. From the discussion, it was not all clear whether the report in the paper was obtained by interviewing Mr. Hawtayne, or whether it was an extract of what Mr. Hawtayne said at the committee meeting. A resolution was proposed to write to the engineer and draw his attention to the matter, but no vote was taken on it.

Catalogue.—We have received from Messrs. E. Green and Son, of Manchester, a copy of their latest catalogue, which gives all details and information respecting the economiser. The economiser is at present a matter likely to interest users of steam plants in consequence of the high price of coal. The catalogue commences by setting forth the advantages to be gained by the use of an economiser, and gives views of the works in which they are produced. Details of the construction are then given, and also figures obtained in tests. Instructions for repairing economisers and several plans of Messrs. Green's apparatus conclude this interesting catalogue.

Perth.—A report has just been issued by Sheriff Sym, who, at the request of the Secretary for Scotland, held the public enquiry in connection with the application by the Perth Gas Commissioners, to which we have already referred, for power to borrow £100,000 under a provisional order. After setting forth the local circumstances, Sheriff Sym says the scheme for the introduction of electric lighting appears to be sound, and that in his opinion authority may safely be given to borrow £50,000 on the security of the gas rates for its extension. It has been remitted to the Lighting Committee to arrange for the lighting of the new bridge pending the installation of the electric light.

Colchester.—It has been agreed that intending consumers should have the services of an electrical engineer, who would inspect the premises and prepare specifications for wiring and fitting. Tenders would then be obtained from local tradesmen and submitted to the consumer. When the selection had been made the work would be done under the supervision of the electrical engineer. It is proposed to make a small charge of £1 on the first £10 outlay, and 10s. for every £10 or fraction of £10 afterwards. The consumer will pay 10 per cent. of the total cost on completion of the installation, and the balance by 20 equal quarterly payments. The outlay by the Town Council is estimated at £270. 10s. 6d. for the first four months.

Belfast.—At last week's meeting of the City Council the Electric Committee reported that having considered the desirability of amalgamating with the Gas Committee, they were of opinion that the committees should remain as at present constituted. The accountant submitted the abstract of accounts of the electric department, which showed a net profit of £1,368. 2s. 2d., which was considered satisfactory, and he was instructed to place this amount to the credit of renewals suspense account. Attention was drawn to the resolution recommending the Council to authorise the committee to make application to the Local Government Board for power to borrow £95,000. It was said that the money was required to carry out works which would place the department in a position to adequately supply light up to the winter of 1902. The minutes were adopted.

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Stock Exchange. — The Stock Exchange Committee have appointed June 13 as a special settling day for City of London Electric Lighting Company's further issue of 10,579 ordinary shares of £10 each, fully paid, Nos. 100,001 to 110,579, and have ordered the undermentioned securities to be quoted in the official list: City of London Electric Lighting Company's further issue of 10,579 ordinary shares of £10 each, fully paid, Nos. 100,001 to 110 579, and New General Traction Company's further issue of 20,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 54,001 to 74 000. Applications have been made to the Stock Exchange Committee to appoint a special settling day in and to grant a quotation to Johnson-Lundell Electric Traction Company's 40,000 shares of £5 each and Potteries Electric Traction Company's £125,000 4½ per cent. debenture stock.

Barrow.—The electrical engineer has been asked to report on a scheme suggested by him for the hire of electric motors to consumers. A sub committee has been appointed to obtain information as to the price to be charged for current supplied to the tramways company and report thereon. The electrical engineer has submitted a list of preliminary details as to the supply of current to the Barrow tramways, and he is now conferring with the company's electrical engineer in the matter. An application for supply of electric current to Messrs. J. Waddington and Sons' works has been accepted, subject to the usual guarantee of 10 per cent. per annum for two years on the cost of the main amount, £45. The salary of Mr. H. R. Burnett, the borough electrical engineer, has been increased by £75 per annum, the engagement to be for a further period of three years from this date.

Tottenham.—The Urban District Council have passed the following resolution which is being sent out by the Edmonton Urban District Council: "With a view to the economy in the supply of electrical energy for power, heating, and electric lighting purposes, this Council is prepared in the next session of Parliament jointly with the other local authorities, or with the Middlesex County Council or both, to promote a Bill in Parliament or a provisional order (if the objects can be effected in that way) for the purpose of enabling the local authorities in the northern and easterns portions of Middlesex either jointly by themselves or with the Middlesex County Council to acquire land and generate electrical energy for the purpose of distributing the same in bulk, and for other purposes in which such local authorities and the Middlesex County Council may have a common interest."

Dudley.—The Tramway and Electric Lighting Committee of the Town Council have issued a report recommending that the Corporation wire the premises of all consumers of electricity free of charge, exclusive of brackets, pendants, or other fittings, and that £10,000 be borrowed to cover the cost. It is further recommended that consumers shall have the option, until further notice, of being supplied at the rate of 5d. per unit throughout or at 6d. per unit for two hours a day, to be determined by the Corporation or their engineer, and 1½d. per unit for the remaining 22 hours, and that no rental be charged for meters. The committee have decided that the town hall buildings be fitted with the electric light. They also recommend that the offer of the British Westinghouse Company to sell to the Corporation the engine and dynamos, hired to the Corporation, for £1,360, less the sum already paid on account, be accepted.

Bridgwater.—At an adjourned meeting of the Town Council last week the following resolution, of which notice had been given since the last monthly meeting, was proposed: "That taking into consideration that opinion is so evenly divided in the Council on the electric light, and the opposition in the town so strong, it is desirable that a poll be taken as to whether the Corporation shall proceed with or abandon the electric lighting scheme, such poll to be taken on the current burgess roll on municipal lines, and the Corporation to abide by the result of such poll, the expense of which the proposer guarantees." Considerable discussion took place, but no vote was taken, as the resolution was ruled out of order. The Mayor stated that it was a resolution to do an illegal act, or an act which the Council had no right to do, and with which the Council had no concern whatever, and it was out of order to discuss it, or for him to put it to the meeting.

Grimsby.—At a recent meeting of the Public Lighting Committee the delay in the progress of the works, including the buildings, chimney, boilers, and dynamos, was referred to. The Chairman said that this was now being rectified, and that it was hoped that by October they would be able to meet the demands of their customers. According to Prof. Kennedy's pamphlet they would be able to supply the electric current to householders at 5d. per Board of Trade unit, which was pretty much the same price as gas. There had been a feeling that 6d. per unit should be charged, but at 5d. it would be the same as gas at 2s. 5d. per 1,000 feet. It was decided to adopt a charge of 5d. per Board of Trade unit for private consumers. It was also decided to carry the current along Abbey-road and Dudley street, and, further, to ask Prof. Kennedy to supply specifications for the additional plant required to meet the demands of the tramway company.

Rotherhithe.—The Vestry have received a letter from the vestry clerk of St. Marylebone, stating that in 1898 the Board of Trade granted to the Vestry a provisional order for the supply of electricity in the parish, which order, however, was subsequently rejected by a committee of the House of Commons. In the following session the St. Marylebone Vestry sought, by means of a private Bill, to attain their object, but again met with defeat. They have decided to again proceed in the matter, and being of opinion that their future efforts to acquire powers would be gravely endangered if the Electric Lighting Provisional Order, No. 11 (Marylebone Electric Supply Company, Limited) is confirmed by Parliament, they invite the Rotherhithe Vestry to take joint action with them in opposing the passage of such provisional order, and thus prevent a second private company from obtaining the right to generate and supply electricity in that parish.

Sunbury.—The negotiations which have been carried on between the District Council and the National Telephone Company, who first applied for wayleaves for overhead wires in 1898, have entered another phase. The Council formerly refused to grant leave, as the roads were too narrow for the erection of poles. In 1899 the application was renewed, and the Council then suggested that the wires should be put underground, with the exception of a stretch from Watersplash-road to the waterworks farm. The company, thinking that this could not be done, said the matter must be allowed to drop, and it was then suggested that a representative should meet the Council and discuss the scheme. This was done last week, when, at the meeting of the Council, the company's representative said that it was intended to open an exchange in Sunbury communicating with London, and for that purpose they must have a wire to Walton. The number of subscribers in Sunbury would be too few to warrant them in laying all underground wires, although it would be necessary in some places. A committee was appointed to meet the company's representative and survey the roads affected.

Leicester.—In order to ascertain the amount of support that would be accorded to a municipal telephone exchange in Leicester if undertaken by the Town Council at low rates and in a modern manner, the Telephone Committee have arranged to conduct a canvass for subscribers on the following terms for a telephone line and instrument: £6. 6s. per annum, payable in advance, to cover an unlimited number of calls; or, alternatively, £3. 10s. per annum, payable in advance, and 1d. for each call (originated by the subscriber), payable every three months. The subscriber may be called up by other subscribers without any charge. The above rates are for service up to a mile from the exchange, and for any excess distance beyond a mile there may be a small extra charge. The agreements are to be for one year. Rates for partnership lines for unlimited user, or on the "toll system," also for second instruments and extensions, are to be quoted on application to the canvassers. Corporation subscribers will have, on payment of the usual trunk wire charges of the Postmaster-General, equal rights with the subscribers of any other telephone undertaking to the use of the Government trunk lines to other towns.

Liverpool.—The following is the comment of a Somerset paper upon the change-over at Liverpool from a company to the municipality. It is but just that one should see both sides of the argument, but we fail to see the logic, or even the correctness, of the conclusion given. However, here is the comment: "At Liverpool the Corporation allowed a company to establish the electrical concern, but eventually bought it out at a considerable premium, and, having done so, set to work energetically to improve matters. What is the result? That the Corporation have reduced the cost of a unit for lighting, which was 7d. under the company, to 4d. under the Corporation, and similarly the cost of a unit of power from 5d. to 2d. The financial results in 1899 were, nevertheless, that all working expenses, and the annual instalments of principal and interest for redemption of the capital, were paid, and yet there was a net profit of £3,000. Strangely enough, the electrical engineer who has carried out this energetic policy is the engineer who formerly served the electrical company. What is the explanation? Why, that when a company has a monopoly and is earning a good dividend, it has no motive but to fold its hands and rest contented with its happy position. Indeed, with regard to municipal trading, it is safe to say that the following maxim seems to be unchallengeable: that where a public want can be supplied only by the establishment of a monopoly, that monopoly should belong to the public to be supplied."

Machine Tools.—We have received from Messrs. Geo. Richards and Co., Limited, Broadheath, near Manchester, an abridged illustrated catalogue of the machine tools, patternmaking machinery, air compressors, pulleys, and line-shaft fittings of their well-known make. Having regard to the extended application which machine tools, and especially those of the automatic order, are finding, this catalogue will be found worthy of careful perusal. It is gradually being recognised that American, German, and other competition from outside can be successfully met only by adopting the most modern and economical means of production in our factories and workshops. But owing to the gigantic proportions which our home industry had already assumed before the advent of modern labour-saving machinery, the change from the old order of things must of necessity be more or less slow. No opportunity, however, should be lost of replacing old machinery by newer and more economical types. Unfortunately, our machine-tool manufacturers have not all been so enterprising as some of their competitors abroad in the production of designs calculated to meet up-to-date requirements; hence orders have been lost to the country in considerable numbers. Messrs. Geo. Richards and Co., Limited, may, however, be instanced as a notable exception in this respect, and we may look to them to maintain the reputation of the old country in the manufacture of machine tools of modern and reliable design.

Seaham Harbour.—An interesting report bearing upon the question of purchase of undertakings was adopted at the last meeting of the Council. The Lighting Committee gave the history of their negotiations with the County of Durham Electrical Power Distributing Company. The report stated that the draft of the proposed agreement with the company was submitted to the committee and afterwards returned with several alterations. A

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conference with Mr. Madgen, managing director of the company, resulted in the adoption of a draft agreement, leaving, however, open certain clauses giving to the Council the option of purchase of the company's works on certain terms. These terms were the subject of considerable negotiations. Ultimately the company applied to the Board of Trade to dispense with the Council's sanction, and the Board of Trade appointed a meeting at which the option of purchase clause again formed the subject of considerable discussion. The committee agreed to make certain modifications. The company, however, rejected the modified clauses, and the Board of Trade had since intimated that they had decided not to proceed with the company's application for their order. The purchase clause insisted upon by the company was such as would, in the opinion of the committee, preclude the Council from acquiring the company's works by purchase, and would give them a monopoly of the supply of electricity for a period of 42 years. The committee, therefore, did not regret the decision of the Board of Trade, as it would give them an opportunity of considering the advisability of taking the matter into their own hands at a later period.

J. and P.'s "Ark" Lamps.—We have received from Messrs. Johnson and Phillips a copy of their new catalogue of "Ark" lamps. It is one of the most artistic productions of its kind which has hitherto come to our notice, besides being, perhaps, the most complete catalogue devoted exclusively to arc lighting and accessories. The numerous illustrations, in every way admirable, are produced direct from the lamps, many of them being printed in colours, a feature which both adds to the attractiveness and utility of the catalogue, since a better idea of the lamp's actual appearance is thereby obtained. Messrs. Johnson and Phillips claim to have taken the lead in employing colour printing for the purpose in question. The artistic merits of the various designs for interior use are certainly done greater justice to by this happy innovation. Great credit must be accorded Messrs. Johnson and Phillips for the eminent success which has attended their efforts to evolve suitable garniture in which to envelope the "Ark" lamp in its application to varying conditions and purposes, the result being a series of designs of the most elegant and choice appearance. The good burning qualities, simplicity of construction, and great durability of the "Ark" lamp itself are already well known, hence need no further recommendation here. The lamp has found considerable favour, not only for street-lighting, but also for the lighting of shops, stores, hotels, churches, halls, offices, factories, warehouses, etc., upwards of 20,000 being installed for these several purposes in various parts of the world. Another and important merit of the "Ark" lamp is its moderate price, the secret of which must be explained by the long experience which Messrs. Johnson and Phillips have had in the manufacture of all kinds of arc lamps, and to their having laid down special automatic machinery for manufacturing the particular type of lamp in question in bulk. Owing to this commendable enterprise, the firm are enabled to compete successfully with America and Germany in the production of the lamps. The best materials and workmanship only are employed, and every lamp is carefully tested before leaving the works. Besides giving numerous illustrations of the "Ark" lamp in various garnitures to suit different surroundings, the catalogue in question also includes a number of views of its actual application, not to mention a large number of artistic designs for lamp standards and brackets, which alone render it worthy of careful perusal.

Leith.—At the meeting of the Town Council on the 5th inst. a report was submitted by the electrical engineer, Mr. W. A. Bryson, with regard to the proposed extensions of the electric light to Newhaven and Trinity, for the following extract of which we are indebted to the *Scotsman*. It stated that the estimated income from public lighting and 40 consumers for this district would amount to £700 per annum. The sinking fund and interest on the capital expenditure of £10,687. 4s. 3d. would be £748. If, however, the main feeders and distributor cables were carried only as far as Dudley-gardens, but of sufficient size to bear the extensions to Trinity in the future, the cost would be £5,495 and the estimated revenue, from 17 consumers and 10 public arc lamps, would be £400. The interest and contribution to sinking fund on this amount would be £384. 16s. He pointed out, however, that the number of consumers would rapidly increase, with a consequent improvement on the annual return. The report concluded as follows: "As there seems to be a feeling in the minds of several members of the committee that I have deceived or misled them regarding the capacity of the cables throughout the burgh, I would respectfully point out to them that my instructions were to lay down an installation for the burgh of Leith, including engines, boilers, dynamos, mains, etc., for 12,000 8-c.p. lamps, which is practically the scheme accepted by you in Prof. Kennedy's report. I think it must be patent on reflection that it is rather too much to expect that the same feeders, as designed for 12,000 8-c.p. lamps, can carry 20,000 8-c.p. lamps, which is our present satisfactory condition." It was agreed to delay consideration of the proposed extension. Bailie Manclark reported on the progress of the electric lighting station since its commencement in February, 1899. The number of consumers had increased from 76 in May, 1899, to 210 in May of this year, with a total equivalent of 18,098 8 c p. lamps. The income for the 10½ months of last year amounted to £3,370, and the working costs to £2,348, giving a gross profit of £1,071. The amount due for interest and contribution to sinking fund amounted to £1,721, which made a net deficit of £649, to cover which £1,000 was borrowed from the burgh general assessments, and of this sum £350 had been carried forward. He pointed out that included in the amount of £1,721 was a sum of £604, which they had repaid the Public Works Loan Board, and the Corporation were therefore entitled to claim as their own part of the station amounting to that value. Adding the £604 which they had repaid to the £350, making £954, and taking this from the £1,000 borrowed from the general assessments, they had a deficit of £45, which was practically their deficit for the first 10 months' running. This statement showed, he said, that it was quite evident they were on the right lines, and he thought that before 12 months were up they would have a surplus on hand. The Council approved of the recommendation to appoint Mr. J. Gray Scott, Whitehaven, electrical engineer for the burgh in room of Mr. Bryson, resigned.

LEGAL INTELLIGENCE.

CROMPTON AND CO. (RE ELECTRICAL POWER SYNDICATE).

On Thursday last week, the case of Crompton and Co. (*re* the Electrical Power Syndicate) was heard before Mr. Justice Wright and a special jury.

Mr. Bray, Q.C., and Mr. Mellor were counsel for the plaintiff company, and Mr. Terrell, Q.C., and Mr. Dunham appeared for the defence.

Mr. Bray, in opening the case, said that the plaintiffs, Messrs. Crompton and Co., were a large electrical manufacturing company, having works at Chelmsford and offices in London. The defendants (the Electrical Power Syndicate) were then in liquidation, but it must not be thought that they were insolvent, as the shareholders had had all their money returned, with a dividend of 100 per cent., and after this there were assets which would be sufficient to pay a further dividend of some 250 per cent. The company had done its work, and was being wound up in consequence, and plaintiffs claimed to have a title to some of its assets. Messrs. Crompton and Co. claimed that, having rendered large services in the promotion and after the promotion of the syndicate, there was an agreement made by which plaintiffs and other companies which had rendered similar services should have the right to be contractors to the syndicate for such electrical plant and machinery as they would in the ordinary course require. They had been refused these contracts, the syndicate had repudiated all liability, and plaintiffs asked for damages, which would represent the profits they would have made on their share of the contracts. As an alternative, they said that if there was no such agreement they were entitled to be paid for services rendered. In 1898 Mr. Addenbrooke, an electrical engineer, of Wolverhampton, was proposing a scheme for having a central station in Staffordshire to supply electrical power to towns near Birmingham, where there were many manufacturers needing it for their works, and there was between Birmingham and Wolverhampton an extensive manufacturing country and a very large demand for power. Mr. Addenbrooke, in order to carry out his scheme, had to look out for some person of high standing in the electrical engineering profession to assist him, and he was advised to ask Mr. Crompton. Mr. Crompton was not able to be present at the trial, as he had gone to South Africa with the Volunteer Electrical Engineer Corps. Mr. Crompton and Mr. Addenbrooke had interviews, and went into the matter in great detail. Mr. Crompton and Mr. Albright, a fellow-director of the firm, agreed to form a syndicate to carry out the idea. The company was incorporated on June 10, 1897, and it was arranged that Messrs. Crompton and Co., Messrs. Callender and Co., and Messrs. Parker, an electrical company in Wolverhampton, should be contractors to the syndicate. It was estimated that the total work to be done by these firms would amount to about £150,000, of which each was to receive as nearly as possible an equal share. It was also provided that any disputes that might occur should be settled by arbitration. Then the Midland Electric Supply Corporation was formed by the syndicate to work the provisional order, and it was agreed that if the corporation took over the concern the syndicate was to pay to the contractors 15 per cent. of the money actually paid to it. Later another dynamo firm came in, and arrangements were come to under which the plaintiffs should have received some £2,500 for their services. The fact, however, was that the syndicate sold to the third company without making any provision for Messrs. Crompton, and plaintiffs' claim was that they were entitled to at least one-third of the profit on the contracts for the machinery and plant for carrying out the scheme.

Mr. Mellor then read the affidavit of Major R. E. B. Crompton, head of the plaintiff firm.

Mr. Justice Wright said it appeared that there had been members of three firms who made themselves directors of the syndicate, and made a contract that they should each have a third of the work and profits. It seemed to him that Mr. Crompton had not done more than look after his own interests.

Mr. Terrell, for the defence, said he would submit that there was no foundation for the action in law. The contract alleged against him was a verbal agreement made by Mr. Albright, on behalf of Cromptons, before the syndicate which was sought to be charged with that contract was registered, and it was a contract that was outside the powers of the memorandum of association, and so could not be adopted after. It was not a contract to do work, but a reward for certain services rendered to the promoters by entering into a contract to make another contract if called upon to do so. It was, in fact, a contract to give them an option. It was *ultra vires* of the memorandum of association, and they had

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no right to make such a contract. Resolutions passed by a meeting of directors did not make a contract.

After some remarks from his **Lordship**, counsel on both sides had a consultation, which resulted in terms being arrived at under which the defendants were to pay plaintiffs £750, without costs.

The case was then withdrawn on the above terms.

COMPANIES' MEETINGS AND REPORTS.

TELEGRAPH MANUFACTURING.

The ordinary general meeting of the shareholders of this Company was held on the 31st ult. at the Law Association Rooms, Liverpool.

Mr. James Taylor, chairman of the board of directors, presided, and, in moving the adoption of the report and accounts (published in our last issue, and which were accepted as read), remarked that it was a great pleasure to the directors to meet the shareholders with such a satisfactory increase in their business and profits. Their gross profit for the past year amounted to £41,284, which was an increase of £13,012 over the figure for the previous year. During the year also their property and assets, including goodwill, had increased from £127,142 to £145,870 in consequence of extended works, and the purchase of 10 acres of land adjoining their works, and the railway at Helsby, which they believed would prove a very valuable acquisition. After deducting depreciation, which was off prime cost, the total of their plant and buildings account now stood at £138,342. The stock-in-trade stood at about £84,000, which was rather large, but necessitated by the frequent demands for immediate supply. They had a large stock at the Cape, of which they hoped to be able to dispose quickly now that hostilities were ceasing.

The proceedings then became special, when the **Chairman** moved that the capital of the Company be increased to £300,000 by the creation of 20,000 additional ordinary shares of £5 each, ranking for dividend and in all other respects with the existing ordinary shares of the Company. He added that the immediate issue would be 5,000 shares at a premium of £4 per share, the existing shareholders to have the first option of taking them up. The amount of the premium, £20,000, would be added to the reserve fund. The increased capital was required through the large and rapid extension of the business of the Company.

Mr. John Shaw, who seconded, said his 20 years' experience of electrical industries convinced him that the Company had a very prosperous future before it.

The resolution was carried unanimously.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS.

The half yearly general meeting of this Company was held on the 31st ult. at Cannon-street Hotel.

The **Hon. Henry Marsham** presided, and referred to the improvement of general business and to the increase in the Company's submarine cable work. The Company's steamer "Silvertown" would in a few days sail to lay about 1,000 miles of cable between Canso (Nova Scotia) and New York. They hoped to complete the laying of that cable with such dispatch as to enable the "Silvertown" to return to England just as the Company were on the point of completing the manufacture of a cable to be laid between Waterville, in Ireland, and Weston-super-Mare. The steamer "Dacia" had returned safely from her voyage to the West Indies, and the steamer "Buccaneer" was now on charter to the Western Telegraph Company. Competition was keen, the price of raw material high, and coal now cost about 25 per cent. per ton more than in the spring of 1899. A satisfactory agreement had been come to between the Dunlop Pneumatic Tyre Company and the Palmer Tyre Company, which concerned this Company as shareholders and managers of the Palmer Company. The Board of this Company much appreciated the assistance which their solicitor (Mr. Stirling) had rendered in dealing with these very difficult negotiations.

The payment of an interim dividend of 2½ per cent., or 5s. per share, free of income tax, was agreed to.

PROVISIONAL PATENTS, 1900.

MAY 24.

9561. Improvements in fuseboards for electric lighting and the like. Charles Curwen, 70, Palace-chambers, Westminster, London.

9563. An electrolysing process for zinc and other salts with soluble anodes. Charles Denton Abel, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (La Société des Piles Electriques, France.)

9567. Improvements in electric traction on a road contact or like system. Silvanus Phillips Thompson, 322, High Holborn, London. (Partly by Miles Walker, United States.)

9576. Improvements in telegraphic transmitting, receiving, and translating arrangements. Alexander Muirhead, 323, High Holborn, London.

9579. Improvement relating to telephonic apparatus. Victor Veysy, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Oct. 24, 1899, being date of application in France.)

9592. Improvements in accumulators or secondary batteries for traction, motive power, or lighting purposes. Alexander Bluhm and Julius Posnansky, 306, High Holborn, London.

9612. Improvements in a commutating switch and combinations of electric motors and batteries for controlling electric carriages and like purposes. Henry Francis Joel, sen., 74, Windsor-road, Forest Gate, London.

MAY 25.

9622. Improvements in or relating to electric storage batteries. Job Thomas Niblett, Malcolm Sutherland, and Elias Marcuson, 61, Chandos-street, Strand, London.

9631. A new or improved detective lock or seal for gas and electric meters, electrical demand indicators, and fuse boxes, or for any other uses or purposes to which same may be applicable. Charles Orme Bastian, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

9632. Improvement in electrical accumulators or secondary batteries. Walter Hibbert, 101, Goldhurst-terrace, South Hampstead, London.

MAY 26.

9699. Improvements in or relating to electric clocks or watches. Arthur James Henderson, 29, Westbourne Park villas, Paddington, London.

9711. Improvements in protective devices for use in the distribution of high-tension alternating currents. Reginald Page Wilson, Clun House, Surrey-street, Strand, London.

9716. Improved electric railway conduit. Edward Bennett Viles, 322, High Holborn, London.

9730. An improvement in electric switches. Frederic Stanhope Worsley and Frederick James Green, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9731 Improvements in apparatus for use in the electro-deposition of metals. Sherard Osborn Cowper-Coles, 47, Lincoln's-inn fields, London.

9744. Improvements in telegraphy. John Lea and Joseph Taylor, 18, Dyott-street, New Oxford-street, London.

9746. Improvements in electrolytic meters. Arthur Wright and the Reason Manufacturing Company, Limited, Norfolk House, Norfolk street, Strand, London.

MAY 28.

9750. Improvements in junction boxes, crosses, tees, bends, draw-in boxes, and other fittings for metallic conduits for electric cables and wires and for similar purposes. Cope, Allman, and Co., Limited, and William Allman, Icknield-square, Birmingham.

9751. An automatic disc-catch lever switch for electric tramways. Samuel Eyre, Glenholme, North-road, Wolverhampton.

9760. Improvements in electrical maximum-demand indicators. George Hookham, 18, Southampton buildings, Chancery-lane, London.

9763. Improvements in the manufacture of electric railway rail-bonds. Thomas Joseph McTighe, 77, Chancery-lane, London. (Complete specification.)

9784. Improvements in electric switches. Walter Frederick Jones, Albert Works, Beaver-lane, Hammersmith, London.

MAY 29.

9822. A new or improved method and apparatus for automatically operating and controlling signal lights on board ships where electricity is employed. John William Garrett, York-street, Hull.

9873. Improvements in electric motors, batteries, and connections thereof for propelling automobiles and like vehicles. John Hewitt, Charles August Lindstrom, and Thomas Hewitt, 18, Buckingham-street, Strand, London. (Complete specification.)

MAY 30.

9944. Improvements in incandescent electric lamps. Bernard Mervyn Drake and the Nernst Electric Light, Limited, 66, Victoria-street, Westminster, London.

9953. Electric switches. Alvi Twing Baldwin, 11, Queen Victoria-street, London.

9954. Electric air-pumps. Alvi Twing Baldwin, 11, Queen Victoria-street, London.

9955. Improvements in electric railways systems. The British Thomson-Houston Company, Limited, 83, Cannon-street, London. (William B. Potter, United States.) (Complete specification.)

9957. Improvements in telephone signalling systems. Newman Henry Holland, Fairfield, Kingston-on-Thames.

9962. Improvements in or relating to alternate-current induction motors. George William Money, 322, High Holborn, London.

9975. Improvements in electrical transformers. Robert Grisson, 45, Southampton-buildings, Chancery-lane, London.

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9968. Magnetic separators. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Mechernicher Bergwerks-Actien-Verein, Germany.) (Complete specification.)

9971. An improved method of utilising electrical earth currents. Emil Jahr, Birkbeck Bank-chambers, Southampton buildings, Chancery-lane, London.

9988. Electric signalling device for preventing railway collisions. Guiseppe Del Monaco, 18, Buckingham-street, Strand, London.

MAY 31.

10061. An improved method and means for controlling the speed of electric motors. Charles William Dawson, 30, Park-row, Leeds.

10022. Improvements in electric tramways or railways on a conduit system. Matthew Gaughren, 115, St. Vincent-street, Glasgow.

10026. Electrical appliance for working pile drivers. James Garvie, Devanha House, New Southgate, London.

10029. Improvements relating to the distribution of electric current. Norman Wilson Storer, Westinghouse-building, Norfolk-street, Strand, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Nov. 1, 1899, being date of application in United States.)

10031. Improvements in arc lamps and in the manufacture of the same. Ernest William Bohle and Hermann Bohle, 77, Colemore-row, Birmingham.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on June 23.

1899.

11172. Apparatus for controlling electric currents, especially applicable for charging secondary batteries or accumulators. Veritys, Limited, and Steele.

11506. Carbons for electric arc lamps. Fleming.

12789. Telephone systems. Weinmar.

13280. Channel rails and current supply for electric tramways. Smith.

14633. Means for constructing a thermopile and for utilising solar rays and other energy for the purpose of generating, transmitting, storing, and using thermo-electricity. Dunn and Bromhead.

14235. Apparatus for measuring time by electricity. Hoeft.

14449. Wireless telegraphy. Brown.

14569. Dynamos. Sayers.

15135. Electrical clock arrangements and apparatus. Hollins and Leake.

15178. Brushes of dynamos. Chaplin.

15440. Electric incandescent lamps. von Recklinghausen, Vogt, and Nernst Electric Light, Limited.

15644. Electrical ignition apparatus. Küpper and Vorreiter.

15720. Electric arc lamps. Crompton and Co., Limited, Hodgson and Tubbs.

18370. Manufacture of electrical insulating material. Boult. (Jungbluth.)

1900.

5496. Process for depositing pure tin by electrolysis. Quintaine.

6188. Armoured conduits for electric wires. Boutillier and Hunter.

7695. Wall plugs for electric lighting and heating. Galsworthy.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	June 2	645	527	+ 18	30,781	26,576
Birmingham Tramways Co.	,, 2	4 500	4,232	+ 268	91,225	86,497
Blackburn Corp'rat'n	—	—	—	—	—	—
Blackpool Corporatn.	May 31	455	905	- 450	3 271	3 680
Blackpool-Fleetwood	June 2	370	887	- 517	5,894	7,370
Bolton Corporation	—	—	—	—	—	—
Bradford City Trams	—	—	—	—	— *a*	—
Bristol Tramways Co.	,, 1	3,046	3 055	- 9	—	—
City & South London	,, 2	1,434	960	+ 474	27,752	23.193
Dover Tramways	,, 2	185	186	- 1	3,587	3,446
Dublin U.T., elec. cars	,, 1	3,412	1,277	+2,135	—	—
Dublin S.D. Electric	,, 1	857	982	- 125	—	—
Halifax Corporation	May 26	747	583	+ 164	5,371	3,709
Hull Corporat'n E.S.	—	—	—	—	— *a*	—
Liverpool Corporat'n	,, 26*b*	8,108	7,246	+ 862	147,458	128 763
Liverpool Overhead	June 3	1,352	1,478	- 126	31,009	30,326
Sheffield Corporation	,, 3	2,281	—	—	—	—
South Staffordshire	,, 1	695	619	+ 76	14 335	13,884

a Since April 1. *b* Partly electrical.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-⅞
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 6¼
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	¾-1
—— 6 per cent. Cum. Pref., 1-50,000	1	—	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	..	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1¾-2
—— Non. Cum., 6 per cent. Pref.	2	..	2-2¼
—— 4½ per cent. Debenture Stock	100	..	109-114
—— 4½ per cent. 2nd Debenture Stock	100	—	103-106
Callender's Cable, Debentures.	100	—	112-116
—— Ordinary	5	—	13½-14½
—— 5 per cent. Pref.	5	—	5¾-6
Crompton and Co.	3	—	3¾ 4
—— 5 per cent. Debentures	—	..	100-103
Edison and Swan United, Ordinary	3	—	2-2¼
—— 5 per cent. Debentures	5	..	3¾-4¼
—— 4 per cent. Deb. Stock, Red.	100	..	93-95
Electric Construction	2	..	2-2¼
—— 7 per cent. Cumulative Pref.	2	..	2¾-3¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	103-106
W. T. Henley's Telegraph Works, Ordinary	5	—	13½-14½
—— 4½ per cent. Preference	5	..	5¼-5¾
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-23
—— 4 per cent. Debentures	100	—	100-103
Telegraph Construction and Maintenance	12	..	34-38
—— 5 per cent. Bonds	100	—	103-106
Telegraph Manufacturing, Ordinary	5	—	11½-12½
—— 5 per cent. Cum. Pref.	5	..	5¾-6
Willans and Robinson, Ordinary 1-30,000	5	..	11-12
—— 6 per cent. Cum. Pref., 30,001-60,000	5	—	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-⅞
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	7-7¾
Charing Cross and Strand	5	..	8½-9½
—— 4½ per cent. Cum. Pref.	5	—	5¾ 6
Chelsea Electricity Supply	5	—	6¾-7¾
—— 4½ per cent. Debentures	100	—	108-111
City of London, Ordinary	10	..	9½-10½
—— 6 per cent. Cumulative Pref.	10	..	12½-13½
—— 5 per cent. Debenture Stock	100	..	124-129
County of London and Brush Provincial, Ordinary	10	..	9½-10½
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	110-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9½-10½
London Electric, Ordinary	3	..	1½-2
—— 6 per cent. Pref.	5	..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	114-117
—— 3½ per cent. Mortgage Debenture, Red	100	..	97-99
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	—	1¾-1¾
—— £5 Shares	5	..	7-7¼
—— £4½ Shares, New	4½	..	6¼-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6¾-7
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	$100	..	105-105 xd
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	4-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	8½-9½
Westminster, Ordinary	5	..	4¾ 15½
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-Shares	5	..	4¾-5¼
—— ,, deferred	5	..	5-5½
City and South London, Consolidated Ordinary	100	..	61-65
—— Ordinary	10	—	5¼-6¼
—— 4 per cent. Debenture Stock	100	—	122-128
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	..	13½-15½
Waterloo and City, Ordinary	100	..	100 103
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17½-18½
Brisbane Tramway	100	..	102-104
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10½-10¾
British Electric Traction, Ordinary, 1-30,000	10	..	15½-16½
—— 60,001-75,000	10	..	15½-16½
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	12-13
—— 5 per cent. Perpetual Debenture Stock	100	..	124-127
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	..	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4¼
—— 5 per cent. Deb. Stock, Red.	100	..	103-106
Isle of Man Electric Power, 1-95,000	1	..	½-5/16
—— 6 per cent. Preference, 100,001-170,000	1	..	15/16-⅞
Kidderminster and District Lighting and Traction, Pref.	10	..	9½-10
New General Traction, Ordinary	5	—	3¾-4
—— 6 per cent. Cum. Pref.	5	..	4½-5½
North Staffordshire Trams	6	..	—
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— Preference	10	..	10½-10
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10½
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	⅜-½
National Telephone, Ordinary	5	..	6¼-6½
—— 6 per cent. Cum. First Pref.	10	..	13-15
—— 6 per cent. Cum. Second Pref.	10	..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	..	5-5½
—— 3½ per cent. Deb. Stock, Red.	100	..	98-101
Oriental Telephone and Electric Company	1	—	15/16-1 1/16

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NOTES.

Physical Society.—At the next meeting of this society the following subjects will be presented: "Notes on Gas Thermometry," by Dr. P. Chappuis; "A Comparison of Impure Platinum Thermometers," by Mr. H. M. Tory; and a note "On the Law of Cailletet and Mathias and the Critical Density," by Prof. J. Young, F.R.S.

Society of Arts.—Remember that the annual conversazione of this society will this year take place at the Natural History Museum on Wednesday, June 20. The reception by the chairman, Sir J. Wolfe Barry, is to commence at 9 p.m. The bands of the Coldstream Guards and Royal Engineers have been secured to supply the musical entertainment.

Music.—We have received from the American Academy of Arts and Sciences a copy of a paper read by Mr. C. R. Cross on "Historical Notes Relating to Musical Pitch in the United States." In this paper is a history of the efforts made to obtain a good musical pitch in the United States, and contains many tables setting forth the results obtained by experiments with tuning-forks at various dates. The paper is well worth reading by those interested in the theory of music.

St. Marylebone.—The St. Marylebone Vestry are now asked by their Parliamentary Committee to recommence action against the Metropolitan Supply Company because that company has broken up the carriageways of Edgware-road and King-street for the purpose of laying mains. The full facts of the case are not known to us, but we do not see how the Vestry is able to prevent the company from carrying out its obligations, and using the powers which have been conferred upon it by Parliament with respect to breaking up the streets.

Municipal Trading.—The Kingston-upon-Thames Municipal Trading Act, which received the Royal assent on the 25th of last month, allows the Corporation to deal in electric light fittings and to erect the same. The Act also provides that they may hire electric light fittings out and maintain the same at an annual charge. We are pleased to note, however, that in this Act, which goes quite far enough to offer strong competition with private enterprise in Kingston, the Corporation are debarred from manufacturing electric light fittings. The powers granted have previously been given to other corporations, and hence there cannot be much reason brought forward against the Kingston-on-Thames Corporation receiving them. Provided, however, that the local contractors are active in meeting the requirements of the Corporation, and are doing their work at reasonable rates, we trust that the Corporation will not use their powers to compete with their own ratepayers out of public funds.

Bicycle Lights.—The intelligence of the members of the police force has been questioned from time to time, but we cannot understand a constable taking a small electric light to be the end of a cigar. The case in point was one brought before Mr. Bros at North London Police-Court. Mr. Joseph E. Thornton, of Hillside-road, Stamford-hill, was summoned for riding a bicycle at night without having exhibited thereon a light. The defence was that though there was no light attached to the machine, still the defendant had a small electric light in the buttonhole of his coat, which, it was contended, was sufficient to comply with the Act of Parliament. The constable admitted that he could see this light some distance off, but said that he thought it was a lighted cigar. The contention that the light was on the man and the man was on the machine did not hold, as the magistrate stated that the Act said that the light must be attached to the carriage, and he consequently imposed the nominal penalty of 1s., with 2s. costs.

Bonding.—The value of any system of bonding rails depends on two factors, the first being the design of the bond, while the second and more important factor is the workmanship in fixing the bond. Even the best bond on the market is rendered imperfect through ignorance or carelessness in fixing. We note in the *Street Railway Journal* that a number of the American street railway companies have introduced a system of piece prices in fixing bonds, which is said to work very advantageously. The resistance of every bond installed is measured in terms of the rail length, and if the resistance of the joint is less than that of 8ft. of rail the bond is accepted. If the resistance comes out at the equivalent of between 8ft. and 12ft. of rail only half price is paid for it, and if it is more than equal to 12ft. of rail the joint is rejected, and has to be remade by the workmen. A system like this tends to make the men exceedingly careful, and we do not doubt that if reasonable care is taken the men can earn more money under the new system than with a standing wage.

Tramway Strikes.—There have been numerous accounts in the daily papers of the large amount of damage done by the street railway employés at St. Louis while on strike. It is interesting in this connection to note the actual demands of these employés, which are such as to make it impossible for any company to run a commercial undertaking. These demands are as follow: That the company shall force all its employés to join their union, and shall henceforth employ union men only; that the company shall not engage or discharge men except with the consent of the union; arbitration to be resorted to in every case when the company and the union cannot agree upon the propriety of the discharge; that if the union suspends or expels a member the company must discharge him also; that all changes in time table shall be submitted to union officials for approval at least 48 hours before going into effect. If these demands were granted, discipline could not be maintained amongst the employés, and the result would be neither to the advantage of the public or of the men themselves.

London County Council Tramways.—The London County Council are proposing to make a large number of tramway extensions in the near future, for which they have to ask the consent of the local authorities. A number of these extensions are through busy streets, in which the tramways will be far from a convenience to the general public. For instance, it is proposed to run a line through Queen Victoria-street, another along Shaftesbury-avenue to Piccadilly-circus, and another down Farringdon-street to Ludgate-circus. The opposition to these tramways is quite reasonable, in spite of the fact that in each case the roadway has a considerable width. This width is often all required at times for the ordinary vehicular traffic, and even if tramways were constructed they could only be looked upon as a temporary expedient. The ultimate solution of the congested traffic problem is more intimately connected with the deep-level electric lines, such as is now about to be opened from the Bank to Shepherd's Bush. It will be interesting to see how far this line succeeds in displacing the omnibus traffic, which is such a large factor in the congestion of Newgate-street, Holborn, and Oxford-street.

Electrolytic Corrosion.—Mr. Samuel Sheldon's paper on the "Electrolytic Corrosion at Brooklyn," read before the American Institute of Electrical Engineers contains some interesting features. Thus he finds that in the hours

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of heavy load about 1,100 cars are in operation, and the total current output from the seven power stations is about 47,000 amperes. The means for returning the current were described, and also the contemplated use of the structures of the elevated railroad for this purpose. He found differences of potential between the rails and the gas-mains and hydrants varying from a fraction of a volt to 25 volts. It was especially noteworthy that no electrolytic corrosion of the cast-iron water-mains has been discovered in the city, although numerous cases have occurred in which the service pipes were attacked. Only within the last year has corrosion of the gas-mains been found, though in one block 38 service pipes were destroyed. The gas company attributes a leakage due to this action of 13 per cent. of its entire output. The underground tubing of the Edison Company has also suffered considerably. It was noticeable that cast iron showed an immunity against corrosion; a condition which the paper undertakes to explain.

Municipal Lighting.—We have had in the past to say a good many hard things about the Hackney Vestry and their electric lighting arrangements, or rather their neglect to make any arrangements for the electric lighting of their district. Since Mr. R. Hammond has been appointed by the Vestry to act as their consulting electrical engineer this has been changed, and the Vestry has authorised Mr. Hammond, as their engineer, to spend a sum of money which will enable very large works to be laid down and mains provided for electric lighting. The question as to the charges for the supply has now come before the committee, and we are pleased to see that the committee has adopted Mr. Hammond's recommendation that the lighting charge should be 4d. per Board of Trade unit. When the energy is supplied for power purposes, the charge will be only 2d. per unit. It is well known that a profitable supply can be given at these prices, and they will induce a large number of consumers to come on, and thus hasten the time when the works will be loaded. Such a course is much better than trying to make a profit in the first year or so of working, which profit is provided by those enterprising ratepayers who first take the light. These first consumers are thus made to pay more than their share of the cost of the undertaking, which is neither fair to them nor to the advantage of the general public.

Accidental Death.—The above heading is the verdict which was arrived at at the coroner's inquest respecting the death of two workmen at Mars Ironworks, Wolverhampton. These two men were killed by an electric shock from an iron wire used to suspend an arc lamp, which was supplied on the continuous-current series system. This suspension wire had evidently become connected with the line. The evidence brought forward at the inquest was to the effect that the plant in question had only been installed recently, and that the machines and lamps, which were of the Brush type, had been purchased second-hand. The installation was done by a man who had not an intimate knowledge of electrical engineering, and hence was not acquainted with the necessary precautions to be made in carrying out high-voltage installations. The firm on whose premises the men were killed will, of course, give compensation to the relatives of the deceased, but we are surprised to find that they were not censured for their neglect to obtain proper supervision when erecting the plant in question. The remarks of an expert witness and of the coroner on the relative dangers of high-voltage and low-voltage systems would be largely nullified if only proper supervision were given when carrying out work. On the whole we consider the firm is exceedingly fortunate not to have a verdict of manslaughter returned against them.

Motor Wagons.—We have received from the Liverpool Self-Propelled Traffic Association an advance copy of the conditions for the 1901 trials of motor vehicles for heavy traffic. The object of the trials is to provide a means for making a preliminary test of types of heavy motor wagons suitable for haulage operations in Lancashire prior to their being taken over by a Lancashire syndicate to be formed to conduct road transport between Liverpool and other Lancashire towns. The trials commence on June 3, 1901, and continue till the 7th. There will be six judges of the competition, each being a well-known man in engineering circles. The vehicles will be divided into three classes, according to size, weight, carrying capacity, and speed. The cost per entry for each vehicle will be 10 guineas, and each competitor is to have his vehicle ready for inspection by the judges on May 31, 1901. A requirement for electrical vehicles in these trials will be that they must have a battery power to travel 40 miles with one charge, and the points considered will include the nature of the arrangements for varying the discharge rate, the method of carrying the battery and replacing the same, the simplicity of the controller, and the units consumed per mile. The hon. secretary of this association is Mr. E. Shrapnell Smith, Royal Institution, Colquitt-street, Liverpool, from whom all information can be obtained.

The American Institute of Electrical Engineers.—At a meeting of the institute held at Philadelphia last month, Mr. Carl Hering was elected president for the ensuing year by a large majority. We offer our hearty congratulations to Mr. Hering on his appointment, and also on the fact that he will represent the institute at the congress in Paris in August next. A report of the committee on units and standards was read as follows: "We consider that there is need for names for the absolute C.G.S. units in the electrostatic and the electromagnetic system; also for suitable prefixes to denote decimal multiples and submultiples of these units, in supplement and addition to those already in common use. That the international electrical congress convening this year at Paris should be urged to bestow the above-mentioned names and create said decimal prefixes. That much advantage would accrue to a universal 'rationalisation' of electric and magnetic units, and that the congress be requested to consider the means and advisability of such 'rationalisation.'" Commenting at length on these results, Dr. Kennelly pointed out the need of a system of units not immediately based on the C.G.S. system. He explained that the 4π, which was said to prove so objectionable in magnetic formulæ, was not quite so bad as it had been painted, but the committee wished to avoid to a certain extent its use.

Electrolysis of Fused Salts.—The following is an abstract of a paper contributed by Mr. R. Lorenz to the *Zeitschrift fuer anorg. Chemie.* The abstract, which appears in the *Journal* of the Chemical Society, reads as follows: "An investigation of this subject from the point of view of Faraday's law shows the great importance of keeping the electrodes apart, and indicates the conditions under which trustworthy values of the E.M.F. of polarisation and its temperature coefficient can be obtained. The current yield in the electrolysis of fused lead chloride diminishes rapidly as the temperature rises, having the value zero at the boiling-point of the salt; this rapid fall is due, not only to the accelerated diffusion of the lead and chlorine vapour in the fused mass, but also to the increasing vapour tension of the lead. At constant temperature, the yield increases with the current density and with the distance between

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the electrodes; it diminishes as the depth of immersion of the anode increases, whilst it is almost quantitative when the anode is quite separated from the cathode. From the above results, it follows that a tube with the electrodes close together is an unsuitable and uneconomical form of apparatus for the electrolysis of fused salts; in such an arrangement, the longer the experiment lasts the poorer is the percentage yield, owing to the more complete diffusion of the products."

Centrifugal Railway.—The American Railway Company, of 6, Wall-street, New York, have solved the problem of enabling human beings to emulate the flies walking on the ceiling. In order to do this they have made use of the well-known laws of centrifugal force in connection with a cycle railway, on which the passengers and cars are inverted at one portion of the run. For this purpose a vertical loop with a diameter of about 20ft. is constructed in the line. The car approaches this loop from a steep incline, which gives it a great speed. The centrifugal force, when passing round a circle 20ft. in diameter, is quite sufficient to keep the passengers and cars from falling downwards. On leaving the loop a slight up-grade is provided to finally stop the car. If the thing is worked out mathematically, it will be seen that the comparatively reasonable speed of 12 miles per hour is quite sufficient to prevent the passengers falling out of the car when they are inverted at the upper part of the loop. As an additional safeguard, however, they are strapped in. An advertisement of the above company discloses the fact that these lines may be bought much in the same way as a pound of tea, as the makers guarantee the erection of the structure in any part of the States within 30 days of the order being placed. We think that the exhibition authorities in Paris should order a couple of dozen of these tracks, and place them on the vacant land to the west of the exhibition.

Tramcar Heating.—The great convenience of using electric heaters on tramcars over the employment of other types of heating apparatus has done much to favour their introduction. Also, with a tramway system, the cost of electrical energy is much lower than with a distribution system laid down for the supply of electric light. In consequence of the above reasons, electric heaters have been largely used in the United States on tramcars, in spite of the extra expenditure which is incurred in supplying them with current. The *Street Railway Journal*, in a leading article, estimates that the heater load on certain lines in the winter amounts to quite 20 per cent. of the operating load. This cost is, of course, largely in coal, but if the generating plant of the station has not a sufficient margin of power, it may also result in an increased capital expenditure unless arrangements can be made that the heaters are not required at times of maximum load. It is suggested by a contemporary that in the busiest parts of the day the animal heat of the passengers in the cars is quite sufficient to keep up the temperature. Another method which is being tried, and, in our opinion, much more reasonable, is to arrange the controller so that it can cut out the heater at points of heaviest load, and in this way the station is relieved from the heater load when the largest call is being made on it. With a large system it would not be required, but it is exceedingly valuable for lines having comparatively few cars. Another company, it seems, is trying to use the rheostats themselves as the heaters, but in this case we should think the heating effect would be rather too intermittent.

Central-Station Economies.—Mr. W. L. Abbott, in his paper before the National Electric Light Association in Chicago, read on May 22, deals with the operating economies in central-station practice. The question of oil and waste is most thoroughly gone into by the author, who advocates the collection of the oily waste, and that the oil be extracted from the same. He states that out of 100lb. of oily waste it is usual to get 40lb. of oil and 40lb. of waste, which can be used again. The details of the cleaning arrangements are described very fully. The question of cylinder lubrication is also well gone into by Mr. Abbott, but we fail to understand what he means by a well-compounded oil. This compounded oil, whatever it may be, is capable of standing a high flash test, and is particularly serviceable for high-pressure cylinders. The author gives his experience that if the lubrication is only suitable for the high-pressure cylinder, the low-pressure cylinder will not give much trouble. With the proper oil he has found that a 1,200-h.p. engine can be lubricated for 12 hours with one gallon of oil. Another interesting feature in the paper is the proposal to vary the times at which the men on the various shifts commence work. By so doing the author arranges that a large number of men are on the works at the time of the greatest load, and a correspondingly small number when there is very little to do. The arrangement, of course, will render the time-keeping slightly more difficult, but it certainly is an advantage that the men become more intimate one with the other, and one shift is less likely to throw over on to its successor faults which have arisen and which they are only too glad not to have to repair.

Wireless Telegraphy with Balloons.—Messrs. J. Vallot and J. and L. Lecarme have contributed to the *Moniteur Industriel* a note on their experiences with wireless telegraphy in a balloon. They state that the object of the experiments was to discover whether it was possible to communicate by Hertzian waves between the earth and a free balloon at a great distance, and without a conductor connecting the receiver to the earth. The transmission post was at Landy, and was composed of a battery of 10 accumulators, a key, an interrupter, and a coil and oscillator. One of the poles of the coil was connected with the earth, and the other with a receiving apparatus composed of an insulated copper wire suspended from a small captive balloon. The receiver was placed in the balloon, which rose at first vertically. The signals were heard very distinctly in the balloon at an altitude of about 600 yards, the horizontal distance being about three miles. They were still noticeable at an altitude of 900 yards and a distance of nearly four miles, but it was necessary to increase the sensibility of the apparatus. Owing to the direction of the wind, the gasometers at Landy were after a time interposed between the receiving wire and balloon, and the experiments were discontinued after 10 hours, at which time the signals could not be distinguished. The authors conclude that a wire to earth is not indispensable for transmission to a long distance, and that when the balloon at first rises vertically to a great height the signals could be clearly heard, although the two antennæ were a prolongation of each other, and that the normal planes of their extremities were parallel and separated by a great distance. In concordance with the results obtained at Mont Blanc, the difference in potential between the two posts did not seem to affect the working of the apparatus.

Alkali Processes with Diaphragm.—The following is an abstract of a paper contributed by Messrs. F. Foerster and F. Jowe to the *Zeitschrift anorg. Chemie*. The abstract appears in the *Journal* of the Chemical Society, and reads as follows: "Theoretical considerations show that the yield of chlorine obtained in the electrolysis of neutral akali chloride solutions will in general be less than the yield

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of alkali so long as the existence of hypochlorite in the anode solution is possible. When a diaphragm is used, the nature of the process depends on three factors—the ordinary electrical conduction in the diaphragm, the diffusion, and the electrical endosmose. Experiments with a platino-iridium anode, in which the anode and cathode solutions were analysed after the electrolysis, showed that the total yield of alkali diminishes with increasing concentration of the alkali hydroxide. The yield of chlorine was found to be less than the yield of alkali, especially in the first stages of the electrolysis; the difference vanished later on when the chlorate and hydrogen chloride concentrations became appreciable. The chloride concentration, owing to the electrical endosmose, falls much more slowly in the cathode solution than in the anode solution. Analysis of the anode solution after electrolysis indicated the presence of free hypochlorous acid and alkali chlorate, but not of alkali hypochlorite. The proportion of oxygen liberated at the anode increases regularly with the progress of the electrolysis. When carbon anodes are used, the process of electrolysis is essentially the same; the gas liberated at the anode contains carbon dioxide, and hydrogen chloride is found in the anode solution at a higher alkali chloride concentration than when platino-iridium anodes are used. Solutions of potassium chloride give a better current yield than those of sodium chloride; this is connected partly with the greater dissociation of the former salt, and the greater velocity of migration of the potassium ion."

Open v. Enclosed Arc Lamps.—Mr. H. H. Wait contributes to the June number of the *American Electrician* an interesting comparison of open and enclosed arc lamps for street-lighting purposes. In view of another note somewhat on the same subject in this issue, it is interesting to glance through Mr. Wait's conclusions, which are independently arrived at. On constant-potential circuits the enclosed arc lamp has, of course, all in its favour, but the question arises as to whether, with a big street-lighting system, it will pay to throw out the open-type lamp in favour of the enclosed type when working on the series system. The author gives two diagrams of candle-power for open and enclosed arcs and the same consumption in watts, which have been carefully made. From these he concludes that with arc lamps taking about 450 watts, the watts per mean spherical candle-power are as follows: with the direct-current open arc, 0·8; with the direct-current enclosed arc with a clear inner globe, 1; with the same arc with an alabaster inner globe and reflector, 2; with alternate-current enclosed arc with the same type of globe and reflector, 1·6. We notice that these two last figures do not at all agree in their comparative values with the results obtained by the committee of the National Electric Light Association. Mr. Wait then looks into the cost of operating lamps per year, assuming that they are burning for 3,800 hours. From the figures given, which are in tabular form, making allowance for different rates of wages in different districts, etc., we gather that the open arc costs somewhere about £2 more per annum than the enclosed arc. The question then arises as to whether this sum is sufficient to meet the additional interest and depreciation charges on the capital required to change not only the lamps, but also to rearrange the mains and to provide the new central-station plant required to work the street-lighting if the open type of arcs already at work are replaced by others of the enclosed type.

Electric Cabs.—The Londoner paying a visit to Paris is pleased to see resurrected electric cabs, which in general design are similar to those which proved a financial failure in the London streets. These Parisian cabs, which are owned by the Compagnie Générale des Voitures à Paris, are in general appearance exceedingly like the old London types, but in details a number of improvements have been made. Amongst these is the use of the pneumatic tyres, which seem to be a success. It is curious in this respect to note how largely pneumatic tyres are used in Paris for heavy vehicles, and we fail to see why the French should have more success than English engineers. Another point in the Parisian cab is that much higher speeds than were possible with the old London cabs are regularly obtained. The motor equipments are of the Johnson-Lundell type, each motor having two commutators, which are used with a series-parallel controller. The motors, which are nominally of 4 h.p., run at 1,500 revolutions per minute when the cabs are going at a speed of 10 miles per hour. There is a reduction gear consisting of a rawhide pinion gearing into a large gearing wheel; the ratio is about 1 to 4. The large gear wheel shaft drives the rear wheels of the cab by means of chain gearing. The accumulators at present being tried on the cabs are mostly manufactured by the Société pour la travail Electrique des Metaux, but other types are also being experimented with. The cabs themselves are made so that they can be converted into open carriages at will, and a good number of landaus are also plying on the streets for hire. A curious fact about these electrical cabs and their drivers is that the drivers are quite prepared to receive at least 100 per cent. more than their legal fare, and that they are very apt to complain if the minimum fare is less than a certain amount. In this respect the ordinary cabman of Paris usually differs from his London *confrère*. We trust that this degrading influence of electricity on the drivers will be rigidly repressed by the public.

American Practice.—The editor of one of our American contemporaries states that the influence of American practice is plainly to be seen in the Continental machines on view at the Paris Exhibition. In personal opinions of this kind it is exceedingly difficult to eliminate personal bias, but we are quite sure that in this respect it would be far more correct to say that the American practice of to-day is based on Continental practice of five years ago. The editor of our contemporary particularly referred to the design of engines and electrical generators. In this branch of electrical engineering the American engineers clung to rope driving and to the use of enormously broad leather belts long after the time that the English system of using high-speed engines directly coupled to the generators had become a standard practice. The next development in this respect was, we think, due to German practice, and consisted in direct coupling large dynamos of the flywheel type on to steam-engines running at slow speeds. We know that certain English engineers claim to have taken the lead in this matter in that they used marine types of engines with the same object. Thus, at the present time, while American engineers are justly proud of the number of steam-engine orders which are being sent to the States from this country, the fact remains that these orders are not obtained on questions of ultimate merit, but on the score of quick delivery and of price. If the various engines in the Paris Exhibition were put to work and run under ordinary working conditions for a number of years, we are confident that the life of the Continental makes and of those engines made in England would be quite 100 per cent. more than the life of the American-made engines. Our conclusion is that both in practice and detail the past experience of engineers in the Eastern Hemisphere enables them to turn out a more economical and reliable engine than their *confrères* in the Western Hemisphere, whose great object always seems to be to "hustle" along with their work.

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Blackburn Trams.—There is nothing reasonable in the criticisms of the daily Press on the first annual report of the Blackburn tramways, which we reproduce elsewhere in this issue. We are told, for instance, that, to the general dismay, the first annual report of these tramways since they were municipalised shows a net loss of £4,500, notwithstanding the enormous increase in passengers and the substitution of electricity for steam traction on half of the system. The facts of the case are so clear from the report that it hardly needs any support on our part to show that Mr. Giles has achieved a great success in obtaining the results he has done for the past year. The Tramway Committee of Blackburn and the Corporation also adopted a broad-minded policy in that, when they municipalised the tramways, they were bound to give an advantage to the general public. In spite, therefore, of the fact that they were equipping the lines electrically, and hence were bound to have heavier capital charges, they decided to at once reduce the fares on all the sections. On certain of the sections these reductions amount to as much as 100 per cent. on the fares previously charged by the company, while on other sections the reduction is not quite so much. Besides this, the frequency of the service has been much increased, and the immediate result is a very large increase in the number of passengers carried, which has gone far to make up for the reduction in fare. In fact, Mr. Giles reports that the cheaper rate is tending to actually increase the receipts per mile. The total result for the year, however, is that the department has not earned sufficient to provide for all the interest and repayment on the loans it has had to incur. Thus, while the gross profit is some £3,433, the interest and sinking fund for the year amounts to £7,886, which accounts for the above-mentioned loss. There are items, however, making up this loss which will not occur again, and we are sure that when the next balance-sheet is presented Mr. Giles will not have to make any call on the rates. In the present case part of the capital on which the charges have to be paid has not been productive during the year.

The National Electric Light Association's Convention.—At the annual meeting of the National Electric Light Association at Chicago, it appeared that great interest was shown in the arc lamp for street-lighting. A notable feature of the discussion which followed papers on the subject was that the difficulty which lately existed as to choosing between the various methods of arc light operation has largely passed away. It was not disputed, for instance, that it was advantageous to use alternating-current arc lights on series circuits supplied by constant-potential alternators for street illumination. Thus in this case, in spite of the lower economy of alternating arcs, the system has been proved almost as economical as that with direct-current arcs, and the lighting value of the two is practically the same. The direct-current lamp is, however, at a disadvantage, as a large percentage of its power is wasted in dead resistance, and the choking effect of the alternating arc being obtained inductively the waste is much less. In comparing series alternating with series direct-current arcs, this greater waste of the direct-current system is not found, as no choking is necessary, and, therefore, in comparing the two systems, the direct is superior to the alternating as a light producer, while the alternating arc can be supplied from large stations at so much lower cost than the direct as to balance the advantage of the superior light produced. These conclusions, which were arrived at by the committee of the electric light convention, were taken exception to, however, by some members of the convention, who spoke in favour of the alternating arc. The argument used in this connection was that the eye could better adapt itself to a well-diffused light than to a concentrated strong light at one point and comparative darkness at others. This was shown by the fact that an opal globe, while apparently increasing the illuminating power of a light, really decreased it. This effect was owing to the better diffusion of the light, and the *Electrical World* thinks that by the same argument the advantage of the alternating arc can be explained. Throwing out a greater portion of its light in a horizontal direction, the direction to illuminate best the darkest points between lamps, it gives a more uniform diffusion than does the direct-current lamp. This decision, it is suggested, should end the troublesome problems which now have to be solved by station managers called upon to operate a large number of arc lights.

Local Action in the Lead Accumulator.—The following is an abstract, appearing in Mr. Carl Hering's digest in the *Electrical World*, of a paper contributed by Mr. Schoop to the *Elektrisches Neusigheits Anzeiger*. The abstract reads as follows: "The author discusses the different reasons of such 'silent' discharges, which are often very obnoxious. They may be due to impurities of the active material or of the cores of the electrodes; small additions of palladium and platinum cause local discharges; additions of copper, arsenic, iron, etc., act in a similar way, as do also impurities of the electrolytes, especially the presence of materials of the sulphide of hydrogen group. He then shows that even if all materials used are of ideal impurity, local discharges must occur, as they are intrinsically connected with the nature of the processes occurring in the accumulator; they are due to potential differences in and at the electrodes, which arise even with pure materials. He found a potential difference of 0·225 volt between charged spongy lead and a core of hard lead containing 12 per cent. of antimony, and a potential difference of 0·055 volt between charged spongy lead and a core of soft lead; after 30 minutes the voltmeter gave 0·16 and 0·1 volt respectively. He found that accumulators with a hard-lead grid develop about double the quantity of gas developed by accumulators with a soft-lead grid. About a quarter of an hour after the interruption of the charging current a charged negative plate of good quality should show no development of gas either at rest or if discharged; at the positive plate, however, generally considerable quantities of oxygen are developed, and that during the whole discharge; probably this is the case with all systems. He thinks that the manufacturer may not be inclined to give up the use of hard lead for accumulators, especially where a certain stability of the plates is required, as for automobiles; nevertheless he recommends using lead containing antimony, but as little as possible, especially for stationary batteries. It appears also why it is of importance whether a capacity test of an accumulator is made immediately after the charging has been done or after a longer time of rest. Finally, he discusses several influences which may cause or increase local discharges, such as the additions of graphite or collodium to the active material; the presence of impurities, especially of chlorine, due to the Planté formation; repeated mechanical shocks and shaking during the discharge, as in automobiles, the decomposition of insulating material, especially celluloid, which is substantially altered by ozone; a bad distribution of current over the surface of an electrode, so that one-half of the plate charges up the other plate, to which process the phenomenon of 'recovering' is partially due, which requires consumption of energy; the exposure of the accumulators to direct sunlight, by which peroxide of lead is decomposed."

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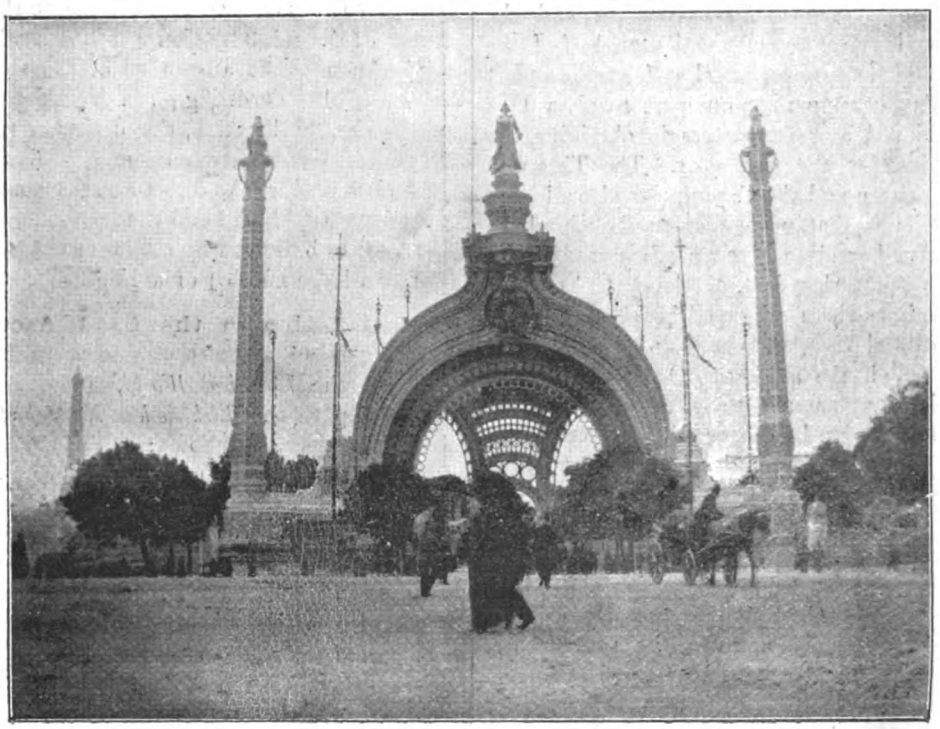
THE PARIS EXHIBITION.

[BY OUR SPECIAL CORRESPONDENT.]

After a week spent in Paris the writer has come to the conclusion that it is quite impossible to inspect all the numerous electrical exhibits in the time he had at his disposal, and hence proposes in the forthcoming notes to give only a few brief descriptions of certain exhibits without any attempt at a complete list or description of what can be seen at the exhibition. It must not be considered that the apparatus described is the most interesting or is all that can be seen, as it is quite impossible to give a complete description of the electrical apparatus on view without having a special volume of the size of a standard dictionary in which to publish the information. To those who contemplate a visit to the exhibition the following advice is given, with the confidence that those who read it will in every instance think they know better how to arrange for their trip to Paris.

In the first place, do not book by any of the well-known tourist agencies in England. Without a doubt a certain amount of money in some cases is saved by so doing, but as a result the freedom both as to the hotel accommodation and as to the daily programme is entirely lost if one is bound by the hard-and-fast rules of the agencies. When Paris is reached, it is well to make up one's mind to see exceedingly little of Paris and very much of the exhibition. In the exhibition grounds plenty of side shows and entertainments will be found to relieve the routine of inspecting the machinery, and if the relaxation is interspersed with business in the ratio of about 2 to 1 a very good impression of the exhibition will be obtained.



The Grand Entrance to the Paris Exhibition.

A View of the Exhibition from the Seine.

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Up to the present it is well to give up all idea of finding any particular exhibit, unless it happens to be a dynamo of about 1,000 kw. capacity; even then one must not be disappointed if the machine is hard to find, as is the case with what is said to be the largest dynamo in the world, which is exhibited by the Allgemeine Elektricitäts Gesellschaft. This is placed in an annexe on one side of the machinery section, but the dynamo is not coupled to a prime mover.

Chateau d'Eau.

Assuming that the visitor has arrived in Paris and has found a hotel, and has informed the owner thereof that he is quite prepared to pay his scheduled charges, provided that he is not to be bound to eat *dejeuner* at the hotel in the middle of the day, or to be in every evening to dinner, the next best thing is to take a cab to the main entrance of the exhibition. Here it will be found that the attendants at the turnstile refuse to receive

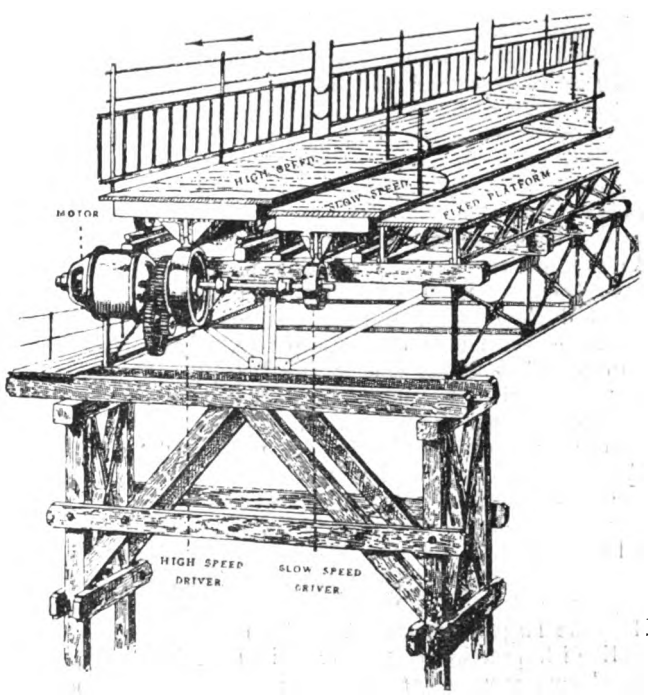

FIG. 1.—Diagrammatic View of Motor Driving the Moving Platform.

hard cash, and insist that the intending visitor to the exhibition should purchase a one-franc ticket for 60 centimes from a hawker outside the gates. This will, of course, delight the Scotch visitor, and it is to be hoped that he will not afterwards find a lead coin amongst his change. Having passed into the exhibition with a good supply of tobacco at one's command, the best thing to do is to get on to the moving platform and smoke. After having made a complete journey on this platform, a good idea of the general bearing of the exhibition will have been obtained, and one can then proceed to take refreshments with a calm mind. For these the Englishman naturally

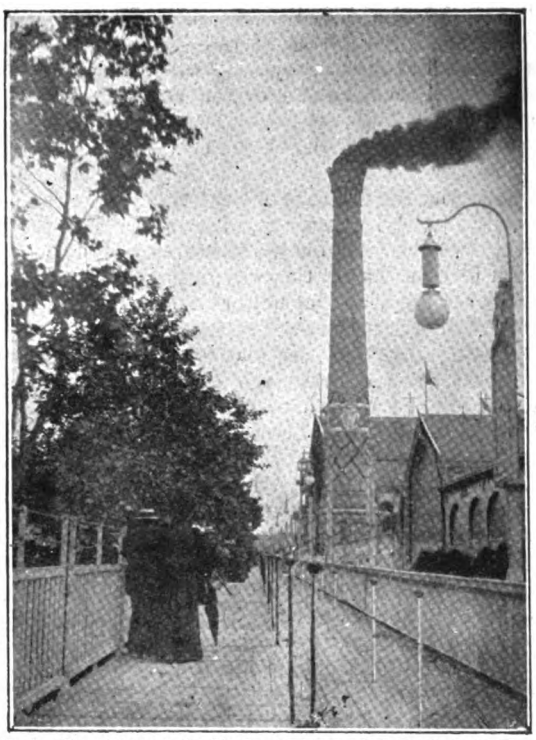

FIG. 2.—View taken on the Moving Platform at the Paris Exhibition.

turns to the English restaurant, and tries to obtain English food such as he is used to. This restaurant provides quite as well as can be expected under the circumstances for these requirements, but a tour of the French and other restaurants in the exhibitions will be found quite as cheap and much more interesting.

As to the moving platform itself, or, rather, platforms, the following few remarks as to the construction of the same may be of interest. In laying-out the exhibition the Paris authorities have not hesitated to place the public advantage before the convenience of private individuals; thus, while this platform cannot in the ordinary sense of the term be considered a nuisance, it is not exactly pleasant for the inhabitants of private houses to have a public way passing close to their windows. This platform, which

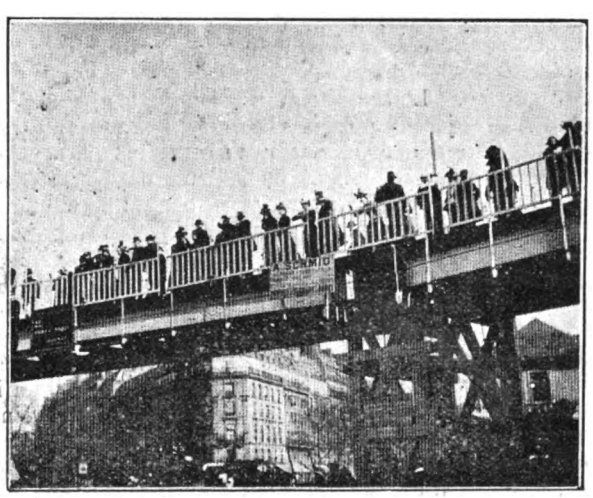

FIG. 3.—General View of the Moving Platform.

traverses an irregular four-sided course, has always one side facing on to private property. A large portion of the track is entirely over public streets. In these streets it is supported by wooden trestles, as seen from the accompanying illustration, which, while quite familiar to those American visitors who are accustomed to the overhead railways in New York, would turn grey the hair of a London county councillor. The platforms, of

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which. there are two—one going at the comparatively high speed of 5 miles an hour, and the other at 3 miles per hour—are, of course, continuous, and are driven by a large number of motors (about 160) placed at intervals along the course. The method of driving the platform can be seen from the illustration (Fig. 1). Each platform, which is composed of a number of small trucks with a flat top, runs on two lines of rails. On the underside of the truck a longitudinal projection with a flat under surface is made, which acts as the driven surface. The electric motors drive by double-reduction gearing, shafts on which two pulleys are secured. The first and largest of these pulleys supports a certain amount of weight of the high-speed platform, and drives it by means of frictional adhesion. The smaller pulley, which has, of course, a less peripheral velocity, does the same for the slow-speed platform.

It will be seen that in this way, although a large number of motors are used, no one motor is rigidly geared to the platform, and this enables the series motors to adjust themselves to the speed of the platform and to each other's speeds, and secures that each of the motors shall do approximately its fair share of the work. The arrangement works so well that the designers of the platforms find themselves able to secure the desired speed with practically half the estimated power. In consequence of this, the series direct-current motors are connected now two in series across the 500-volt mains, instead of all in parallel. The power to drive this platform (of which a general view is given in Fig. 2) is obtained from the Westinghouse Company. In another view (Fig. 3) one of the monumental chimney shafts of the building is shown in the distance. We are not quite sure how far the Parisians blame *le perfidious Albion* for the black smoke issuing from the top of the shaft, but we are quite sure it would not be tolerated in this country.

The sub-station provided by the Westinghouse Company in the exhibition also provides the power for driving the electric tramway, which is placed alongside or underneath the moving way, and which, of course, far outstrips it in speed. The power is received into the station from the Moulineux power station, which is now being equipped by the Westinghouse Company with some 13,000 h.p. of three-phase generating machinery. The supply is received into the sub-station at 5,000 volts on the three-phase system with a frequency of 25 complete periods per second. In this sub-station the following plant is provided: Two 850-h.p. induction motors, wound to take the full pressure of 5,000 volts. These run at 300 revolutions per minute, and are 10-pole machines. Coupled to each of these induction motors is a 600-kw. 600-volt direct-current dynamo. These direct-current machines have each eight poles. The couplings between these induction motors and the dynamos are of a flexible type, which has given every success. The couplings consist of two discs facing each other, each provided with a number of projecting pins. Links of triple-ply raw hide are used to connect the adjacent pins of the two discs and transmit the torque from one machine to the other. This type of coupling is now standardised by the Westinghouse Company. It gives a certain amount of insulation between the two shafts if required, but its principal object is to provide a flexible connection so that slight errors in the alignment of the two axes may not cause any trouble with the bearings. These two sets are further supplemented by two 450-kw. rotary converters for changing three-phase alternating current into direct current at 600 volts. Each of these converters is provided with three 170-kw. static transformers for reducing the pressure of the alternating current from 5,000 to 350. The converters are compound-wound, and have on their shafts a four-pole induction motor, which is used, as afterwards described, for starting up the machines to synchronous speed.

There are also in this station two smaller converting sets, each consisting of a 40-h.p. induction motor, with its shaft direct-coupled to a 30-kw. direct-current dynamo. Each of the three-phase motors is supplied from three 10-kw. static transformers, which reduce the voltage from 5,000 to either 220 or 110 volts. The lower voltage is used for lighting purposes. As to the use of all these machines when once started, we need not refer in detail, except to state that private exhibitors are supplied with light and power in a way which renders them quite independent of the supply to the moving platform and to the tramway. A description, however, of the routine of starting up every day is of interest, as exemplifying the great simplicity which is introduced into the switch gearing by not making the large machines self-starting. The first step is taken by switching on one of the 40-h.p. induction motors. This drives the 30-kw. dynamo, giving sufficient current to enable one of the 600-kw. direct-current dynamos to be speeded up. The 5,000-volt circuit to the alternate-current motor coupled to this machine is then closed, after which a very large power can be obtained in order to start any of the other machines, or to start the moving platform. In starting the platform the following is the procedure, as described by the American engineer in charge: "Switch on your 850-h.p. induction motor, then 'kill dead' your field of the direct-current dynamo coupled to it; close the switch gear connecting the terminals of this direct-current dynamo to the mains supplying the motors on the moving platform. (By-the-bye there is no starting gear whatever provided on these motors individually.) Then slowly excite the field current direct dynamo." It is found in this case that when the voltage has reached about one-half its normal value, and the current is about 1,000 amperes, the platform will start moving. Then, of course, the excitation can be increased until the normal speed is obtained. As regards the starting of the rotary converters, which are synchronous, it will be noticed that the induction motors on the same shafts have four poles, as against six poles of the converters. As a consequence, the speed of the induction motor is above the synchronous speed of the rotary converter. In starting up, the speed is allowed to increase until the point of synchronism is passed, and then the current is switched off the induction motor. As the speed gradually drops through frictional losses, the synchronising lamps are watched, and the switch is closed just when the machine has fallen to that speed which gives synchronism with the supply. This sub station and exhibit of the Westinghouse Company is particularly interesting, because all the machinery intended for the sub-station went down in the American liner which contained so much of the materials intended for the exhibition. The present equipment is borrowed from other jobs, but it works remarkably well and shows the advantage of having standard plant which can be interchanged between different installations. In the switch gearing, which is exceedingly simple, this is particularly apparent. All the high-tension switches are so interlinked that it is quite impossible for an inexperienced man to make a mistake. To quote the expressive words of the gentleman who showed us the installation, "A man who has lost his head can pull on that handle till hell freezes without doing any damage." As regards the capacity of this platform, over 40,000 have been on it at one time, and the present record for a day's takings represents nearly 150,000 people. To the mathematical man, and particularly to the gentleman who has to set mathematical papers, this platform opens a fine field for interesting problems. For instance, certain ladies prefer to stand on the slow platform rather than to trust themselves on a moving floor going at 5½ miles per hour. If the husband of such a lady stands on the fast platform and leaves his child on the fixed footway by the side, when will they three meet again?

In looking through the electrical section, which can be conveniently reached from the moving platform, the English engineer will naturally wish to find the English exhibit. Here the largest machine and the most typical example of English practice is that exhibited by Messrs. Siemens Bros.' company. The dynamo is coupled to an engine made by Messrs. Willans and Robinson, of Rugby, which is up to the present the largest of the Willans central-valve type which has been made. It is provided with three cylinders on each line, and is in general arrangements identical with the Willans engines of the smaller size. The following facts about this engine have been supplied to us by the makers, and hence can be accepted as correct. Messrs. Willans state that the only difference between this engine and the smaller sizes is in a

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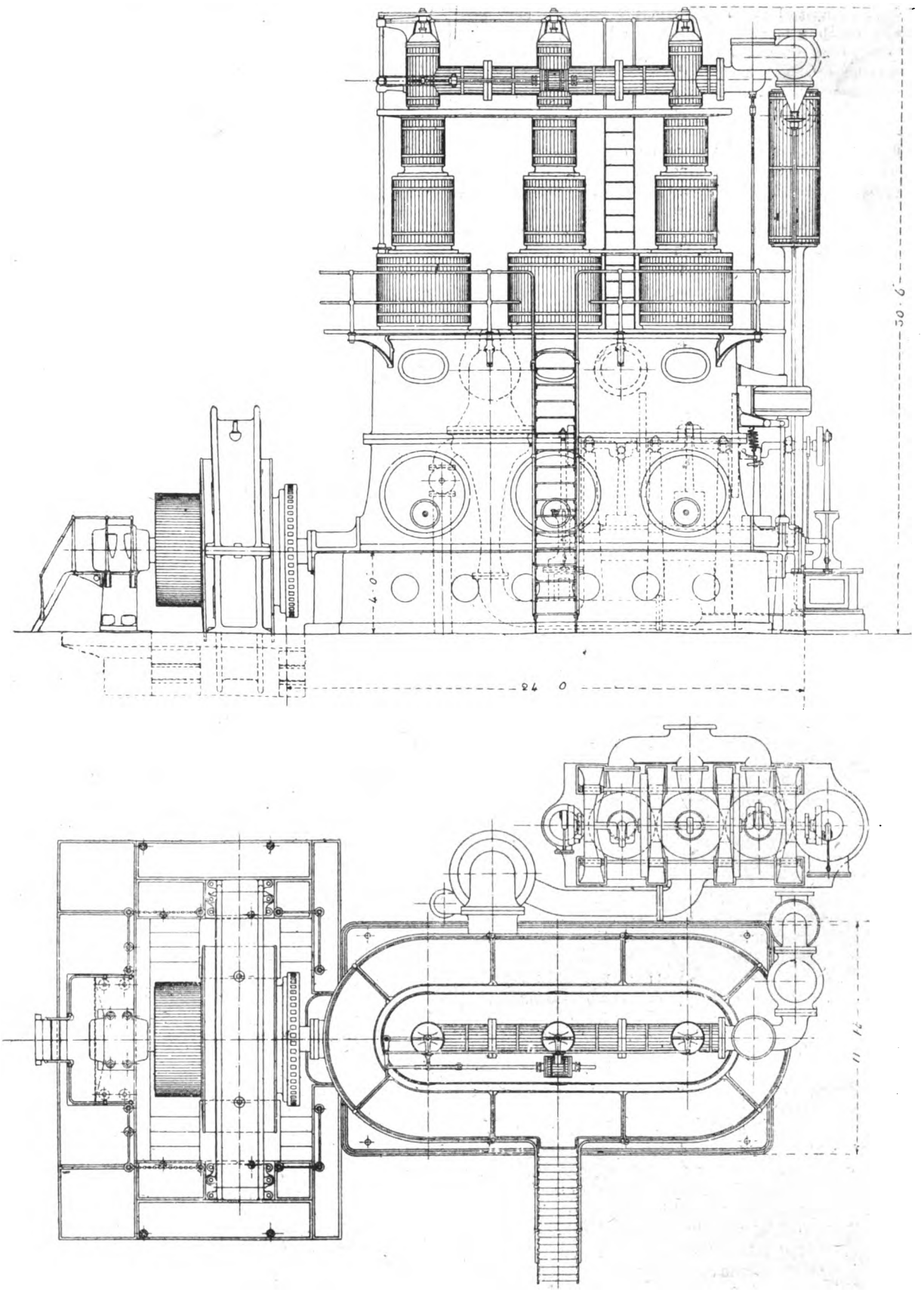
few constructional details. The bed-plate, for instance, is divided into two parts longitudinally down the centre line of the crankshaft, and is bolted together to form the usual oil-bath. Each piece weighs about 15 tons. The crank chamber upper part is also divided, the lower portion into four pieces, so as to enable the crankshaft, connecting rods, shaft, in spite of its size, is in one piece, with the eccentric forged upon the crank pins as usual. The diameter of the journal is 14·5in., and the total weight of the shaft about 12 tons. This is the crankshaft which the French railway company lost, and the fact reminds us somewhat of the stealing of a steel chimney 120ft. high



FIGS. 4 AND 5.—Plan and Elevation of the Willans-Siemens 2,400-h.p. Steam Dynamo.

and cross-heads to be got at and withdrawn, if necessary, without dismantling the engine. The exhaust chamber is in one piece. The governor is of the usual Willans centrifugal pattern, but is placed vertically, and driven by screw gearing on the crankshaft, in accordance with the practice adopted by the makers in all the larger sizes. The crank- by an American thief. The necessary flywheel is obtained in the armature of the dynamo, and a coupling disc only is supplied upon the engine, which serves also for the purpose of barring. Figs. 4 and 5 show the general arrangement of the plant.

The engine is triple expansion, with three lines of

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cylinders arranged tandem in the usual Willans manner, the diameters being 49in., 30$\frac{5}{16}$in., and 18$\frac{7}{8}$in. respectively. The stroke of the engine is 23$\frac{5}{8}$in. The maximum power for continuous running is 2,400 h.p., but the engine is capable of developing 3,000 h.p. for short periods. The speed is 200 revolutions per minute. The total weight of the engine is about 120 tons. The floor space occupied is only 31ft. by 11ft. 1in. The steam pressure under which it works is 10 atmospheres, and it exhausts into a jet condenser supplied by the Worthington Pumping Engine Company (Fig 6).

Drawings of this engine we reproduce herewith, which also show the dynamo on a small scale. We regret, however, that the makers of the dynamo will not at present supply us with a drawing to enable us to show the constructional details of the machine more fully. As regards the engine, the standard practice of making only to template is again exemplified. The tools and templates for making this engine were got out in order that this machine might be sent to the Paris Exhibition, but already the Glasgow Corporation have placed with the makers orders for two engines of the same size. As a consequence there have been three of these large engines put through the shops with all their parts strictly interchangeable, and repeat orders can therefore be executed or parts renewed in much less time than if the engine had been made with such tools and templates. Up to the present two steam trials have been made on this engine, owing to a dispute with the authorities as to the steam-pipes. These were supplied in cast iron, and at the last moment the administration refused to accept anything but welded steel pipes. As a consequence the supply from the dynamo has not been given up to the present to the public mains.

The Siemens dynamo which this engine drives is designed to give 3,200 amperes at 550 volts. It is of the multipolar type with 16 poles. The armature is 9ft. in diameter, while the core is 21in. long. The commutator, which is designed with a large surface for carbon brushes, is 5ft. 9in. in diameter, and 19 brushes, each with one square inch of bearing surface, are provided on each of the brush arms, of which there are 16. The commutator support is of cast steel, and is divided up into segments, so that a few of the sections of the commutators can be removed without disturbing the rest. The dynamo, of course, runs at the same speed as the engine, making 200 revolutions per minute. The field of the machine is cast in two halves, and cast-steel pole-pieces are secured on to the face of the steel cores provided for the exciting coils. As regards the armature construction, the core is slotted to receive the conductors, four pairs being placed in each slot. The approximate total number of conductors on the armature is 308, there being about 19$\frac{1}{2}$ slots per pole. The construction of the supports for the brush ring are exceedingly well got out, and there being no bare conductors running round the ring. Instead of these, insulated wires are led to connect up the various alternate brush arms, which wires are contained in a channel constructed in the ring, which revolves on rollers. As mentioned above in the description of the engine, the exhaust of this set is taken into a Worthington condenser, and we notice that there is no provision for the exhaust to atmosphere. What would happen to the circuits supplied by this machine should the air-pumps cease to work, will be quite obvious to every engineer. We believe that this is not the only case in which the running of the plant supplying light to the exhibition are absolutely dependent on the continuity of working of the condensing gear. We presume that in this respect the individual exhibitors are to blame.

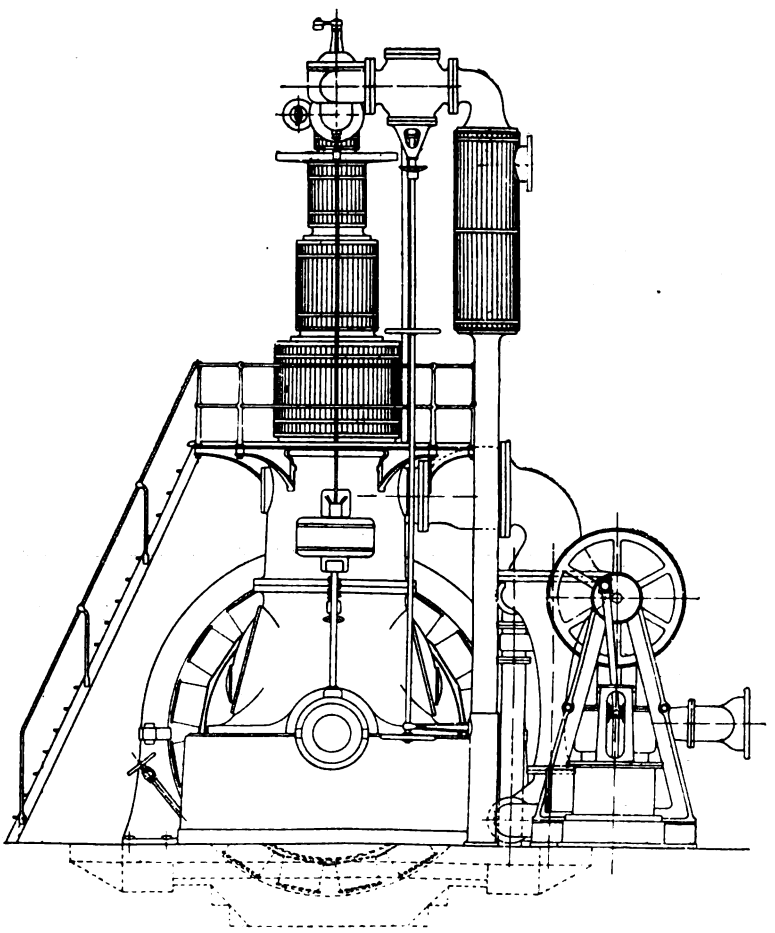

FIG. 6.—End Elevation of the Engine, showing Condensing Plant.

THE LONDON HIPPODROME.

With the marvels of the Hippodrome as a place of entertainment no doubt Londoners are by this time thoroughly familiar, but there is another world behind the scenes, and under the floor thereof, and high above in the sky, which we recently explored by the kind permission of Mr. Frank Parker, stage director, and Mr. H. W. Garrick, Press manager, and under the guidance of Mr. H. W. Hawkins, the chief engineer of the Hippodrome Company, and to whose courtesy we are indebted for the illustrations accompanying this article.

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An electric supply which covers about 2,000 incandescent lamps and 20 arcs is not to be found in every house, and in this case an independent supply is secured,

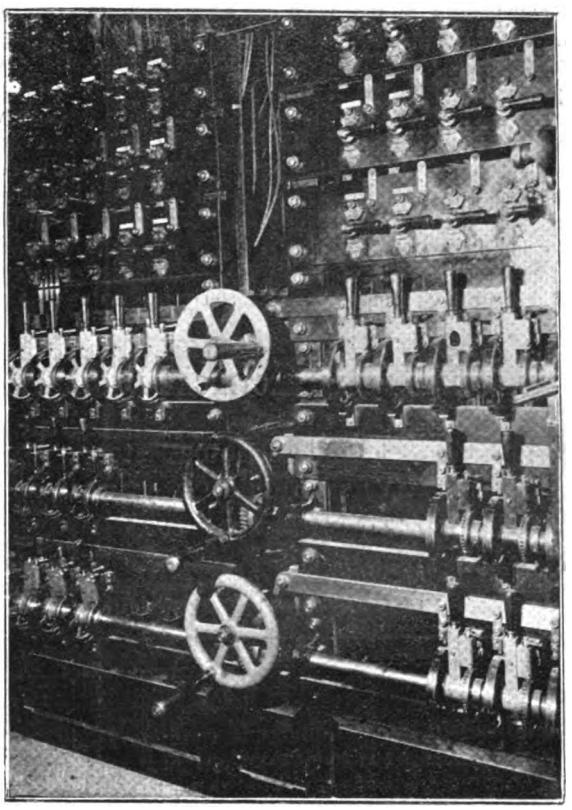

FIG. 1.

as the lights throughout the building are alternately connected with either of the centrals of the Charing Cross and Strand Electricity Company at Shorts-gardens and at Maiden-lane. All this means complicated switching arrangements, and the switchboard-rooms are, of course, of the most interest. The one controlling the stage-lighting is just a step from the stage when the latter is at high tide, but it means a steep ascent up a ladder which is perfectly vertical, like a fire-escape, when the floor of the stage has sunk. There are two double switchboards in this room (Fig. 1). They are covered with black marble, and resplendent in shining copper, and have handles, too numerous to mention, which control the footlights, the red, white, and blue gamut in the flies, the pilot lights, the six arcs illuminating the tank, and so forth. An ingenious contrivance in the wall allows the attendants a view of the house, and a telephone connects with the second switchboard-room (Fig. 2) in the basement. The latter board controls the front of the house and the outside of the buildings. Liquid resistances are used. Mr. Wingfield Bowles was the consulting engineer for the electric installation. The switchboards and the larger fixings were supplied by Blackburn, Starling, of Nottingham, and Ernest Moy, of Camden Town. There are five very elegant chandeliers, four in the auditorium and an especially artistic ten-armed specimen in the vestibule.

The four great chandeliers, which carry 40 lights each, were made by Messrs. F. and C. Osler, of Oxford-street. They are also under the control of the stage switchboard, while the lights over the seats and in the passages are connected with the other, an arrangement which is very convenient when it is necessary to darken the house during cinematograph performances. The current is supplied by meter; the daily consumption amounts to about 1,000 units, which at 4d. per unit, spread as it is over a day load and night load, must constitute an ideal customer for the electricity works.

There is a great deal more to see underground of objects in which the engineer takes a delight, the foremost being the easily-worked levers controlling the hydraulic apparatus working the rising and lowering of the stage.

The arena has a capacity of about 100,000 gallons, its girth is 230ft., and the average depth 8ft. It is made of steel boiler plates, and when full of water it weighs 400 tons. This weight is supported by a strong steel platform with eight radiating lattice steel girders and circular bearers, thus leaving open under the tank a space 4ft. to 5ft. high,

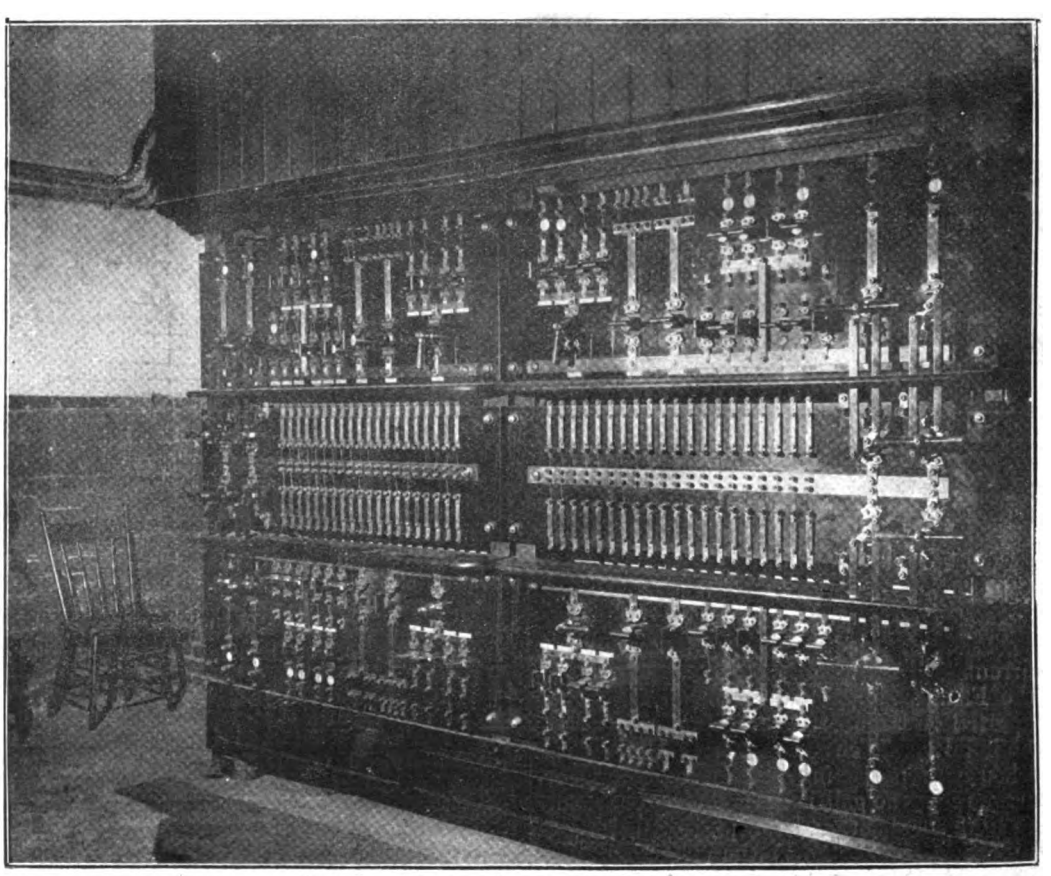

FIG. 2.

which serves a variety of purposes. Inside the tank is a steel-framed table, similar in shape to a railway turntable, but which instead of revolving works up and down. It is attached in the centre to a powerful hydraulic ram. The two

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exits on either side are similarly arranged, and each works by an independent hydraulic ram. Entering the tank at the bottom there are eight telescopic fountains worked by the pressure of the water in the mains; these fountains force themselves to the top of the water in the tank and immediately commence playing, throwing up jets of water some 20ft. high. Round the outside of the tank a series of eight hydraulic rams are placed; upon the tops of these circular lengths of railings are fixed working in guides, which work the silver grille alluded to elsewhere. The stage is constructed of specially designed steel girders, and is capable of being raised and lowered some 6ft. or 7ft. The girders act as cantilevers during the process of raising the stage, and supporting centre weight of the stage and live load upon it at a span of 48ft. when at rest. The supports and guides are strong iron standards bolted firmly to the wall, fitted with a rack; and to the bottom of the girders strong steel pawls are fixed. By means of these the stage can be raised, lowered, and supported at any intermediate position, and is worked by two hydraulic rams, the centre ram being used for lifting, the other for tilting. Both are under the control of the same man, and are operated from the same position as the other rams, etc.

Going into the front of the house, we cannot fail to notice the pretty effect obtained in the lighting of the foyer, with its painted glass dome and its staircase columns and walls of marble. What strikes one first upon entering the immense gilded hall of the auditorium is the projector gallery (Fig. 3)—in a figurative sense, of course, as it is several feet too high to do so literally. This is an entirely new feature as far as English theatres are concerned. With the projecting lantern at the back of the house and its attendant troubles most of us are acquainted. The gallery really consists of a large square opening in the centre dome surrounded by a handsome open colonnade, in keeping with the Flemish Renaissance style of the whole hall. It is supported on large brackets springing from the main ribs of the building. Ten arc lamps of 15 amperes each and furnished with projecting mirrors are placed in the corridor surrounding the gallery. Ample scope is given to the operators to move about, and for purposes of lime-light effect (by means of electricity) the arrangement is simply invaluable. All the arc lamps are hand fed, and a staff of 12 men is kept to manipulate the score of them. The light effects are obtained by means of special screens, some of which are made of glass and some of gelatine. At the same time, the lamps here are the means of lighting the circus, and are casting a brilliant, yet softly diffused, light on the arena, where the lion roareth and the wangdoodle playeth his frolicsome antics. The auditorium part of this palatial building is well looked after, the accommodation consisting of everything which may be suggested by the words comfort, luxury, and splendour. Nor is the safety of the onlookers neglected. Silver-plated grilles rising, when required, all round the ring separate the audience from the ferocious beasts, ponies, monkeys, and baa-lambs while they are being exhibited. The orchestra has been displaced from its usual interfering position between audience and performers, and is provided with a fine minstrels' gallery at a large expense of valuable seating space, but resulting in great comfort to the audience, and no doubt to the musicians themselves. Taking it all round, the whole arrangements may be summed up as being "strictly up to date."

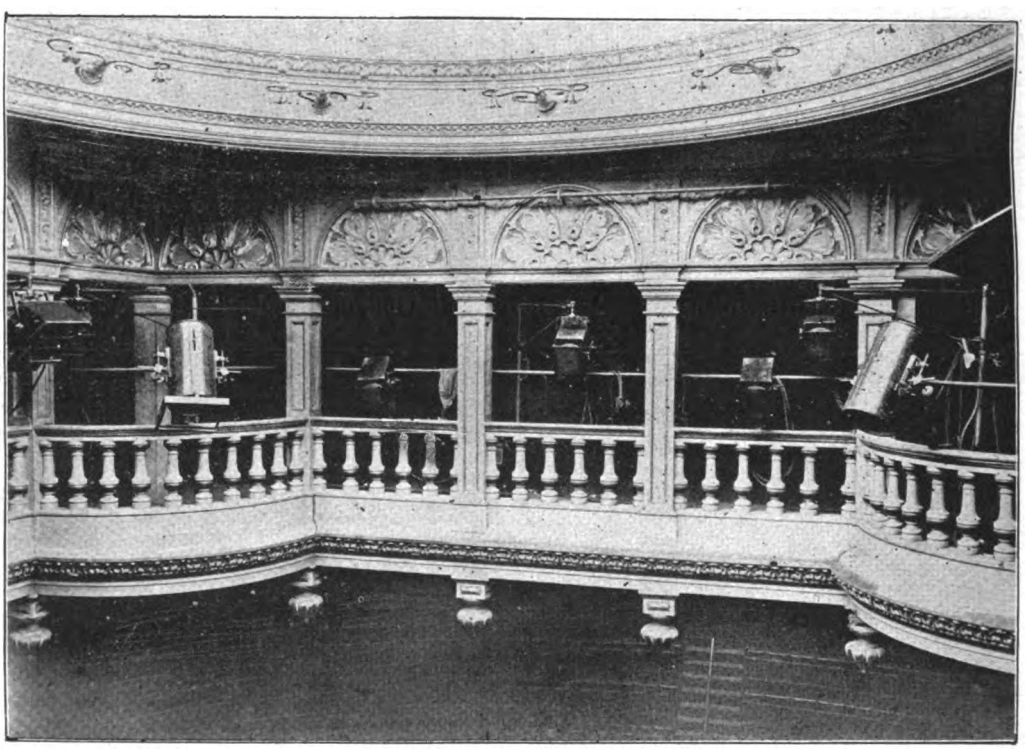

FIG. 3.

INSTITUTION OF ELECTRICAL ENGINEERS.

A Frictionless Motor Meter.

BY S. EVERSHED, ASSOCIATE-MEMBER.

(Continued from page 809.)

Essential Points in Magnetic Suspension of Meter Axles.—Magnetic attraction has been used to partially support the weight of dynamo armatures by the simple expedient of boring the pole-pieces eccentrically. Again, if a dynamo has a vertical axle, the whole of the pressure upon the step bearing may be removed by allowing the armature core to fall a little below the level of the pole-pieces; but these and similar applications of magnetism to the relief of bearing pressure must not be confounded with its use as a means of reducing the resistance to rotation of a meter axle. Our object in magnetically suspending the axle of a motor meter is twofold. It is certainly an advantage to reduce wear and tear of bearing, but primarily we desire to improve the meter as regards accuracy and waste of energy, and to that end it is essential that there should be a reduction of all the resistances to rotation other than that offered by the brake. Now, while it is easy to suspend a meter axle by some such means as those just referred to as applicable to dynamos, a moment's consideration shows that in reducing the friction of the step bearing to zero, we have at the same time introduced a new source of friction—namely, hysteresis in the iron core on which the two pole-pieces act. This, as is well known, offers a resistance to rotation. Its amount in any practical example will be found to be enormously greater than the frictional torque of the step bearing. In a dynamo or motor the hysteresis torque is there in any case, whether we suspend the armature or not, so that the relief of bearing

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friction by displacing the armature in the pole-pieces is a clear gain, but in the meter there is no iron core within the armature, and in order to suspend the axle in the same way a core must be put upon the axle for that purpose, thus introducing a resisting torque which did not exist before. We thus arrive at an essential principle for magnetic suspension of meter axles: the induction density in the magnetic devices used for support must remain absolutely constant during rotation of the axle. This at once disposes of unsymmetrical bipolar arrangements; nothing of the nature of two poles attracting a piece of iron will serve. To secure uniform induction density in the rotating part of the magnetic circuit, the attracting pole must be a figure of revolution with its axis coincident with the axis of rotation. As an example, the attracting pole might be a ring concentric with the axle; an iron disc fixed upon the axle a little below the plane of the ring pole would be attracted upwards, and if the ring and disc could be made mechanically true and magnetically homogeneous, the induction density would be uniform in the disc and there would be no resistance to rotation due to hysteresis. In practice it is exceedingly difficult to ensure these conditions. The disc is in unstable equilibrium transversely, and as there is necessarily a little clearance between the axle pivots and their bearings, the disc will alway run a little out of centre; this at once raises the density at one part of the annular air-gap and lowers it on the opposite side, and during rotation

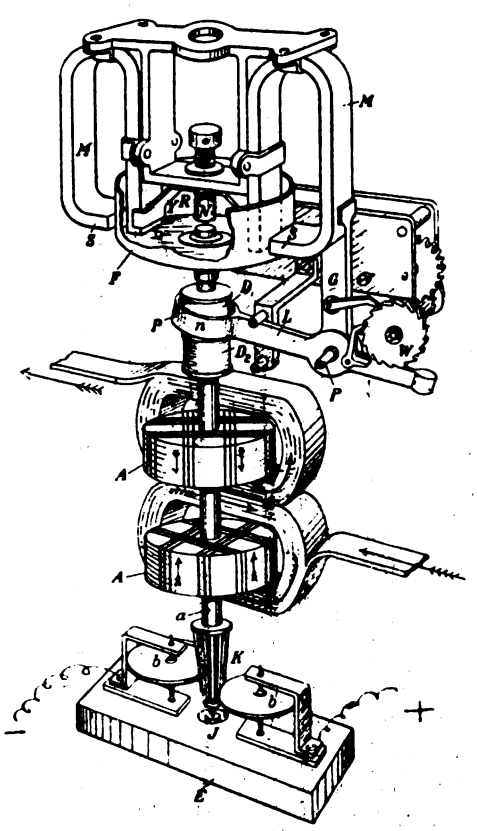

FIG. 7.—General Arrangement of Astatic Frictionless Meter.

the iron of the disc goes through a minute magnetic cycle, absorbing a corresponding amount of energy. The disc is also pulled sideways and causes the pivots to press against the bearings. These effects were very marked in the experimental devices already referred to (Figs. 3 and 4), and led the author to abandon that type of suspension for the simple form finally adopted—namely, a cylindrical magnetised rod fixed with its lower end immediately above and in line with the cylindrical iron axle. It must not be supposed that this is a complete solution of the problem, but it has proved itself to be a thoroughly practicable one, and if the diameter of the supporting pole and axle is small enough, there appears to be no trace of hysteresis, nor is any difficulty experienced in obtaining the requisite mechanical truth. Of course, the position of the axle is one of unstable equilibrium in a vertical direction, the magnetic attraction increasing rapidly if the axle rises towards the supporting pole; but if means are adopted to confine the possible travel of the axle within narrow limits, it will run with very little pressure on the step bearing.

Description of Frictionless Meter.—The essential working parts of the author's meter are shown in Fig. 7. The armature, A, brake-dish, F, and train-driving coils, D_1 D_2, are mounted on a mild-steel axle, *a*. The axle has a hard-steel point at its lower end resting in a jewel-cup, J; its upper end has no mechanical support, but is maintained in position by the magnetic attraction of an iron rod, R, which is magnetised by the brake magnets, M M, through an iron yoke, Y, and forms the supporting pole. The distance between R and the end of the axle is adjusted by screwing R in the yoke, Y, until the vertical force nearly suffices to lift the whole weight of the armature, brake, and other parts attached to the axle. The arrangement is more clearly seen in Fig. 8, which is a section through the magnetic pivot. A magnetic pivot of this type may easily be made to support a weight of from 100 grm. to 200 grm.

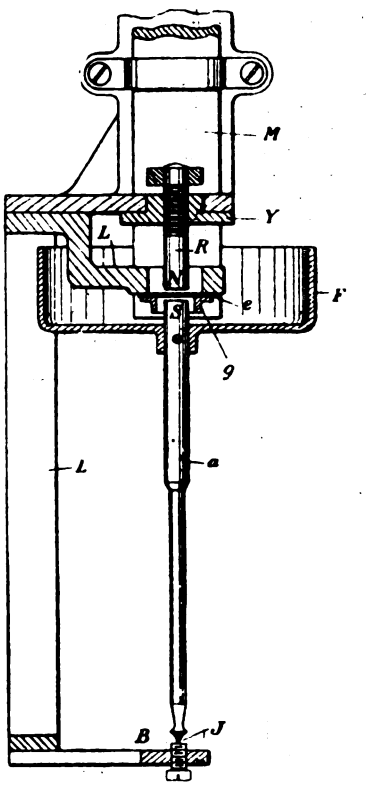

FIG. 8.—Axial Section showing Details of Magnetic Suspension in a Frictionless Meter. *M*, brake magnet; *Y*, iron yoke between the brake magnets; *R*, iron rod forming supporting pole *N*; *a*, iron axle having upper end *S* beneath pole *N*; *e*, end-plate (non-magnetic); *g*, guard ring to prevent axle from being displaced; *F*, brake dish; *B*, step bearing with jewel cup *J*; *L*, axle bearing frame.

The commutator, K, is placed beneath the armature, and the wheel brushes, *b b*, are pivoted in frames attached to an ebonite plate, E. The commutator and brushes are shown on an enlarged scale in Fig. 9. The segments are fine iridio-platinum wires, supported at one end in an ivory collet and entirely free at the other end, where they impinge and roll on the brush wheels. The commutator is about 3mm. in diameter at the rolling circle; the wheels are about 36mm. in diameter, so that they make one revolution to 12 revolutions of the commutator.

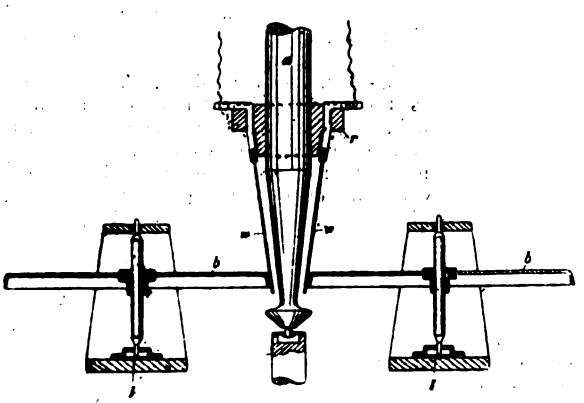

FIG. 9.—Elastic Commutator. *a*, axle; *r*, insulating collet; *w w*, iridio-platinum wires forming commutator segments; *b b*, brush wheels; *p p*, iridio-platinum pivots; *I I*, iridio-platinum bearing plates.

The pressure current is led to the brush wheels through their frames, and to ensure good contact between frame and wheel the step bearing of each wheel is an iridio-platinum pivot resting on a flat plate of the same metal. A drum winding is used for the armature, a break being made in the ordinary course of winding in each parallel, in order to insert the two little coils, D_1 D_2. Thus D_1 is in series with one of the two parallels of the drum winding, and D_2 in series with the other; they are consequently each traversed by one-half of the whole armature current, and since they are, electrically, a part of the armature circuit, the current in them is reversed twice in each revolution of the axle. D_1 and D_2 are inserted at corresponding points of the drum winding, so that their currents reverse at the same instant, and they are coupled up so that the two

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currents flow in the same direction, and to all intents and purposes D_1 and D_2 behave like one coil. Fig. 10 shows the connections of the train-driving coils in diagrammatic form, a Gramme winding being substituted for the drum for the sake of clearness. Surrounding the train coils, D_1 and D_2, but not touching them, is a ring of soft iron, P (Fig. 7), forming part of an iron lever, L, mounted on an horizontal axle, *p*. L is magnetised by induction from one of the brake magnets, an iron bar, G, serving to complete the magnetic circuit between S and *n*. The induction leaves the ring pole, P, and passes radially through the train coils into the axle, and P consequently experiences a vertical force alternately upwards and downwards as the currents in the train coils periodically reverse. The result is that L oscillates on its axis, making a double stroke or complete cycle once in every revolution of the armature. The motion of the lever is limited by stops, and is communicated by means of a pawl to a ratchet wheel, W, which is attached to the first axle of the counting-train, T. It will be seen at once that this device opposes no retarding moment on the armature axle. The only mechanical force called into play is in a vertical direction and has no component tending to turn the axle. The train coils and magnetised lever form a reciprocating electric motor, and during the time the ring pole is moving up (or down) there is a back E.M.F. in the train coils, and the product of this back E.M.F. into the armature current and the time gives the consumption of electrical energy per stroke. It is, of course, equal to the mechanical work done—product of force on P into length of stroke. The force actually provided is far greater than that necessary to drive the train. The friction of an ordinary train is just overcome by a turning moment of about four dyne-centimetres applied to the

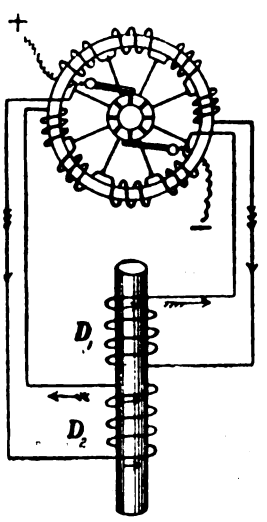

FIG. 10.—Diagram of Connections between Armature and Train Coils.

worm or pinion commonly used on a meter axle to gear into the first wheel of the train; six dyne-centimetres will generally keep a train running at a speed a good deal higher than anything save a short-circuit can produce. The author has tested many trains taken out of different electric meters, and, curiously enough, they differ very little as regards friction. Now, if the train were geared to the axle in the usual manner, and required a moment of six dyne-centimetres to keep it going, the work done by the meter in driving the train, being, of course, 2π times this moment in each revolution, would be about 38 ergs. The stroke of the train-driving lever is about 1·0cm., so that the force upon it must be at least $\frac{38}{1\cdot0} = 38$ dynes. The force actually obtained is about 750 dynes, which leaves an ample margin for accidental friction. It is assumed that the lever does no useful work on its return stroke. A number of different forms of this train driver have been designed, and several of them have been tested in actual work. Fig. 11 shows a modification characterised by the same fundamental principle—namely, a coil producing an alternately upward and downward force upon the free end of a lever. In this modification the two train coils, D_1 and D_2, are coupled back to back, so that they produce a consequent pole in the space between them, and the movable coil attached to the end of the lever is alternately forced up and down. This coil forms part of the series resistance in the armature circuit, and carries the whole of the pressure current. Fig. 11 is intended for alternate-current meters where a permanently-magnetised lever would of course be useless. There are other features in the design of the meter which will be of interest to station engineers, but which are hardly of sufficient general interest to warrant such a detailed description as has been given of the means adopted to reduce friction. The whole of the working parts of the meter, with the exception of the main current coils, are attached to a light framework, which is bolted to the top of the casting which forms the back, top, and bottom of the meter-case. The other three sides of the case are formed by a bent sheet of zinc, which is screwed and sealed to the casting. The terminals project below the bottom, and are covered by an insulating box, which may be sealed after connecting-up on the consumers' premises. The Foucault brake is in the form of a shallow dish, and the two brake magnets are fixed in positions which make it impossible for any excess of current in the main coils to demagnetise them. Their stray field is at right angles to that of the main coils.

Range of Frictionless Meter.—A meter in which frictional resistance is so small as three dyne-centimetres will obviously have an unusually long range, even if nothing be done to correct the small remaining friction error. If the same limits are imposed as were assumed in making up Table I.—namely, about one volt drop in the main coils and three watts wasted in the pressure circuit—the meter may be wound to give a maximum driving torque of 15,000 dyne-centimetres. The friction is then only 0·02 per cent. of the full-load torque. The resulting range and uncorrected errors are set out in Table II. It will be seen that the standard range of this uncorrected meter is 1 to 250. The range may be greatly extended by introducing a device to compensate for friction, and the very long range of such compensated meters may be useful in special cases. The author believes, however, that if advantage is taken of the enormous reduction in friction to improve the meter in other ways, even at a sacrifice of some part of the long range, a more generally serviceable instrument will be secured. An examination of the available statistics with regard to numbers of consumers and the lamps (or equivalent load) connected to the mains of the supply undertakings of this country, shows that on an average about 50 8-c.p. lamps or their equivalent are wired per consumer. If we assume these to be 40-watt lamps, the maximum load of the average consumer will be about

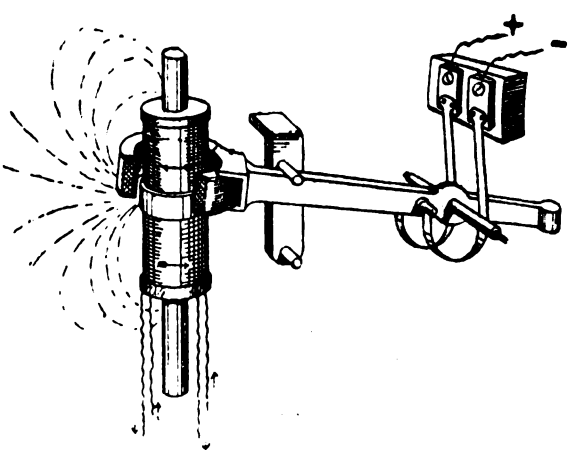

FIG. 11.—Train Coils and Lever for Alternate Currents.

2,000 watts, and his minimum about 40 watts. Now, although the maximum demand of the consumer will not much exceed half this amount (the "maximum demand" for nine of the largest undertakings in London is 46 per cent. of the total load connected), the meter installed may be assumed to be wound for 2,000 watts, so that if the meter is to register correctly at the smallest load its range must at least be 1 to 50. It is, of course, quite probable that within a few years consumers will be using lamps taking far less power, but there is no reason to believe that the ratio of smallest load to maximum load will be much, if at all, affected by the introduction of more economical lamps. The standard range may then be reduced to 1 to 50, but any further decrease will be at the expense of revenue. A reduction of range enables us largely to reduce the power wasted in the armature circuit, but a limit to this reduction is imposed by the fineness of the wire it is possible to employ upon the armature and in the series resistance. On this account it is at present not advisable to reduce the pressure current below 0·01 ampere, and this value has therefore been adopted for all voltages. The waste of power in the armature circuit is then 1 watt for 100 volts, 2 watts for 200 volts, and so on.

TABLE II.—Errors of Uncorrected "Frictionless" Meter. Maximum Driving Torque = 100, Friction = ·02. Full Speed = 100; Arbitrary Units.

Driving moment, M.	Friction, *f*.	Speed, numerically equal to M − *f*.	Percentage error.
·02	·02	0	Inf.
·04	·02	·02	50
·10	·02	08	20
·40	·02	·38	5
1·00	02	·98	2
10 00	·02	9·98	·02
50 00	·02	49 98	·04
100·00	02	99 98	·02

Standard range = 1 to 250.

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The voltage drop in the main coils may be left at 1 volt, this being only ½ per cent. on the 200-volt supply, which is now being rapidly adopted. An additional improvement in accuracy has been secured by making the meter astatic, so that it is not affected by external magnetic forces.

Astatic Meter.—The astatic meter has its armature divided into two equal portions, placed one above the other, on the axle, as shown in Fig. 7. These two parts, although physically separated, form one complete drum winding connected to a single commutator. Following the process of winding a drum, the first coil will be wound on the lower spider; the second will be wound on the upper spider in exactly the same position as regards azimuth as it would ordinarily occupy if wound on the lower armature, but it is wound in the opposite sense. The third coil is on the lower spider; the fourth on the upper and reversed in sense. Thus, numbering the coils in succession, all the odd numbers will be found on the lower half armature and all the even numbers will be found on the upper half. Each half armature is surrounded by its own pair of main current coils, the two pairs being coupled so that the current flows in them in opposite senses, their magnetic fields being in opposite directions. This reversed coupling is, of course, necessary to drive both parts of the armature the same way, but it has the incidental advantage that it greatly reduces the stray field of the main coils, and so renders the brake magnets doubly secure against excessive currents. The advantage of an astatic armature is, however, only gained at the cost of a reduction in driving torque, for a little consideration will show that when a non-astatic drum armature is converted to the astatic form shown in Fig. 7, and one half of the copper on the main coils is taken off and made up into a second pair of coils, so that each of the two parts of the armatures may be driven, the field in which the armature rotates is halved although the number of turns on the armature itself remains the same as before. Probably very few consumers possess the requisite combination of knowledge and knavery to enable them to attempt a reduction of their electric light bill by the use of a strong magnet placed near the meter, but meters are always liable to be fixed in positions where stray fields exist, and the author is inclined to believe that the astatic armature will prove to be a clear gain. To sum up, the astatic meter is wound to give a driving torque of about 2,000 dyne-centimetres at full load; the current in the armature circuit being 10 milliamperes and the drop in the main coils one volt. The frictional resistance is about two dyne-centimetres when the meter is new, and the tests to be presently referred to show that a frictionless meter will run for many million revolutions before any serious increase in friction takes place.

Compensation for Remaining Friction.—The initial value of friction is compensated for by means of a little strip of sheet iron placed within the field of the main coils. When once magnetised by the main current, the coercive force of the iron is sufficient to provide the very small driving moment required to overcome friction. As has already been pointed out, compensation for friction will cause a meter to run at no load if it is subjected to vibration; but when friction is only a very minute fraction of the maximum driving torque, the over-registration of a corrected meter would be quite negligible even if it could occur, but as a matter of fact the elastic commutator has a directing moment upon the axle which prevents the meter from running until the driving torque is two or three times as great as the moment of friction. Hence it is impossible for the compensator to start the meter or to keep it running. The corrected meter starts with from 1/500th to 1/300th of full load, and has a standard range of about 1 to 200. The range and accuracy of a corrected meter are well exemplified by the two curves given in Fig. 12, which show the variation in the constants of two meters having a ratio of about 1 to 1,250 between friction and full-load torque. This happens to be approximately the same ratio as that it is proposed to adopt as a reasonable compromise between the conflicting elements of accuracy and waste of power, so that although these meters have a much larger frictional resistance than is now obtained, yet as regards accuracy and range they are very nearly identical with the astatic meter. The latter has much less driving torque, but its frictional resistance is smaller by a corresponding amount. The larger friction in meters Nos. 3 and 4 arises from the fact that they were made before the adoption of the elastic commutator and other improvements. They are fitted with very small commutators with rigid sections made of iridio-platinum wires, which form a sort of squirrel-cage round the axle. The diameter of the commutator is about 1-16in. Fine wire brushes are used, pressing very lightly upon the commutator. The frictional resistance in meter No. 3 is 7·9 dyne-centimetres, and the driving torque at full load is 10,000 dyne-centimetres. The corresponding quantities in meter No. 4 are approximately the same, but they were not accurately measured. These meters are corrected by a thin steel rod having the necessary coercive force, and, as will be seen on reference to the curves, they are both slightly under-corrected. The Board of Trade limits are, however, nowhere exceeded throughout the whole range from 0 to 5,000 watts. Meters Nos. 3 and 4 are in use in the meter testing department of the Manchester Corporation as standards for checking the accuracy of other meters intended for commercial purposes, and the author is indebted to Mr. Wordingham for his permission to make use of the curves which accompanied the Board of Trade certificate. He desires also to thank Mr. Rennie, who very kindly supplied a copy of the tests made at the Board of Trade laboratory.

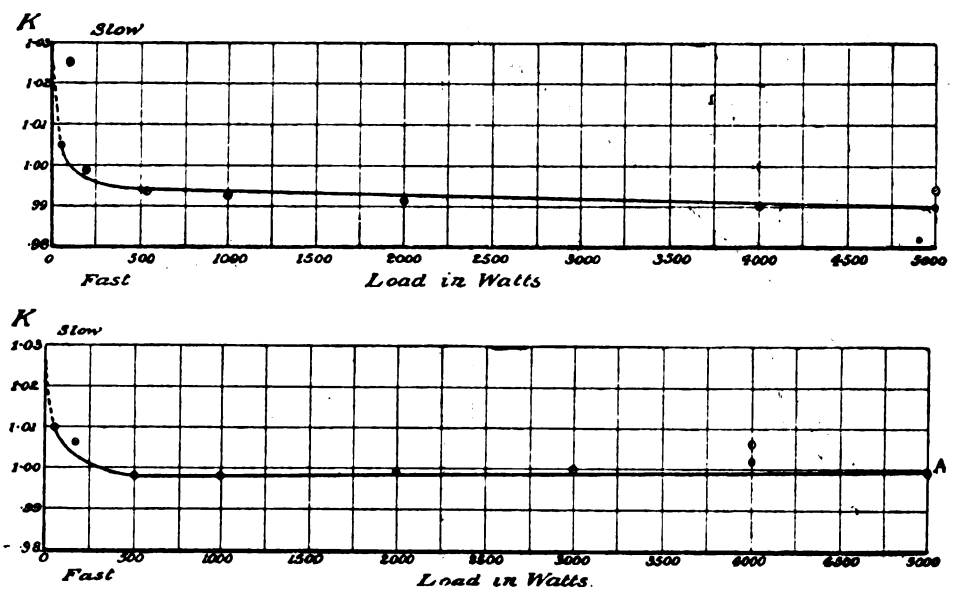

FIG. 12.—Curves for Meters Nos. 3 and 4 showing Variations of Constant with Load. • Points determined by the Author in July, 1899. ○ Points determined by Mr. Rennie at the Board of Trade Laboratory, September, 1899. At *A*, Mr. Rennie's observation falls exactly on a point determined by the Author. N.B.—The horizontal lines are drawn at intervals of 1 per cent.

Tests for Endurance.—There would be little advantage in any reduction of friction which was either not permanent or obtained at the cost of great delicacy of adjustment, and therefore liable to increase whenever the adjustment was accidentally disturbed. Prolonged trial in actual service is, of course, the only conclusive test of the trustworthiness of any novel apparatus, but the tests to which the frictionless meter is being subjected show already that the mechanism has a remarkable power of endurance. Two meters had been made in 1898, and after many trials with different forms of commutator and train-driving apparatus, in the course of which No. 1 meter had made between three and four million revolutions, the elastic commutator was fitted to this meter, and after preliminary tests for friction it was put on to a 100-volt circuit on May 25, 1899, and driven at 80 revolutions per minute by means of permanent magnets placed near the armature, this method of driving being adopted in order to avoid waste of current in the main coils. This meter has been running continuously since that date, with the exception of the few hours occupied in making friction tests. The tests made up to the date of writing are given in Table III. The revolutions are reckoned from the day when the test began, and give the total made by the commutator correctly; but, as already mentioned, the meter had previously run for over three million revolutions, so that the step bearing

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has been subjected to so much more wear and tear. The standard pressure current is 10 milliamperes, but for the purpose of this test it was raised to 18·2 milliamperes in order to make the energy running down in sparks upon the commutator when the train coils are reversed the same as it is with the standard size of train coil—No. 1 being fitted with a smaller train coil. This increase of current increases the sparking on all the sections, so that the total energy tending to destroy the commutator is far greater than it is with a standard train coil. During the first few weeks some sparking was visible, but this has gradually diminished until at the present time sparks are only seen occasionally. There is no apparent wear either on the commutator wires or on the brush wheels.

TABLE III.—Friction Tests* of Meter No. 1. This Meter was started on May 25, 1899, and has been running at about 80 revolutions per minute continuously since that date.

Date.	Total revolutions of armature axle.	Moment of frictional resistance (dyne-cms.).
May 25, 1899 ...	0	Not measured accurately, but about=7 dyne-cms.
June 28, 1899...	3,460,000	6·8
Sept. 26, 1899...	12,275,000	6·8
March 30, 1900..	29,046,000	7·2

* For methods of measurement see appendix.

Platinum in the form of black powder clings to the inside of the wires, and has also settled in a ring round the axle inside the commutator, otherwise there is no visible change. It is possible that the presence of the powder accounts for the diminution of sparking; the energy may be absorbed in heating-up the powder, which quite possibly acts as a variable resistance, and so ensures a gradual reduction of the current to zero instead of a sudden interruption and consequent spark.

TABLE IV.—Friction Tests* of Meter No. 2. This Meter was started on Oct. 12, 1899, and has been running at about 57 revolutions per minute continuously since that date.

Date.	Total revolutions of meter axle.	Moment of frictional resistance (dyne-cm.).
Oct. 12, 1899	0	3·2
Oct. 12, 1899	100	2·1
Oct. 13, 1899	not noted	2·3
Oct. 16, 1899	not noted	2·4
Oct. 20, 1899	not noted	3·2
Nov. 7, 1899	2,088,000	2·9
Nov. 20, 1899	3,030,000	3·0
Dec. 21, 1899	4,313,000	2·9
Jan. 29, 1900	—	3·3†
Jan. 30, 1900	7,233,000	3·5‡

* For methods of measurement see appendix.

† Commutator observed to be making irregular contact. After making test, examination showed a fine hair wound round and entangled in commutator. The hair was removed as carefully as possible without taking the meter to pieces.

‡ Taken immediately after removal of the hair.

On the other hand, the commutator may still be sparking as at first, and the powder may simply prevent the sparks from being seen. As soon as it was seen that the elastic commutator was a step in the right direction No. 2 meter was similarly fitted, but with a commutator having much finer wires—about four mils diameter—and with brass brush wheels lightly gilt upon their edges. After long tests with different pivots, during which time the elastic commutator made 3½ million revolutions, No. 2 meter was put on to the 100-volt circuit on Oct. 12, 1899, and it has been running at about 57 revolutions per minute day and night since that date. Periodical friction tests have been made, and the results are given in Table IV. No. 2 meter is fitted with a standard train coil, and the pressure current was, therefore, fixed at the normal value—namely, 10 milliamperes. No appreciable wear is visible on the commutator wires, but a curious change has gradually become apparent in the brush wheels. Where they roll in contact with the iridio-platinum wires their edges have acquired a smooth deposit of platinum, and under a magnifying glass they have the characteristic appearance of a surface which has been platinised by the ordinary electro-chemical process. During these tests no adjustments or alterations of any kind have been made in the meters, nor have any precautions been taken to keep dust and dirt away from them. They are running in a dirty workshop with loose covers over them, and the slowly increasing friction noticed with No. 2 meter is probably due to the collection of dust—which is very visible—within the step bearing and in the brush-wheel bearings. The normal speed at full load has been fixed at 50 revolutions per minute, so that No. 2 meter is running 14 per cent. and No. 1 meter 60 per cent. above full speed. If we assume the average consumer to use the equivalent of 1·8 hours at full load each day, his meter will at the above speed (50 revolutions per minute) make 2,000,000 revolutions per annum. No. 2 meter has, therefore, been subjected to wear and tear corresponding to five years' service, while No. 1 meter has run for a period corresponding to about 14 years. These figures are mentioned in order to enable the value of the tests to be estimated with some sense of proportion. They are not adduced as in any way a substitute for the test of hard work under all the varying conditions necessarily imposed upon supply meters in everyday use.

Possibility of Further Reductions in Friction.—The results so far obtained, and an examination of the causes of the remaining friction, afford some ground for believing that its limiting value has not yet been reached. The calculated value of the total frictional resistance in meter No. 2 (see appendix) is 1·6 dyne centimetres, 1·1 being attributable to the step bearing and 0·5 to the brush-wheel bearings. It is quite possible to use aluminium wheels and so reduce the pressure on their step bearings to about one-half of the present amount, reducing this part of the friction to 0·25. The pressure of the steel point upon the jewel of the armature axle bearing can be reduced by coupling the train coils back to back, as in Fig. 11, so as to eliminate the effect they now have in alternately increasing and diminishing the induction through the axle and supporting pole. If at the same time some means can be found to prevent the axle from accidentally rising from the step bearing, the only absolutely unavoidable pressure downwards will be about 1 grm., an amount which is, of course, necessary to prevent the mutual force between the train lever and the train coils from lifting the axle. To err on the safe side, we may assume that is possible to reduce the pressure from 12 grm. to about 2 grm., the corresponding reduction in friction being from 1·1 to about 0·2 dyne-centimetres. Hence it seems not impossible to reduce the 1·6 dyne-centimetres of total calculated friction to 0·45, or, say, 0·5 dyne-centimetres, a reduction of 1·1. This should be subtracted from the lowest observed value of the frictional resistance in No. 2 meter, and would bring the initial friction in a new meter down to about one dyne-centimetre. Again, the moment of frictional resistance per gramme weight upon the step bearing depends on the acuteness of the steel point resting upon the cup jewel. In the meters hitherto tested no attempt has been made to secure a fine steel point. The point having been ground to an angle of about 30deg., is rounded off at the tip until it forms a hemispherical end of from five to seven mils radius. This rests in a sapphire cup of from 20 to 40 mils radius, and although two spherical surfaces of different radius ought to touch in a point quite independently of the ratio of their radii, it is obvious that in practice we must look upon our spherical steel point as one with a rough surface making contact with the jewel in a number of points distributed over a very small and approximately circular area, the diameter of which will depend on the ratio of the radii of jewel and point, and upon the smoothness of the two surfaces. Now, as the formula for point friction indicates (see appendix), the moment of friction is proportional to the diameter of contact, so that we may expect a decrease in moment if we diminish the radius of the spherical point—an expectation which is, of course, borne out by the result of everyday experience. Whether the reduction so brought about will be permanent depends on how far the gradual burnishing of the steel by the jewel is affected by the pressure per unit of contact surface, and on the effect of the burnishing itself upon the coefficient of friction. No data drawn from engineering experience are likely to afford any clue to the answer to these questions, and no means have hitherto existed for obtaining a direct answer by experiment. The author is now investigating the behaviour of different kinds of step bearings for use in meters with a view to the determination of the type having the greatest power of endurance. Engineers accustomed to dealing with power in kilowatts and friction measured by hot bearings will be inclined to regard all such discussion of apparently insignificant details as so much industry wasted in the splitting of hairs. It will, however, be agreed that we cannot be said to have solved the problem of metering electric energy until meters possessing an adequate range and accuracy can be so constructed that they may be relied upon for many years' service without need of adjustment or repair. In this matter we may learn something from the gas-meter, of which, in spite of much unmerited and ignorant abuse, it may safely be said that while in point of accuracy it compares not unfavourably with the average electric meter, in other respects it is far in advance of any electric meter at present in use. The value of gas to a consumer depends upon its calorific and illuminating powers, and only in a minor degree upon its pressure. Hence the gas-meter may, and does, absorb a large fraction of the available pressure without much disadvantage to the user, and its remarkable power of endurance has been brought about by the use of a motor capable of doing a far larger amount of work than is required to overcome friction, even when the mechanism is much worn by use. A properly-made gas-meter may be installed upon the consumer's premises and remain there in constant use without adjustment or repair of any kind for from 10 to 15 years before the motor is sufficiently worn to cause a serious error. With an electric supply, on the other hand, energy is what the consumer wants and what he pays for, and for lighting purposes he must have the energy supplied at constant pressure; hence the electric meter cannot be allowed to

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absorb more than a very small fraction of the energy and pressure of supply. The mechanical power of the electric meter being therefore limited by the conditions of supply, it is only by diminishing friction and wear and tear that we can hope to attain and maintain the required accuracy throughout many years of service. From this point of view it is clearly of the greatest importance that every cause of mechanical friction should be ascertained, and as far as possible removed. It was with this conviction that the author, quite in the early days of public electric supply, set about devising means for diminishing meter friction, and the outcome of a good many years of experimental work is the meter described in this paper. It is not claimed for it that it is in all respects the ideal of what a meter should be, but the author hopes it may be regarded as a step in the right direction.

Note.—The author desires to acknowledge his indebtedness to Mr. Cox, who has the charge of the experimental department at Woodfield Works. During three years' continuous work upon the meter Mr. Cox's fertility of resource and inexhaustible patience have surmounted many difficulties and led to numerous improvements. When it was decided to try roller brushes making elastic contact with the commutator, and some trouble was met with in producing rollers of the requisite elasticity, Mr. Cox proposed to have the rollers rigid and make the commutator wires thin enough to provide the necessary elastic rolling contact—an idea which has been adopted with the happiest results.

(*To be continued.*)

THE "BUSH-JENKINS" AUTOMATIC ELECTRIC SAFETY LIFT CLUTCH.

The General Electric Company, Limited, have just introduced what they call the "Bush-Jenkins" automatic electric safety lift clutch. This safety clutch has been specially designed as a means of rendering impossible accidents on lifts and hoists; at the same time it fulfils the requirements of the Factory Act relative to the locking of lift gates or doors, which is automatically accomplished, and does not interfere with the working of the lift by causing loss of time, etc., and inconvenience. It is electrically controlled, and may be worked either from storage batteries or lighting main, alternate or direct current, at slight annual cost. It may be fitted to any existing lift without entailing structural alterations, being situated either on the cage in a convenient part to control the starting rope or gear, or at top or bottom of the lift-shaft. A special feature of the apparatus is that it is impossible to start the lift while the door is open, and no other door can be opened except the one at which the lift is stationary.

In the accompanying illustration (Fig. 1) the apparatus is shown with the starting rope seized, which position is maintained while the door is open, and owing to the construction of the grip it is impossible to pull the rope in either direction, a lift working by hydraulic power being therefore effectively prevented from creeping away from the floor. In Fig. 2 the action is reversed, and the rope is released by suitable switches, which are controlled in opening or closing the door or gate. An electrical contact made through the cage automatically locks the door or gate, which can only be opened from inside, and when the cage has left the floor it is impossible to open the door.

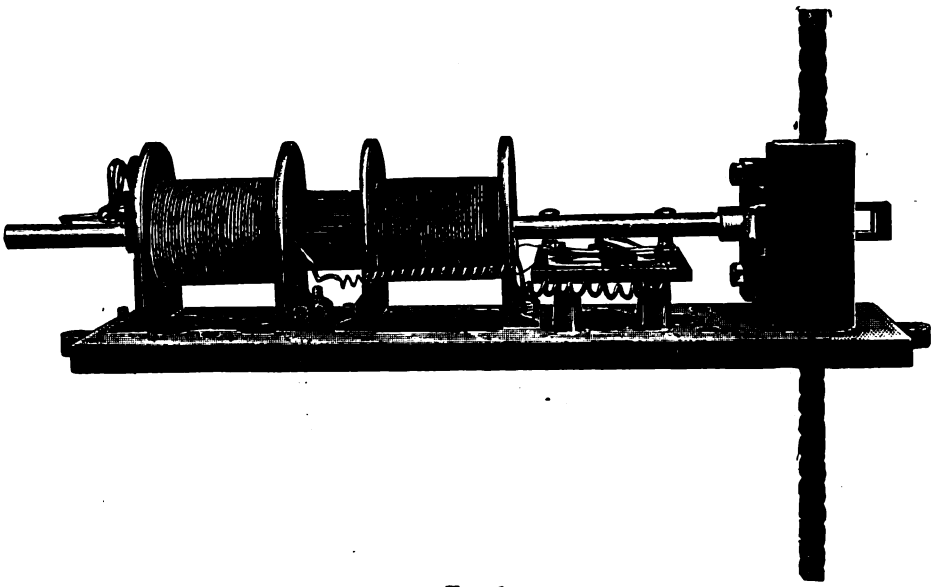

Fig. 1.

The introduction of the above-described piece of apparatus is very opportune, and its employment should be the means of greatly reducing the number of accidents which occur through persons walking into the lift-shaft presuming the lift to be at the door. Such accidents have been by no means infrequent of late, in some cases being attended with fatal results. The General Electric Company, Limited, claim that the above safety clutch absolutely precludes the possibility of all such accidents, for it prevents the cage being moved away from the floor while the door is open or insecurely fastened, and it is impossible to open the doors on any floor except that at which the cage is standing.

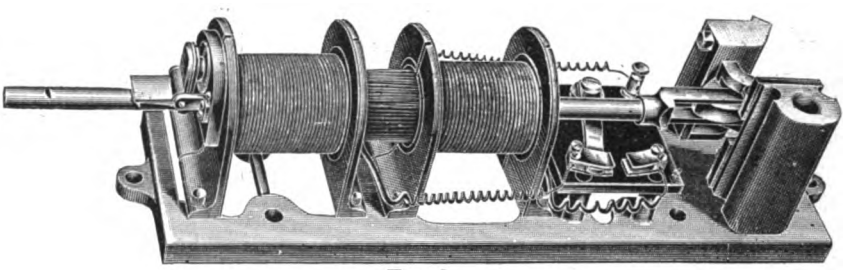

Fig. 2.

Chicago Telephones. — The Chicago Telephone Supply Company have recently adopted a new "Express" switchboard, which, it is claimed, combines all the latest and best ideas in telephone work. Thus, a 100-drop section of this switchboard is 4½ft. high by 18in. wide, and 100 drops occupy a space 16in. square. An improved standardised Bell construction is used throughout the system, and every contact from pole terminals is mounted on hard rubber, which is an entirely new feature. Each drop and jack are self-contained, and can be removed from the board in a very short time. The board, which is of the metallic circuit type, is stated by the *Telephone Magazine* to be absolutely free from cross-talk.

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THE PARIS EXHIBITION.

The electrical exhibits at the Paris Exhibition are worthy of careful study, and contain much which will be of interest to every class of electrical engineer. It is doubtful, however, whether the engineer who goes to Paris prepared to criticise will not have a considerably easier time than the engineer who, expecting to learn the latest improvements in various branches of electrical engineering, lays down a predetermined programme as to which exhibits he wishes to see. In other words, the difficulty in finding any particular exhibit is very great, and is in some cases quite insuperable. We know of an instance in which an engineer spent a week in searching for a particular exhibit which the officials were quite sure was to be found if their directions were only followed. It was discovered at last that the exhibit in question was peacefully reposing on the bed of the Atlantic, regardless of the fact that it was being sought on the banks of the Seine. At the present time the steam dynamos in the exhibition may be divided into three classes. In the first of these, which contains an unduly large proportion of the total, are those dynamos which are not complete and ready for running. This class is so great, that if it were not for the help of the electric lighting authorities of Paris, the exhibition would have to be closed every night for want of light. The next class consists of those machines which are nominally ready for running, but which are still being subjected to the hundred and one adjustments necessary when starting all new plant. These are used to give a certain amount of current to the exhibition mains, but they cannot be worked at full load or for many hours at a time. The remaining section contains dynamos in which the makers have been successful in speeding the erection and in obtaining good running conditions, in spite of the disadvantages they have had to contend with. We regret to say that the largest English exhibit comes in the first class. While the manufacturers of the engine and dynamo are not free from blame for the delay in erecting their plant, they have had to encounter risks which can hardly have been foreseen. For instance, the crankshaft of the engine, with its three-throw cranks, is not quite as easily lost as a needle, and yet this crankshaft was, we understand, mislaid by the railway company for over a month on its way from the steamer to Paris. This and some trouble over the steam-piping have prevented the engines being run up to the present, but the makers have hopes of getting steam on the engines before very long. In fact, an eminent electrical engineer in Paris assures us that by the time the exhibition is closed most of the electrical appliances will be in working order. In our opinion, it is very difficult to predict the exact closing time of the exhibition, and particularly of the electrical and machinery section. This is so because the administrative engineers have laid a number of electrical mines under the floor in all directions. These mines consist of four hundred and forty volt fuses, round which well-dried match-wood is piled so as to catch any sparks which may fall when the fuses blow. Then wooden covers are again

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placed over these fuses to communicate the fire with the floor. As a result of the use of these ingenious contrivances the illumination of the electrical fountains has been delayed by some months, and much valuable cable destroyed. We regret that it is impossible for the Electrical Congress to be arranged earlier than August, as we fear that some other part of the exhibition will suffer before then. If an electrical inspector of a fire insurance office should be contemplating a visit to the exhibition, we would seriously advise him to reconsider the matter unless he is absolutely sure his office has no pecuniary interest in the building. As to the electrical exhibits themselves, we cannot refer to them in detail here; but there are, of course, the usual monstrosities, amongst which is a cinematograph for the blind, and a phonograph for the deaf, said to be exhibited by a Swiss engineer, but we fancy, however, from an inspection of the inventor's space, that in this case also the apparatus must have been dispatched *viâ* the United States and the bed of the Atlantic.

MUNICIPAL MUDDLING.

If the work done by the aldermen and councillors of the Cardiff Town Council could only be measured by the heat of the expressions used in their discussions and their indignation over electrical affairs, Cardiff would be the best-governed town in the United Kingdom. As it is, the members of the Council, whether aldermen or councillors, spend a vast amount of time in wrangling, and grossly mismanage their affairs in consequence. In the vain endeavour to make every member of the Electric Lighting Committee a responsible electrical engineer, and to make each member of the electrical staff a personal friend of one member of the committee and an enemy of all the rest, the electrical undertaking became seriously muddled. It at length dawned upon the members of this committee, and also on the Corporation, that having a good electrical engineer in their employ it might be well to make him responsible for the management of the works, and to give the councillors much more time for wrangling pure and simple. The first outcome of this is that the engineer signalised his accession to power by increasing the salaries of certain individuals. We would presume from the public Press, not knowing this engineer personally, that the members so selected for increases in salary were the honest workers in the hive, and that those members who did not get increases were indignant at the distinction made. This indignation was, of course, reflected in the Council, and such terms as "An impudent assumption," etc., were used to support the vote of censure on the engineer, which, however, was hidden behind an amendment to the report of the Electrical Committee, which proposed to confirm the increases of salary so granted, in the case of certain members of the staff. We are pleased, however, that the indignant councillors have still cause for complaint, as the report was carried by a large majority. We trust that the electrical engineer of Cardiff will continue to use his power of controlling his staff, and that, if need be, he will instantly discharge any member of the same who tries to undermine his authority by going direct to the Electric Lighting Committee or the Council. The indignant councillors are now turning their attention towards a proposal to limit the size of family to be allowed to their employés in another department of their municipal work. We trust they will be more successful in this respect than with the superintendence of their electric lighting undertaking.

MANCHESTER TRAMWAYS.

The first step in the establishment of the Manchester Corporation's electric tramway system was taken on Tuesday last, when the chairman of the Tramways Committee (Mr. D. Boyle) laid the foundation-stone of the car-shed which is to be built at Queen's-road, Cheetham. It is estimated that the shed will be the largest of the kind in Europe. At the outset the deputy-chairman of the committee (Mr. W. H. Wainwright) presented a silver trowel and mallet to Mr. Boyle wherewith to perform the ceremony, and the stone was duly laid.

Mr. BOYLE then spoke of the importance of the work of the municipalisation of the tramways upon which they had entered. He said that the works in course of construction would provide accommodation for housing 252 cars. The area of ground to be covered was about four acres, and the works when completed would consist of a building 85 yards long by 11 yards wide, comprising offices, guards' and drivers' messroom, mechanics' shop, store and other rooms, and a house for the yard foreman. There would be an entrance gateway 16ft. wide to a covered approach 48ft. wide, with track lines leading to 14 bays of sheds These sheds would be 37ft. wide, and would each contain 18 cars. A pit would be formed in 11 of the sheds for examination of the motors beneath the cars, while the remaining three sheds would be for 54 trailing cars, to stand on the solid ground. The principals of the shed roofs would consist of upwards of 400 tons of steel, carried by steel girders on about 100 cast-iron columns, and the roofs would be covered by boards and slating and about 60,000 square yards of patent glazing. Three gateways, 14ft. wide, would be provided as emergency exits only, to provide for any temporary block in the entrance roadway. The tracks and connections within the shed were equivalent to a length of two miles of single line of tramway. The tracks would be supported on steel stanchions. Free access would be obtained over the whole area of pit, which would allow of 200 cars being under inspection at one time. The total weight of the steelwork in the tracks and connections would be about 500 tons, and in the stanchions and girders for supporting the tracks about 250 tons. The total estimated cost of this work was £11,000. The shed and pit would be lighted by electricity, and would also be heated by a system of hot-water pipes. It would be necessary to have three additional sheds of almost equal size, and probably one or two smaller ones, for other roads. The system was new in Manchester. They intended stabling cars at different parts of the city instead of having sheds only at one place. The substitution of electric traction for horse traction made a great difference in this respect, and the cost would be small.

Mr. J. JOHNSTON proposed a vote of thanks to Mr. Boyle for laying the stone, and complimented the committee on their pursuit in a quiet way of what represented an interesting movement in municipal work.

Later in the day the company took luncheon, on the invitation of the committee, at the Manchester Town Hall, Mr. D. Boyle occupying the chair.

Blackpool.—The Corporation invite tenders for the electrical equipment of 15 single-truck tramcars. Tenders by June 18, Details in our advertisement columns.

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ELECTRIC ILLUMINATIONS DURING THE PRETORIA CELEBRATIONS IN GLASGOW.

The ease with which electric lighting lends itself to artistic treatment has been long recognised, and with the more extended use of electricity for lighting purposes its adoption for artistic illumination has been very general. Glasgow, like other towns, waxed jubilant over the success of our arms in South Africa, and, lest the orations of the Lord Provost and the cheering of the citizens should not be sufficient evidence of its patriotism, it decided to illuminate; and when the "greatest municipality on earth" decides to do anything it generally does it.

The municipal buildings facing George-square lend themselves particularly well to such illuminations as were deemed necessary, and the electricity department set to work to fix the lamps, their exertion accelerated perhaps by the knowledge that their chief's younger brother, Mr. A. D. Chamen, was serving with the Imperial Yeomanry.

A Glasgow Tramcar Pretoriarating.

The pediment of the buildings, containing a very fine carving illustrating the British Colonies, was illuminated by a batten carrying 50 lamps of 50 c.p. each, and a smaller batten of 24 32-c.p. lamps. The domes flanking this had their extremities illuminated by 150-c.p. lamps. The word "Pretoria" was shown by means of 250 lamps of 32 c p. The Royal monogram was composed of 32-c.p. lamps, the "V" having 35 and the "R" 40 lamps. Surmounting the whole was the Goddess of Liberty, who held in her uplifted hand a torch consisting of 120 lamps of 50 c.p. each, with a 200-c.p. lamp on the top. A searchlight, lent by the General Electric Company, completed the display.

It was the tramways department, however, which really made the show of the evening, thanks to the efforts of Mr. Nelson Graburn, M.I.E E., the rolling-stock superintendent, and Mr. John Young, the general manager. The car, a photo of which we reproduce, was a triumph of artistic treatment; and whatever may be said against the trolley by those whose æsthetic taste is over-developed, it cannot be denied that it lends itself, pole and all, to artistic illumination in a manner which any other system could not even approach. It says much for Mr. Graburn's efforts that the whole was practically completed in about 20 hours. The car was draped in the inevitable khaki and Union Jacks, while round the railings and up the pole were variously coloured lamps. On one side were the words "Orange River State," and the other "Vaal River State," brought out most effectively against the dark background. One end had the word "BOBS" in letters alternately clear and electric blue, while the other end had the Royal monogram and a St. Andrew's Cross. In all 456 lamps were employed on 76 circuits of six lamps in series, 83-volt lamps being used.

Mr. Graburn, who conceived the idea of illuminating the car, and who was responsible for the work, was for a number of years engineer to the Montreal tramways, and carried out the Jubilee illuminations of the electric tramway system there, in which some 11,000 lamps were used. His patriotic enthusiasm is not the evanescent product of momentary excitement, but is partly hereditary and partly acquired. The son of an English naval officer, he has spent most of his life in Canada, and served through the Canadian rebellion, where his two brothers were killed. Before coming to Glasgow he spent seven years as engineer and assistant manager on the Montreal electric tramway system.

THE "ARK" LAMP.

We referred last week in general terms to the catalogue of their "Ark" lamps we had received from Messrs Johnson and Phillips. These lamps are of the enclosed type, and we have now obtained from the makers a technical description of the same, which will be of interest to our readers. As to the advantages of the enclosed arc lamp for private installation work, and also in certain instances for public lighting, we need not at the present say much, as these advantages are so well recognised. With, however, the enclosed arc lamp and its consequent slow feed and infrequent inspection, it becomes of the utmost importance that the lamp should work regularly without atten-

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tion. The features of this arc lamp are particularly designed to this end, and the inventor has simplified the construction of the lamp to almost an irreducible minimum. As a result the whole of the parts, of which there are exceedingly few, are of massive construction, and are hence unlikely to be deranged by the lapse of

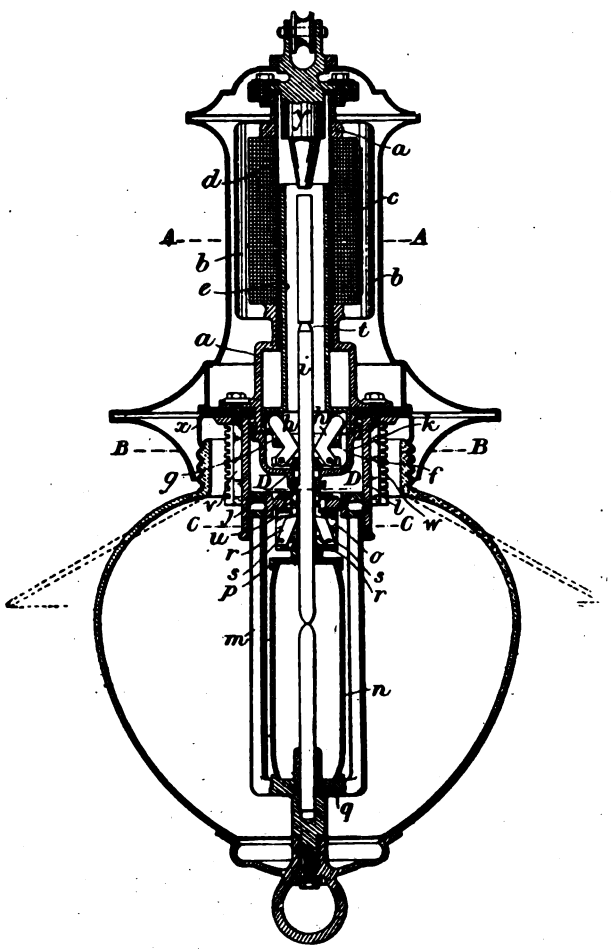

FIG. 1.

time. The details of the feeding gear are exceedingly interesting, as is also the arrangement for securing the globes to the framework. The following illustrations will make the construction of the lamp clear. Thus the upper carbon works entirely free, and without holder in a cylindrical core or armature of the regulating solenoid, the feed of the carbon being regu-

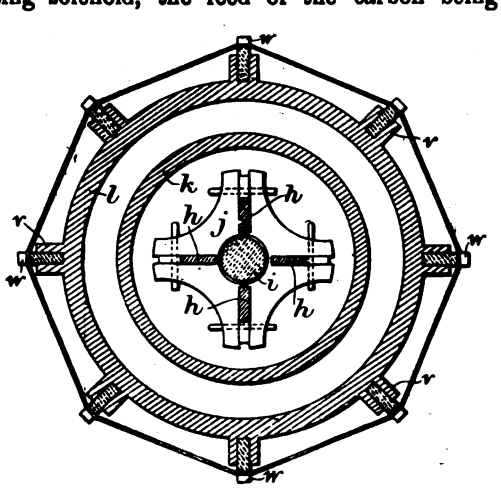

FIG. 3.

lated by a clutch device carried by the lower end of the armature, and consisting of a number of pivoted levers or cam pieces so formed and acted upon by pins on the solenoid armature that when the armature is in the lowered position the cams are caused by gravity to move away from the upper carbon, which can thus descend freely. When the armature is raised these pins act upon the cams so as to press these against the carbon, which is thus raised by the armature. The current is conveyed to the upper carbon by contact pieces pivoted to a plate, which also forms the top enclosure of the lamp glass, and these contact pieces are also arranged to effect the automatic cut-out by forming on the upper part of the upper carbon a circular groove, with which the contact pieces engage like pawls when the carbon has descended to such an extent as to bring the groove on a level with the contact pieces.

In the accompanying drawings Fig. 1 shows a vertical section of the improved lamp, while Figs. 2 to 5 show enlarged sections taken respectively at A A, B B, C C, and D D of Fig. 1. Fig. 6 shows the lamp resistance with covers removed.

The regulating mechanism is contained in a casing, *a*, formed of a single casting, in the looped part, *b*, of which is situated the solenoid, *c*. Within the central tube, *a*, of the solenoid is the tubular core or armature, *e*, also formed as a single casting, the lower flanged end of which has brackets, *f*, that carry pins, *g*, which operate upon the device, *h*, for clutching the upper carbon, *i*. This clutch device consists of a series of cam-shaped levers, *h*, that are

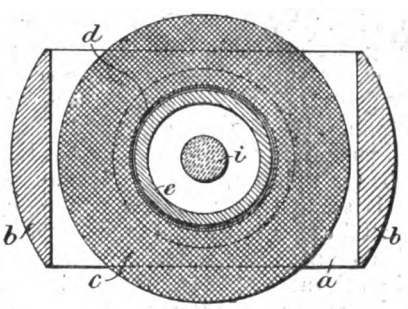

FIG. 2.

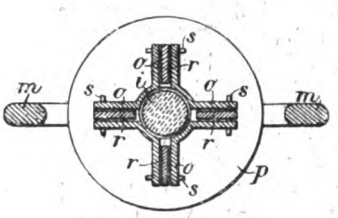

FIG. 4.

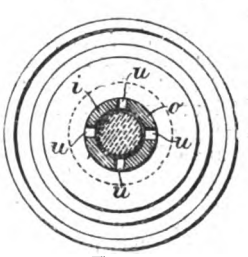

FIG. 5.

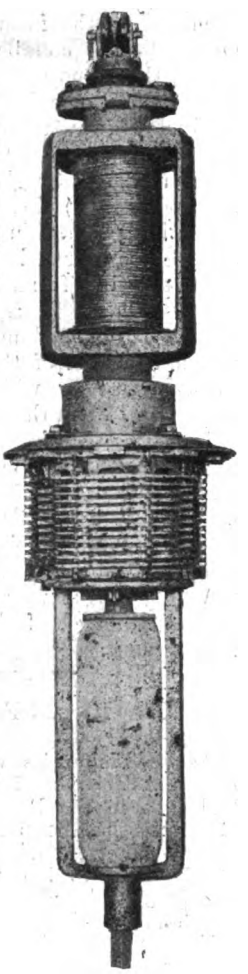

FIG. 6.

pivoted to brackets on a loose annular plate, *j*. When the armature, *e*, is in the lowered position the plate, *j*, rests upon the bottom of the cup-shaped piece, *k*, that is secured to the lower end of the casting, *a*; in this position the action of gravity upon the upper ends of the clutch levers, *h*, causes these to turn outwards upon their pivots so that they release the upper carbon, which is then free to descend towards the lower carbon. On the other hand, when the lamp is put in circuit the armature, *e*, being drawn upward, first acts upon the levers, *h*, by the pins, *g*, so as to cause these to clutch the carbon, and then raises them, together with the carbon, so as to strike the arc. As the carbons consume (which takes place at an exceedingly slow rate owing to their being enclosed in practically airtight compartments) the armature descends again, causing the levers, *h*, to release the carbons sufficiently to effect the required downward feed for maintaining the arc. To the underside of the casting, but insulated from

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it, is secured a cylindrical piece, *l*, into the lower end of which is screwed the upper end of the frame, *m*, that holds the glass, *n*, enclosing the carbons. Into the central opening of this frame is screwed a disc, which is secured in an insulated manner to a central brass casting, *o*, having a disc, *p*, at its lower end which constitutes the cap for closing and holding the glass, *n*, the lower end of which rests upon a disc, *q*, forming the bottom of the frame, *m*. The casting, *o*, is formed with a central cylindrical piece having four vertical slotted wings in the slots, *u*, of which are situated contact pieces, *r*, pivoted at *s* to the wings, and formed as shown at Fig. 1, so that they tend to fall inwards and thus make the necessary electrical contact with the upper carbon for conveying the current to it. The upper carbon has a circular groove, *t*, formed near its upper end, and when it has burnt away to such an extent that this groove arrives on a level with the upper ends of the contact pieces, *r*, these become engaged with such groove, and in this preventing the farther descent of the carbon, operate as an automatic cut-out. On the outer surface of the cylindrical piece, *l*, are formed ribs, *v*, carrying notched insulating pieces, *w*, in the notches of which is wound the resistance coil of the circuit, which coil is made in the form of a thin metal band as shown Owing to the coil being made of this form, and so supported that almost the entire surface thereof is in contact with the air, the heat generated will be most efficiently conducted away therefrom. By this arrangement of the resistance coil a great economy in space is obtained. For carrying the outer globe (or reflector, as shown in dotted lines, or screen) there is secured between the casting, *a*, and cylinder, *l*, a thin metal cap, *x*, having a rounded coarse screw thread formed thereon as shown, and a corresponding screw thread is formed on the neck of the globe or reflector, thus providing a ready means of attachment without requiring the usual metal fittings on the globe, etc. The magnetic circuit of the solenoid is closed at the top by the soft-iron piece, *y*, which is extended conically downwards so as to act upon the upper end of the armature, *e*.

It will be seen from the above description that the lamp is one which can be manufactured for a comparatively small cost, and which can be placed in the hands of an untechnical man. The artistic details of the cases in which the lamps are supplied we have not referred to, neither have we published illustrations of the same, but these "Ark" lamps leave nothing to be desired in this respect. The small length of the lamp (28½in.) is also a great point in its favour.

ASSOCIATION OF MUNICIPAL CORPORATIONS.

As noted in our last week's issue, the conference of delegates of the Association of Municipal Corporations opened on the 2nd inst. in the Royal University Buildings, Dublin. The Right Hon. the LORD MAYOR of DUBLIN (Sir T. Pile) presided at the opening, and, in speaking upon the subject of private Bill legislation, said that in dealing with that subject he would ask the careful consideration of the assembly. The resolution which he wished to propose upon the subject was as follows: "That in the opinion of this association the procedure in municipal private Bill legislation should be shortened, and the expense curtailed, and that the question of the best means of achieving that object be and is hereby referred to the council of the association for consideration and report." The subject was, he said, one of vital importance to the municipalities. The unnecessary doubling of the cost of submitting Bills to Parliament was unquestionably a great hardship, and more especially so in the case of municipalities which were situated at a great distance from the House of Commons. He thought some means should be adopted by which a dual trial would be avoided.

The motion was seconded by the TOWN CLERK OF WOLVERHAMPTON, and adopted unanimously.

The PRESIDENT (Sir A. Rollit, M.P.) afterwards rose to propose the following resolutions:

"1. That enterprises which have hitherto been entrusted by Parliament to municipal corporations, such as gas, water, tramways, electric lighting and power, markets, docks, piers, and other similar undertakings, have been managed efficiently and economically and for the general benefit of the inhabitants of the localities, and any abridgment or interference with such powers would in the opinion of this meeting be a misfortune to the communities served by such undertakings and a retrograde step in the principles of self-government.

"2. That in the opinion of this meeting all undertakings in the nature of a local monopoly or quasi-monopoly in which the general body of the inhabitants of the locality is interested, should be entrusted to the municipal authority, as has in effect been recognised by the Tramways Act, 1870; the Gas and Water Facilities Act, 1870; the Electric Lighting Acts, 1882 and 1888, and other Acts which require the consent of the local authority to applications for powers under those Acts.

"3. That municipal corporations cannot exercise any trading or other powers beyond those authorised by the general or local Acts. That it is inexpedient to fix any limit to the powers to be granted in future to municipal corporations, and that each case should be dealt with on its own merits.

"4. That having regard to the fact that the town council is a representative body, and that manufacturers and traders are members of such council, or are fully represented thereon, there is no fear that any undue interference with the trading interests of any town will be proposed or carried out.

"5. That the secretary of the association be requested to send a copy of the foregoing resolutions to the Joint Committee, and that evidence be submitted by representatives from cities and boroughs in support of such resolutions."

The PRESIDENT said he had already dealt with the subject of the resolution in his speech at the Guildhall and also in his place in Parliament. He would not move the second resolution; they should resist being shut into a straight jacket, curtailing the operations which had hitherto been so successful.

The LORD MAYOR OF DUBLIN proposed the following rider to the resolutions: "That any legislation which repeals the principles contained in the above resolutions be opposed by the association." They were now face to face with a House of Commons which was not in favour of municipal trading, and were also face to face with opposition to the works which corporations were legitimately entitled to keep in their hands. Therefore, he thought they should do everything possible to prevent interference with what were unquestionably their rights.

The rider and the resolutions as proposed were adopted.

THE MUNICIPAL ELECTRICAL ASSOCIATION.

We would again remind our readers of the meeting of this association next week. Thus on June 20 the convention will open with a general meeting for the discussion of papers at the Technical College, Huddersfield, and Mr. A. B. Mountain will deliver his presidential address. Papers will be read by Alderman Potter and Mr. H. C. Bishop on "Means for Stimulating the Demand for Electrical Energy," and on "Electricity Works for Small Towns" by Messrs. C. S. Vesey-Brown and G. M. Harris. In the afternoon the Bradford electricity works and electric tramway system will be visited. In the evening a dinner will be given at the Huddersfield Town Hall by Mr. J. Hopkinson to the members of the association.

On Thursday the papers for discussion will be on "Electric Motors," by Messrs. T. P. Wilmshurst and C. A. L. Prussman; "The Combined Management of Tramways and Lighting Departments," by Mr. R. C. Quin; and "Methods of Reducing Light-Load Losses," by Mr. H. L. P. Boot. After lunch the Mayor's garden party will take place, and at 7.30 p.m. the association dinner at the town hall.

On Friday the papers for discussion will be on "The Distribution of Electricity in Scattered Areas," by Messrs. L. Andrews and G. Wilkinson; "Maintaining Certain Portions of Electrical Distribution Systems at Earth Potential," by Mr. C. H. Wordingham; "Impressions of Present American Tramway Practice," by Mr. A. E. Le Rossignol; and "Protection of Telegraph and Telephone Wires." After lunch, the Leeds Corporation electricity works, etc., will be visited.

On June 23 the annual business meeting will be held at the Technical College, Huddersfield.

BLACKBURN TRAMWAYS.

The following is the report of Mr. Alfred S. Giles, general manager of the tramway department, to the chairman and members of the Tramways Committee on the working of the Corporation tramways undertaking. The accounts cover the year from March 25, 1899, to March 25, 1900:

Darwen Section.—The service on this section has been improved from a 20 minutes' interval to a 12 minutes' interval on Mondays, Tuesdays, Thursdays, and Fridays; from 15 to 12 minutes on Sundays and Wednesdays; and from 15 to 10 minutes on Saturdays. The fares have been reduced from 5d. all the way to 3d. The passengers travelling on this section during the year have numbered 2,814,876. The mileage run is 278,241. The receipts have averaged 12·37d. per mile. The working expenses have averaged 7·25d. per mile. The total receipts on this section are 20 per cent. in excess of the previous year worked by the late company. The rolling-stock belonging

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to the joint Corporations of Blackburn and Darwen numbers 10 engines and 10 cars, and there are three engines and cars working on this section which belong to the Blackburn Corporation. The whole of the permanent way is being relaid as a double line in the Blackburn borough. The balance-sheet for the year is very satisfactory, for after paying the Darwen Corporation their share of the profits, and putting away interest and sinking fund on our capital, there is a net profit of £1,153 on the year's working. This section is managed by the staff of the Blackburn tramway department, while previously the company were paying a separate secretary, manager, and engineer, which with other charges and direction cost £730 per annum. This economy, and the increased receipts per mile, account for the favourable balance.

Blackburn Section.—The electric lines (Preston-road and Witton) have been working for a full year, having been opened in March, 1899. The service on these sections has been improved from a 15 minutes' interval to a 10 minutes' interval. The fares were reduced from 2d. to 1d. from the railway station to Billinge End, and the line was extended from the Griffin Inn to Witton Stocks without increasing the fare. The passengers travelling on these sections have numbered 2,079,633 in the year. The mileage run by the electric cars is 169,942. The receipts on the Preston-road electric section have averaged 15·11d. per mile, and on the Witton electric section 9·25d. per mile. The working expenses on the electric sections have averaged 6·82d. per mile. The total receipts on Preston New-road and Witton are 65 per cent. in excess of the previous year's working. The drivers and conductors on these sections have been provided with uniforms. On the steam sections, church and cemetery, the service has been improved from a 15 minutes' interval to 12 minutes' interval on Mondays, Tuesdays, Thursdays, and Fridays, and from a 12 minutes' interval to a 10 minutes' interval on Sundays, Wednesdays, and Saturdays. The fares have been reduced on each route from 3d. and 1½d. all the way to 2d. and 1d. respectively. The passengers travelling on these sections numbered 2,152,893 in the year. The mileage run is 268,206. The receipts on the church section average 11·99d. per mile, and on the cemetery section 10·80d. per mile. The working expenses on the steam sections have averaged 6·92d. per mile. There is a loss on the year's working of £4,452, which is accounted for in the following manner: the total receipts for the year are £23,246. 5s. 6d., and the working expenses amount to £19,812. 17s. 1d., leaving a balance of £3,433. 6s. 5d. as gross profit. The charges for interest and sinking fund for the year amount to £7,886. 1s. 7d., so that the loss in this first year is £4,452. 12s. 2d.

In comparing the expenses side of the balance-sheet with that of last year the increase in working expenses arises principally in connection with the following items:

The horses which were sold in October cost £1,936 to keep whilst working on the cemetery section, while the receipts from the horse cars were but £1,315, a loss of £621, while the sum of £1,329 realised on the sale of the horses had to be paid into capital account	£621
The rise in coal has sent up the prices of the hard coke we use on the steam locomotives from 17s. to 23s. per ton, and this has made a difference of £545 in the item under this head	545
The repairs on the steam locos. and cars are heavier than last year on account of their age	1,080
A sum of £210 has been expended in overhauling and placing on the road seven engines and seven cars, which were purchased to enable a quicker service to be given on the church and cemetery sections	210
The increased wages paid on the steam sections amount to £350 in excess of last year, and on the electric cars the wages are increased by £849, due to shortening the men's hours and working two shifts	1,199
A sum of £243 has been expended in providing the men with uniforms	243
The rates and taxes since the Corporation took over the undertaking have increased from £337 to £610 per annum	273
The repairs to the permanent way on all sections are £500 heavier owing to the depreciated condition of the lines when taken over	500
	£4,671

The capital of the Corporation tramways is about £140,000, and it has not all been productive during the year, as the church and cemetery routes have not yet been adapted for electric traction, and the Corporation have not had the requisite number of cars to run a quicker service, so that the advantages from the relaying of the track with the double lines have not yet shown themselves; but in respect of all this capital expenditure the annual repayments of interest and sinking fund have had to be made. The rolling-stock of the Corporation is 21 steam locos. and cars and eight electric cars. During the year the following work has been carried out: The Simmons-street car depôt has been adapted and is being extended for the electric cars, and a repairing shop fitted up with the necessary tools required. The Intake car depôt is being extended and adapted for the electric cars. The whole of the permanent way on the church section has been relaid, and a double line substituted wherever the roadway was sufficiently wide. The Corporation having decided to equip the church, cemetery, and Darwen sections as soon as possible with electric overhead traction, placed an order with the British Thomson-Houston Company for 40 electric cars, and with Dick, Kerr, and Co. for 20 electric cars, the deliveries commencing in August next. On my recommendation the committee decided to carry out the overhead line work themselves. The materials and poles are well in hand, and a commencement has been made in planting the poles on the Darwen section of the Blackburn tramways. The fares during the year have been considerably reduced, and the cheaper rate is tending to swell the receipts per mile, which I have no hesitation in stating will be very materially increased during the next year.

PHYSICAL SOCIETY.

At the ordinary meeting of this society held on June 8, Dr. J. H. Gladstone, F.R.S., vice-president, in the chair,

A paper on "**The Magnetic Properties of Alloys of Iron and Aluminium, Part II.**," by **S. W. Richardson** and **L. Lownds** was read by Dr. Richardson. Experiments have been made to ascertain in what way the hysteresis loss between given limits of the field strength is connected with the temperature for an alloy containing 3·64 per cent. of aluminium. The experiments show that the hysteresis loss attains a maximum value at a temperature considerably higher than the temperature of maximum induction. The changes produced in the magnetic properties of the alloy by heating and subsequent cooling have also been investigated. The properties depend largely on the previous history of the specimen, but there does not appear to be any essential difference between the behaviour of the alloy during heating and cooling (except near the temperature of minimum permeability). Experiments have also been conducted on the abrupt change in the permeability that takes place at a temperature of about 650deg. C. The conclusions arrived at are as follows: (1) The hysteresis loss at first diminishes as the temperature rises. It then increases, and reaches a maximum at about 550deg. C. On further heating it falls off rapidly, and is negligible at 700deg. C. (2) The magnetic properties of the specimen depend largely on its previous history. (3) There is no essential difference between the behaviour during heating and cooling except near the temperature of minimum permeability. (4) An abrupt increase in the permeability takes place at about 650deg. C. during heating, followed by an equally abrupt diminution on further heating. (5) This abrupt change is more marked with falling than with rising temperatures. (6) Continued heating and cooling diminish the permeability. (7) The curve connecting temperature of minimum permeability and percentage of aluminium is a straight line. (8) The microscopic examination of the specimens shows the presence of crystals.

Prof. S. P. Thompson asked if the specimens had been kept for any length of time at a high temperature, because crystals changed and grew in metals at temperatures even far below their melting points.

Prof. Reinold asked if any specimens had been examined where the crystalline structure had not been observed.

Mr. Blakesley asked if any explanation of the orientation of the crystals could be given.

The **Chairman** said it was difficult to know exactly what substances were being dealt with. They might be pure alloys or mixtures of two or three alloys with iron or aluminium.

Dr. Richardson, in reply, said the crystals might be dissolved in nitric acid and analysed, but at present he did not know their composition.

The meeting then adjourned until June 22.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

279. Describe Prof. Kennedy's battery-regulating switch, especially the novel features and the operations of the

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switch in conjunction with the booster two-way switch to which it is interlocked. (Diagrams of this switch appeared in a recent issue of the *Electrical Engineer* in connection with York central station.)—E. E.

280. Describe and sketch a consumer's double-pole fuse-box to carry up to 50 amperes, which has the following qualifications: (1) the box or boxes to be of cast iron, with glass front, and cover which can be removed quickly; (2) fuses easy to renew; (3) no thimbles to sweat on to cables; (4) good insulation between poles and from earth; (5) arrangement for sealing; (6) cheap—not more than 10s.—E. L.

ANSWERS.

Question No. 273.—Sketch and describe a good form of flexible coupling for use between engine and dynamo.

Best Answer to No. 273 (*awarded* 10*s.*).—A form of flexible coupling which admits of all parts being substantially proportioned, and therefore unlikely to give trouble, is shown in Fig. 1. It is really a modified form of the well-known "Hooke joint," and needs little explanation. Similar cranked arms, A A', are journalled in pairs of lugs, B B', one such pair of lugs being fixed to each coupling face and at right angles to each other. Bearings at right angles are provided in the centre cross piece, C, for the cranked arms, A, A'. A double-hinged connection is thus formed, and it will be seen that while one cranked arm will permit a vertical movement, the other will allow a lateral movement between the engine and dynamo shafts.

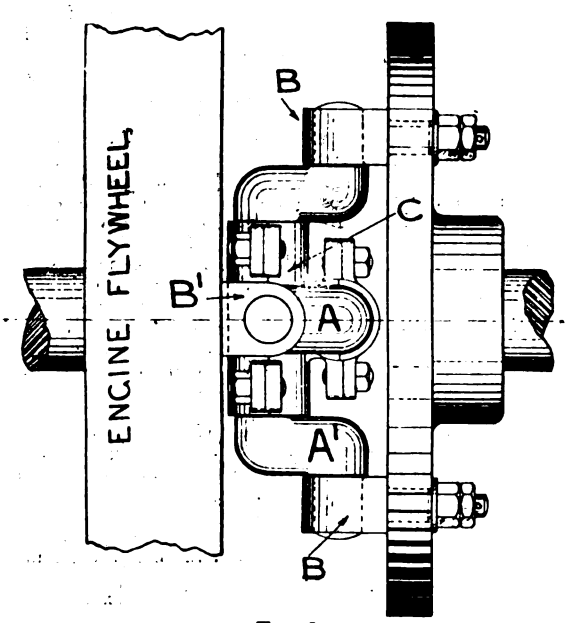


FIG. 1.

No provision is made for end play due to the working of the coupling, because there is always sufficient freedom in engine and dynamo bearings.

The coupling shown in Fig. 2 has proved very satisfactory, and while occupying very little room is of such construction that, when necessary, it can readily be taken apart for examination or renewal. E is the engine flywheel or driving half of the coupling carrying stud bolts, D, and similar bolts, D', are fixed in the dynamo coupling face, X. These bolts are arranged round a pitch circle of the same diameter for each face, so that when the stout leather links, L, have been threaded into place, the available space is filled. The direction of rotation is indicated by the arrow, in the end view showing the dynamo coupling face, and as the bolts, D, are on the engine side, it follows that the links are in tension, and that the power is transmitted through a number of leather drag links. When links need replacing, they may be taken out in the following manner. The driving bolts, D, are first knocked out through the holes opposite to them in dynamo coupling. (One of these holes is shown at A.) The engine may then be barred round, and the remaining bolts, D', removed through a hole, A', cored for this purpose in the engine flywheel.

Both forms of coupling shown are suitable for use with direct-coupled high-speed sets. One of the form shown in Fig. 2 has been in use for some years between a high-speed engine of 240 b.h.p. and an alternator, and runs exceedingly well. The leather seems to be quite happy, and shows no signs of requiring renewal. Flexible couplings are seldom used with the high-speed sets which are so much employed now, and it was only under exceptional circumstances that those shown were required. The engines and alternators

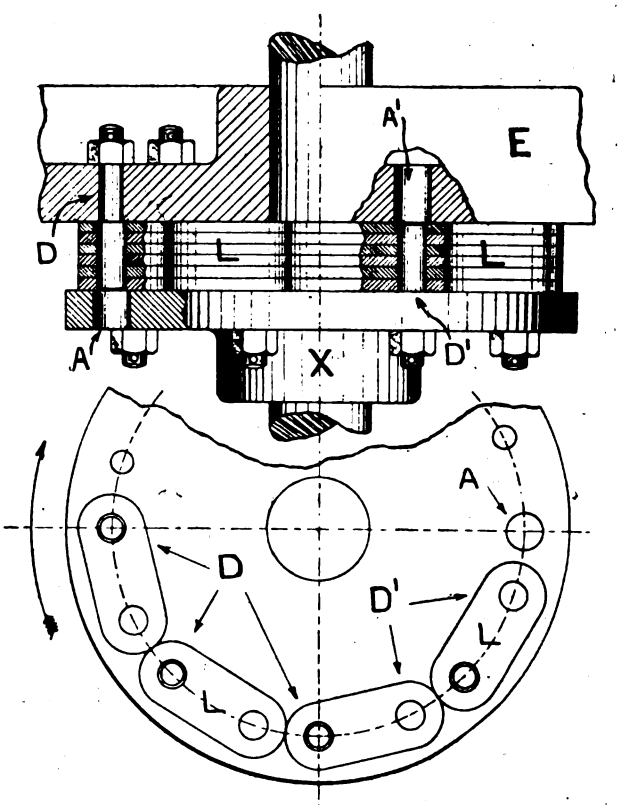
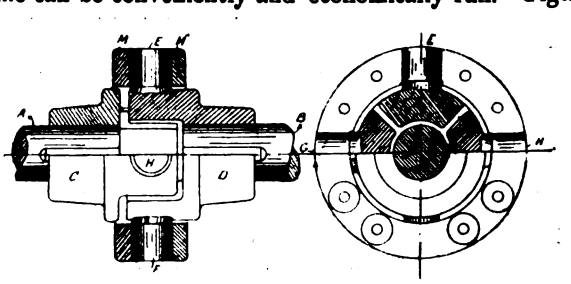


FIG. 2.

for which these couplings were designed were not mounted on a single bed-plate, but were lined up, as they stood on their foundations, as accurately as possible, and the couplings were left to deal with any want of alignment there might be.—E. G. BEAUMONT.

Answer to No. 273 (*awarded* 5*s.*).—In recent years it is general practice in central-station design to have the dynamo directly connected to the driving power; the one great advantage of this arrangement is that all belting is dispensed with. This not only eliminates the wear and tear of belting, but ensures considerable economy in floor space, which is in some cases of great importance. On the other hand, the first cost of a direct-driven dynamo of given power is generally greater than the first cost of a belt-driven dynamo, for the reason that the latter is usually run at a greater number of revolutions per minute than an engine can be conveniently and economically run. Figs. 1



FIGS. 1 AND 2.

and 2 show an elevation and end view of a flexible coupling, A and B being the ends of the shafts of the engine and dynamo respectively; on the ends of each are keyed ordinary shaft couplings, C, D, having on the outside of each two pins, E F, G H, opposite one another. The metal between the pins is cut away so as to form recesses to allow the four pins to be in line; clearance is given in each recess to allow for the flexibility. M, M' are two rings each having four half-holes, so that when bolted together it forms four holes for the pins to work in, each hole having a brass liner, as shown in the illustration. The advantage of this

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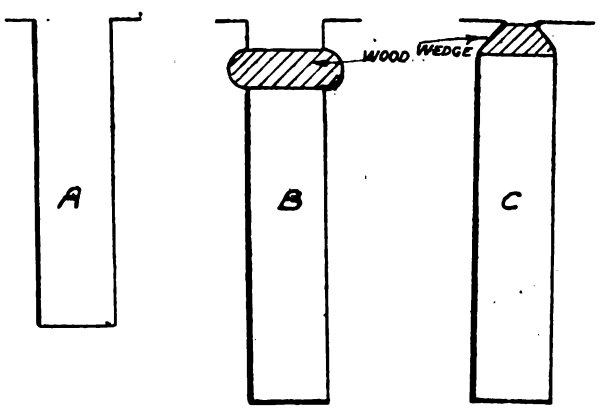
coupling is that it is really a form of universal joint adopted for heavy driving. The rings, M M', not being attached to the shaft, allows of movement of each, the pins of one being the axis for the other. Recesses are made in the ring for the boltheads and nuts, and the whole coupling being only slightly larger than an ordinary flange coupling, it forms a very effective and compact method for central-station work.—R. E. P.

Question No. 274.—In a traction generator it is proposed to do away with binding wires on the armature core, the slot being shaped as shown at B or C, and having insulating wedges driven into them at the top to keep the bars in



position. If binding wires were adopted the shape of the slot would be as at A. With exactly the same armature winding in each case, would there be a greater tendency to sparking with slots shaped as B and C than with A, and if so, why is this so?

Best Answer to No. 274 (*awarded* 10*s.*).—Sparking at the brushes is caused in many different ways, but for only one does the shape of the slot at all affect the tendency to spark; for instance, sparking may be caused by bad bedding or wrong position of the brushes, but sparking due to such a cause would in no way be affected whatever form were given to the teeth. When the commutator section to which any coil is connected passes under a brush, the direction of the current through the coil is reversed; now in the operation of reversal, the current must be first stopped and then started in the opposite direction. Lenz's law, however, tells us that, owing to self-induction, there is a force tending to prevent the stoppage of any current, and in a conductor through which no current is flowing it tends to prevent the starting of any current. Experiments have shown that the more permeable the external field is, the more powerful are these forces which tend to prevent alteration in the direction or dimensions of a current. Now the condition for sparkless running is that any coil which is carrying the normal current, x, in, say, a right-handed whorl before its commutator section passes under the brush, shall carry a current of the same value x, but in a left-handed whorl, when the segment leaves the brush; this alone will ensure sparkless commutation. If the self-induction be very great it may be difficult at heavy loads to secure this necessary condition.

Let us now consider the following four diagrams. No. 1 shows an ordinary smooth-core winding. Here, owing to the

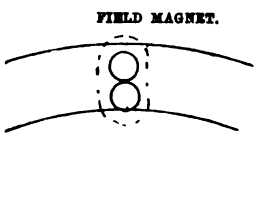


Fig. 1.

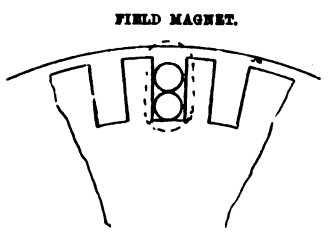


Fig. 2.

length of the air gap, requisite for clearance and space for the inductors, the reluctance of the path of the lines of force due to the self-induction of the coil—this path is shown dotted—would be very great. No. 2, which is similar to A in the question, has a path which lies mostly through iron, and consequently the reluctance will be considerably less, and there will be a greater tendency for sparking to be set up, as the self-induction will have more power. In Fig. 3, which is equivalent to C, the tendency will be still greater as the reluctance will be less, the lips of the teeth offering an easy path No. 4, equivalent to B, shows a different state of affairs. Here much of the cross-section of the teeth is cut away, and if this cutting away is carried to any extent the part shaded in the diagram will be so saturated that the lines due to self-induction, which will oppose the field lines in one tooth, but which will flow with them in the other, will in the latter case find themselves throttled, and hence the reluctance of this magnetic circuit will be enormously increased, and the tendency to spark will correspondingly decrease.

It might be as well to point out that this cutting away of the teeth would not be an unmixed blessing, and that other considerations, such as the heating of the core, come in. Emmerson remarks about the attributes of human life, "Whatever you gain in one direction you lose in another, and the eternal law of compensation is fulfilled," and this applies with equal force to dynamo design. The good designer is he who either abandons questions of small

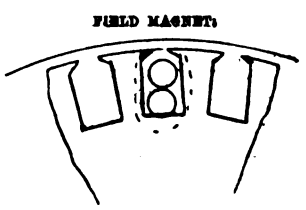


Fig. 3.

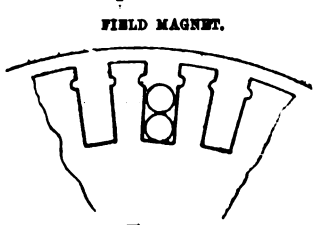


Fig. 4.

moment and develops those of great importance, or he who, recognising the impossibility of making an absolutely perfect machine, advances all the salient points equally without in any straining after the impracticable ideal.—M.

COLCHESTER.

The Town Council have adopted the following report of the Electric Light Works Committee, showing the expenditure and revenue from Dec. 1, 1898, to March 31, 1900. The figures were as follows:

Expenditure.

	From Dec. 1, 1898, to March 31, 1899.	From April 1, 1899, to March 31, 1900.	Total.
Generation of electricity	£ s. d.	£ s. d.	£ s. d.
Salaries	78 7 9	195 3 3	273 11 0
Wages	65 6 7	188 13 3	253 9 10
Fuel	69 15 7	211 14 6	281 10 1
Oil, waste, water, etc.	19 3 6	38 16 3	57 19 9
Repairs and maintenance	24 1 1	130 8 6	154 9 7
Distribution of electricity	—	9 8 5	9 8 5
Rates and taxes	18 8 0	50 1 6	68 9 6
Management expenses:			
Printing, stationery	2 8 0	20 3 6	22 11 6
Office furniture	—	5 16 6	5 16 6
Stamps, rail fares, etc.	—	12 0 10	12 0 10
Miscellaneous: Insurance	—	32 16 0	32 16 0
Balance, gross profit	159 0 5	737 15 1	896 15 6
	£436 10 11	£1,632 17 7	£2,069 8 6

Income.

	From Dec. 1, 1898, to March 31, 1899.	From April 1, 1899, to March 31, 1900.	Total.
Sale of electricity by meter	£ s. d.	£ s. d.	£ s. d.
Current supplied	429 14 10	1,599 15 10	2,029 10 8
Rental of hired meters:			
Rent of meters	6 16 1	32 5 10	39 1 11
Electric fittings trade:			
Fittings sold, £3. 7s. 9d. less cost, £3. 4s. 4d.	—	3 5	3 5
Miscellaneous: Charging batteries	—	12 6	12 6
	£436 10 11	£1,632 17 7	£2 069 8 6

Of the £896. 15s. 6d. returned as gross profit, £297. 7s. 11d. had been paid in the last year to the Public Works Loan Board, with interest, and £323. 13s. 7d. repayment of loan account, leaving a net profit from Dec. 1, 1898, to March 31, 1899, of £159. 0s. 5d., and from April 1, 1899, to March 31, 1900, of £116 13s. 7d. The total net profit shown was therefore £275. 14s. 3d.

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HANLEY ELECTRICITY WORKS.

From the accounts of the Hanley Corporation electricity works just issued, it appears that the total expenditure up to Dec. 31, 1899, amounted to £67,829. We give herewith the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., for the past year:

REVENUE ACCOUNT.

Dr.		£ s. d.
Generation of Electricity.		
Coal or other fuel	£2,539 15 9	
Oil, waste, water, and stores	460 5 10	
Wages at generating stations	975 5 9	
Repairs and maintenance: (*a*) buildings, £318 15s. 4d.; (*b*) engines, boilers, £846. 3s. 3d.; (*c*) dynamos, transformers, motors, etc., £125. 17s. 5d.; (*d*) other machinery, instruments, £77. 18s. 2d.; less old material, £42. 15s.	1,325 19 2	
		5,301 6 6
Distribution of Electricity.		
Wages to linesmen, etc.	93 7 8	
Maintenance of mains	38 1 10	
Maintenance of meters and other apparatus	286 5 8	
Maintenance of apparatus at distributing stations	194 19 4	
		612 14 6
Public Lamps.		
Attending and repairs	343 4 1	
Renewals of lamps	142 9 8	
		485 13 9
Rates and taxes		585 10 6
Management Expenses.		
Salaries, engineers' department	506 17 5	
Stationery and printing	31 9 9	
General establishment charges	45 11 7	
		583 18 9
Law and parliamentary charges		23 0 0
Insurances, etc.		39 15 7
Total expenditure		7,631 19 7
Amount carried to net revenue account		1,177 7 9
		£8,809 7 4

Cr.	£ s. d.
Sale of current per meter	7,067 18 0
Public lighting	1,447 0 0
Rental of meters and other apparatus on consumers' premises	268 8 6
Sale of lamps, etc.	26 0 10
	£8,809 7 4

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	64,990 0 0
Overdraft on account of loans sanctioned	2,839 0 10
Sundry creditors	669 14 11
Net revenue account—balance due to general district rate account	2,269 2 4
Balance	301 10 4
	£71,069 8 5

Cr. Assets.	£ s. d.
Capital account—amount expended for works	67,829 0 10
Store on hand: coal, £20; oil, waste, etc., £19. 14s. 6d.; general, £319. 10s.	359 4 6
Sundry debtors for current supplied to Dec. 31, 1899	2,771 15 1
Other debtors	109 8 0
	£71,069 8 5

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		638,025
Quantity sold { Public lamps	123,070	537,893
Quantity sold { Private consumers by meter	414,823	
Quantity used on works		14 199
Total quantity accounted for		552,092
Quantity not accounted for		85 933
Number of public lamps		145
Total maximum supply demanded in kilowatts		550

WOLVERHAMPTON.

The following is the report of the Lighting Committee to the Council on the Wolverhampton electricity undertaking, together with an abstract of accounts, for the year ended March 31, 1900:

Your committee have the pleasure of reporting that the result of the year's working has been very satisfactory. From the accounts it will be seen that the net result, after payment of interest and sinking fund charges, is a profit of £402. 6s. 11d. In addition to this, it should be pointed out that the sum of £911. 15s. 4d. has been expended during the year out of the revenue of the department, representing the cost of rewiring armatures (£256) and the cost of altering the wiring of fittings, changing lamps, etc., of 121 consumers, to suit the increased pressure of the supply of electricity (£655. 15s. 4d.), sanctioned by the Council in November, 1898. The amount in hand on account of the working of previous years is £416. 5s. 4d., and it is proposed to add the profit made last year to this, making a sum of £818. 12s. 3d., and to set aside this amount to form a reserve fund. In considering the result of the year's working, your committee desire to point out that the past year has been one of exceptional difficulty. The alteration in the system of supply has necessitated two systems being in operation for the latter six months, involving considerable additional expenditure out of revenue on account of working costs, more especially in the consumption and cost of fuel. The considerable increase in the cost of fuel during the last 12 months has also had a most important and adverse bearing upon the financial result. The delay in the completion of the battery-room at the generating station has seriously handicapped the department, and has greatly affected the efficient working of the undertaking, and this delay, in combination with the change in the system of supply, has very materially increased the amount of supervision necessary for the satisfactory working of the department. In presenting the report your committee again desire to call attention to the satisfactory growth of the undertaking. From the following figures it will be observed that the percentage increase in the amount of electricity sold, the increase in the number of consumers, and the number of lamps connected compare favourably with previous years.

Year	No. of consumers.	Percentage increase.	No. of lamps connected.	Percentage increase.	No. of units sold.	Percentage increase.
1st	113	—	8 941	—	191,701	—
2nd	154	36	11,307	26	224,709	17 2
3rd	208	35	14,151	25 2	291,233	29·55
4th	276	32·7	13,932	40·8	371,830	27 5
5th	364	32	25,184	26·3	482,247	29 7

Financial Result.

1½ years	Loss	£1,403 9 3		—
2nd year		—	Profit	£225 14 5
3rd year		—	,,	589 14 4
4th year		—	,,	1 004 5 10
5th year		—	,,	402 6 11
		£1,403 9 3		£2,222 1 6

It will be seen that, including the cost of the change-over (£911. 15s. 4d.) the net profit for the year would have been £1,314. 2s. 3d.

Your committee are pleased to report that the supply of electricity for power purposes in the borough is gradually increasing. Among the pioneer users of electricity for motive power purposes in the borough may be mentioned the following, and there is every reason to conclude that a good start has been made, and that manufacturers and other users of power in the borough will avail themselves of the favourable terms offered by the Corporation, and render this branch of the undertaking even more successful than that of the supply of electricity for lighting purposes.

Name.	No. of motors.	Size H.P.	Purpose for which motors are used.
Mr. Harry Jones	1	2½	Driving passenger lift.
Fisher, Perry, and Co.	2	1½ and 3	Driving mineral-water factory.
Empire Theatre	2	½ and 1	Driving fans.
Free Library	1	5	Electrical laboratory.
Chubb and Son's Lock and Safe Company, Limited	8	From 1½ to 10	Driving lathes, planing machines, punches, shears, etc.
Corns and Sons	1	10	Driving lathes, milling machines, stamps, and drilling machines.
Baker and Sons	1	20	Driving portion of boot factory.

The growth of the electric lighting portion of the undertaking is also very satisfactory, and it is worthy of note that during the past year 21 private consumers in the better-class residential districts were connected to the mains, whereas during the four preceding years the number of private residents connected was only 11, and the increase is being maintained. The committee has only just concluded negotiations to light the whole of the existing premises and new buildings of Messrs. Orme, Evans, and Co., of Great Brick-kiln-street. The new pupil teachers' centre is also to be connected to the mains, and there are satisfactory signs that the progress hitherto experienced will be continued during the present year.

CHARLES T. MANDER, Chairman.

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Revenue Account.

Expenditure.

Generation of Electricity.				£	s.	d.
Coal	£1,888	6	0			
Oil, waste, water, and engine-room stores	364	10	3			
Wages at generating station	1,208	18	5			
Repairs and maintenance—buildings	52	4	7			
Engines, boilers, transformers, other machinery and plant	192	17	8			
				3,706	16	11
Distribution of Electricity.						
Changing over system of distribution of electricity	911	15	4			
Repairs and maintenance of mains	71	14	6			
Ditto of meters, switches, etc.	3	2	9			
Ditto of apparatus at distributing stations	6	18	2			
				993	10	9
Public Lamps—attending, repairs, and carbons				184	17	5
Rents, Rates, and Taxes.						
Rents	6	6	2			
Rates and taxes	176	18	6			
				183	4	8
Management Expenses.						
Salaries—Engineer's department	661	13	7			
Ditto, accountant's staff (proportion)	50	0	0			
Stationery, printing, and advertising	58	14	5			
Cost of management of proportion of Corporation 3 per cent. stock	42	12	1			
General establishment charges	108	2	5			
				921	2	6
Law expenses				4	1	0
Insurances, etc.				100	13	4
Bad debts and allowances				65	9	8
				6,159	16	3
Balance carried to net revenue account				3,381	15	8
				£9,541	11	11

Income.

	£	s.	d.
Sale of current per meter :			
At 6d. per Board of Trade unit	5,944	6	6
,, 4½d. ,, ,,	69	18	9
,, 4d. ,, ,,	131	13	0
,, 3½d. ,, ,,	391	2	6
,, 3d. ,, ,,	1,456	13	6
,, 2d. ,, ,,	28	13	4
,, 1½d. ,, ,,	10	19	0
,, 1d. ,, ,,	12	14	1
Ditto under contract	0	15	0
	8,046	15	8
Public lighting (street arc lamps)	1,275	0	0
Ditto (street incandescent lamps)	3	18	4
	9,325	14	0
Rental of meters, etc.	178	8	6
Work executed on account of customers	37	9	5
	£9,541	11	11

Balance-Sheet.

Liabilities.

	£	s.	d.
Redeemable stock, £32,314. 16s. 11d. ; loans fund, £5,389. 16s. 4d. ; less amount appropriated for extinction of debt, £5,505. 2s. 9d.	32 199	10	6
Sundry creditors at March 31, 1900	3,757	8	4
Cash balance March 31, 1900, due to treasurer	31,358	17	5
	67,315	16	3
Surplus—loans repaid out of revenue, £1,279. 16s. 6d. ; loans fund contributions from revenue, with accumulations to March 31, 1900, £5,505. 2s. 9d.	6,784	19	3
	74 100	15	6
Sundry creditors at March 31, 1900	517	10	5
Sundry consumers—deposits	45	10	0
Interest accrued, but not paid at March 31, 1900	130	3	2
Cash balance, March 31, 1900, due to treasurer	2,936	13	2
Net revenue account—balance, profit for year ended March 31, 1900, £402. 6s. 11d. ; add profit to March 31, 1899, £416. 5s. 4d.	818	12	3
	78,549	4	6

Assets.

	£	s.	d.
Capital expenditure, as per capital account	73 662	18	7
Costs of issue of stock ,, ,,	403	18	9
Sundry debtors at March 31, 1900	33	18	2
Stores on hand : coal, £43 12s. 8d. ; oils, waste, etc., £70. 7s. 1d. ; general, £411 19s. 2d. ; tools, £117, 12s. 4d.	643	10	10
Sundry debtors	3,804	18	2
	£78,549	4	6

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			603,954
Quantity sold	Public lamps	81,250	482,277
	By contract	30	
	Private consumers by meter	400,997	
Quantity used on works			6,514
Total quantity accounted for			488,791
Quantity not accounted for			115 163
Percentage of electricity sold to electricity generated			79·85
Number of public lamps			53
Total maximum supply demanded in 32-watt lamps			25,184

LIGHT RAILWAYS.

The tramways question was discussed at Wednesday's meeting of the Crewe Town Council. It was resolved to make application to the Light Railway Commissioners for an order, and that the County Council and the Nantwich Rural Council be consulted in reference to the application. The borough surveyor was instructed to submit to the Council a scheme or line of route of the proposed tramway.

Two of the Light Railway Commissioners, Mr. G. A. B. FitzGerald and Colonel Boughey, on the 7th inst., at the Leeds Town Hall, enquired into applications made by the British Electric Traction Company, Limited, for powers to construct lines in the West Riding. Bradford, Drighlington, Gildersome, Morley, and East and West Ardsley were interested in the first enquiry, and all these authorities approved generally of the scheme, with the exception of the county borough. The second enquiry had reference to the Spen Valley, Dewsbury, and Ravensthorpe tramways, in favour of which project the Commissioners pronounced some months ago, deciding for the company. Mr. FitzGerald, in announcing the Commissioners' decision, said that in the case of the Morley and district light railway they were prepared to recommend the granting of the order, with the exception of the portion of the railway within the borough of Bradford, and subject to the proviso that if, within two or three years of the confirmation of the order, the Bradford Corporation extended their system of tramways to the cross roads at Drighlington, the powers of the company to construct a corresponding portion of the line should not be operative. In the case of the Spen Valley extensions, the Commissioners were prepared to recommend the order for the whole of the lines outside the borough of Batley, subject to a proviso, as regarded the portion in Hunsworth and part in Birkenshaw, that if the Bradford Corporation obtained parliamentary powers to make a line from that point and work it within a certain period, the powers of the company as regarded that portion would not be operative. With regard to Batley, the Commissioners felt that the fair and right thing to do was not to stop the application of the company altogether, but to leave Parliament to decide upon the whole of the scheme. What they proposed to do was to recommend an order, subject to a proviso that if the Corporation's order was confirmed by Parliament, the company should not exercise any powers with regard to the line within the borough. They also decided that the short line, No. 9, should be omitted from their draft order.

The Commissioners held an enquiry last Friday into the application of the Wakefield Corporation for power to carry out a system of electric tramways. Some opposition was raised on account of the Kirkgate Bridge, and at the close Mr. FitzGerald said the Commissioners were prepared to recommend the order the promoters asked for on the understanding that a mutually satisfactory arrangement was made with regard to Kirkgate Bridge. If such an arrangement was not made, they would take care that the County Council and the Corporation were protected in such a way as, in the absence of an agreement, they would themselves settle. They proposed to insert in the order a clause extending the gauge to 4ft. 8½in.

Plans, estimates, etc., for the proposed Deanhead light railway have been prepared, and are in the hands of the various district councils through which the line passes for examination. The scheme now comprises four sections, estimated to cost £61,117. 14s.

The Commissioners held an enquiry on the 14th inst. into the application for Warrington and Northwich light railway.

The enquiry into the proposed electric light railway which is being promoted by the Blackpool and Garstang Electric Light Railway Company, Limited, will beld at Preston to-day.

The Gloucestershire County Council propose to apply for an order authorising them to advance money to the Witney, Burford, and Andoversford Light Railway Company.

At last Thursday's meeting of the Ramsgate Town Council the minutes of the meeting of a recent committee of the whole Council with respect to the appeal of the light railway company to the Board of Trade upon the subject of widening Bradley's corner in the Plains of Waterloo were read, together with a letter from the Board of Trade stating that they were advised by Lieut.-Colonel Yorke, R.E., that the plans submitted by the promoters of the light railway company of laying railway at the corner of Belle Vue-road and Plains of Waterloo would best provide for the safety and convenience of the public and the frontagers. Should the roadway be at any time suitably widened a double line would be preferable. The Board added that they adopted the recommendation of their inspecting officer.

At a meeting of the Pwllheli Town Council on Tuesday, it was decided to support an electric light railway scheme for Pwllheli to Nevin by a Manchester syndicate.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Shoreditch.—The Vestry invite tenders for various plant at Whiston-street station. Tenders by 19th inst.

Paris.—The Under-Secretary of Postal Telegraphs will receive tenders at Rue de Grenelle, No. 103, for 12 lots of paper-insulated cables on the 26th inst., at 11 a.m.

Dudley.—The Corporation invite tenders for condensers (barometric), pumps, cooling tower, etc. Tenders by 30th inst. Details in our advertisement columns.

Larne.—The Urban District Council invite tenders for lighting their district by coal or acetylene gas or electricity for three years from Aug. 1. Tenders by June 18.

Manchester.—The Tramways Committee invite tenders for the overhead equipment of three routes of tramways. Tenders by June 30. Details in our advertisement columns.

Paris.—The Under-Secretary of Postal Telegraphs will receive tenders at Rue de Grenelle, No. 103, for 300,000 kg. copper wire and 30,000 jointings (seven lots) on June 19, at 11 a.m.

Madrid.—The Secretary for Public Works invites tenders for the construction and working of an electric tramway from Puerto de Hierro to Aravaca and Pozuelo. Tenders by July 7.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for (Contract No. 16) trolley wires and attachments. Tenders by 25th inst. Details in our advertisement columns.

Bury.—The Art Gallery Committee invite tenders for the electric wiring of the art gallery and free library situate within the borough. Tenders by 18th inst. Details in our advertisement columns.

London, S.E.—The Bermondsey Vestry invite tenders for the supply and laying of insulated electric mains, conduits, junction boxes, etc. Tenders by noon on June 18. Details in our advertisement columns.

Heckmondwike.—The Urban District Council invite tenders for the various works required in the erection of electric light and power station, public baths, and fire brigade station at Heckmondwike. Tenders by June 28.

Glasgow.—The Corporation invite tenders for outside coal storage and steel structure for coal handling, and locomotive travelling cranes for outside coal handling. Tenders by June 21. Details in our advertisement columns.

Limerick.—The Council invite tenders for the supply, delivery, and erection of cables, arc lamps, engines, dynamos, boosters, balancer, switchboard, instruments, and gas plant. Tenders by July 4. Details in our advertisement columns.

Newcastle-on-Tyne.—Tenders are invited for the wiring of 6 and 7, Park-terrace, including the supply of 55 electric lamps. Specification, etc., can be obtained on written application to Mr. J. R. Sisling, 7, Park-terrace, by whom tenders will be received up to 23rd inst.

Wolverhampton.—The Tramways Committee invite tenders for the construction of tramway track and contingent work in Dudley-road, Cleveland-road, Bilston-street, Piper's-row, and Fiveways, amounting to a route length of about one mile seven furlongs, mainly double track. Tenders by June 26.

Sutton Coldfield.—The Corporation invite tenders for the supply and erection of water-tube boilers, with fittings, economiser, feed pumps, etc., pipework, etc., in engine and boiler house, three steam dynamos (vertical enclosed high-speed engines) and motor boosters, storage batteries, main switchboard and connections, eight-ton overhead engine-room travelling crane, underground mains, conduits, and roadwork for private and public lighting, arc lamps (enclosed) and posts, and station lighting. Tenders by June 21. Details in our advertisement columns.

London, S.W.—Tenders are invited for the supply, within three months of the order being given, of about 70 arc-lamp standards, required in connection with the electric light installation for the Victoria-embankment, for the London County Council. The standards are to carry the lamps suspended, at about 23ft. from the ground level, at the end of a curved arm extending over the carriageway. Each person tendering is to submit his own design for the standard, or, if he so desire, he may submit alternative designs. A short description of the standard, showing generally what is required, may be obtained at once on application to the Clerk to the Council. Specification may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on July 10.

Alexandria.—Tenders will be received at the Central Office of the Administration of Ports and Lighthouses, up to 12 noon on July 1, for supply of the whole or part of an electric generating machine for the Port Said lighthouse, and the tools for the lighthouses workshop at Alexandria. Persons wishing to tender can consult the conditions of tender and the specification, on all days on which public offices are open, from 9 a.m. to 1 p.m., at the office of the Administration of Ports and Lighthouses, Alexandria. Copies of conditions and specification can also be had on application to the Controller-General of Ports and Lighthouses, Alexandria. Tenders must be submitted on stamped paper and addressed to the Controller-General of Ports and Lighthouses, Alexandria, in sealed envelopes, bearing the inscription "Tender for the Supply of Electric Generating Machinery for Port Said Lighthouse," or "Tender for the Supply of Tools for the Lighthouses' Workshop, Alexandria."

Durban.—The Corporation invite tenders for supply, delivery, and erection of materials under the three following sections: (Part A) comprising the supply, delivery, and erection of the entire overhead equipment for about 16 miles of equivalent single track, including poles, overhead trolley wire, distribution boxes, etc.; (B) comprising the supply, delivery, and erection of 22 double-deck motorcars, complete; (C) comprising the supply and putting into working order of a complete steam and electric generating plant in a power station to be built by the Corporation, including three 250-kw. direct-coupled generators, boilers, condensers, cooling tower, switchboard, etc. Parts A and B will not be separated, but will be let to one contractor. Part C may be let separately. Preference will, however, be given to a contractor who will undertake all three sections, and a separate form of tender for all three sections will be supplied. Specifications, bills of quantities, forms of tender, and lithographic drawings may be obtained on application to Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation, on and after 29th inst. A deposit of £10. 10s. must accompany application for specifications and forms of tender. The deposit will be returned on the receipt of a bona fide tender. Sealed tenders, in duplicate, under separate cover, in specially-provided envelopes, to be delivered to Messrs. Webster, Steel, and Co., by June 29, or to the Town Clerk of Durban by mail delivery on or about July 23. The successful tender will be accepted by cable from Durban.

RESULTS OF TENDERS.

Tanat Valley Light Railway.—The acceptance of tenders for the above has been deferred for the present.

Battersea.—The Vestry have accepted a tender for the supply of an electric organ to the town hall, at an estimated cost of £1,912.

Barnsley.—The tender of Crompton and Co., Limited, to provide and fix 15 arc and incandescent lamps, posts, etc., at £501. 14s., has been accepted.

Longton.—The Corporation have accepted the following tenders: A. H. and J. W. Moore, erection of foundations and boiler-house, etc.; T. S. Bromage, Longton, new boiler-house and chimney.

Wimbledon.—The Council have accepted the tender of Messrs. Foote and Milne, 66, Victoria-street, Westminster, at £321, for an installation of electric wiring and fittings at their new isolation hospital.

Leyton.—The Council have accepted tenders for the supply of feeder cables, etc., in connection with additional feeders, from the Western Electric Company and the British Insulated Wire Company.

Belfast.—The Electric Committee have accepted the tender of Messrs. J. H. Holmes and Co., Portland-road, Newcastle-on-Tyne, at schedule prices, for the supply of electric motors for a period of 12 months.

Dudley.—The offer of the British Westinghouse Company for the sale to the Corporation of the engine and dynamos, hired to the Corporation, for the sum of £1,360 (less the sum of £500 already paid on account) has been accepted.

London, S.W.—The following tenders have been received for (Section A) house wiring, (B) bells, (C) lamps, at Cardinal Vaughan's residence, Westminster, S.W.:

	Section A.	Section B.	Section C.
Tamplin and Makovski	£2 053 5 9	£299 2 9	—
Eastlakes, Limited	1 236 0 0	101 0 0	1/9 & 2/3
Middleton and Co. (informal)	910 10 0	166 9 0	£56 15 0
Tyler and Duncan	958 16 0	92 19 0	56 15 0
Slater and Co.	915 0 0	120 15 0	54 10 6
Drake and Gorham	878 0 0	138 15 0	64 5 0
Glover and Co.	809 10 0	99 15 0	1/7 & 1/5
F. Hodgson and Co.	686 16 0	65 0 0	64 0 0
Donnison, Berlyn, Sillem, and Co.	580 5 0	98 10 0	60 0 0
A. H. Wood	587 0 0	74 0 0	65 0 0
W. J. Fryer and Co., Limited (accepted)	538 0 0	49 0 0	54 0 0

Lump sum for A, B, and C if placed together.

Eastlakes, Limited	£1,437 0 0
Middleton and Co.	1,140 6 0
Tyler and Duncan	1,108 10 0
Slater and Co.	1,090 5 6
Drake and Gorham	1,051 0 0
Glover and Co.	966 0 0
F. Hodgson and Co.	795 8 6
Donnison, Berlyn, Sillem, and Co.	688 15 0
A. H. Wood	645 0 0
W. J. Fryer and Co., Limited	610 4 0

	Schedule prices — Flex. s. d.	Elec. pt. £ s. d.	Bell pt. £ s. d.
Tamplin and Makovski	3 0	2 15 0	2 5 0
Eastlakes, Limited	—	2 17 6	1 4 0
Middleton and Co. (informal)	2 10	1 9 0	1 11 3
Tyler and Duncan	2 2	1 2 0	0 15 0
Slater and Co.	3 0	2 18 6	1 16 0
Drake and Gorham	3 0	1 15 0	1 7 6
Glover and Co.	1 6	1 17 0	0 17 6
F. Hodgson and Co.	1 6	1 14 6	1 0 0
Donnison, Berlyn, Sillem, and Co.	—	1 10 0	1 2 6
A. H. Wood	2 6	1 10 0	1 5 0
W. J. Fryer and Co., Limited (accepted)	1 10	1 8 0	0 16 0

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Birkenhead.—The Corporation have accepted the tender of Messrs. Babcock and Wilcox, 147, Queen Victoria-street, London, for the supply, delivery, and erection at their South End generating station in New Chester-road, Birkenhead, of (Contract N) steam-exhaust, feed-water, and drain-pipe work, etc.

Wimbledon.—The Urban District Council have accepted the tender of the Berrenberg Electric Lamp Syndicate, Limited, Southfields, for the supply of 5,000 16-c.p. incandescent electric lamps, at 1s. 5d. each, packed and delivered free at Wimbledon in such quantities as may be required during year ending March 31, 1901.

Chester.—The Corporation have received the following tenders for supply, delivery, and erection of the following plant at the electric lighting station, New Crane-street: steam, exhaust, feed, suction, and delivery and condensing water pipes and valves, for the Corporation:—Babcock and Wilcox, Limited, 147, Queen Victoria-street, E.C. (accepted); Aiton and Co., 25, St. Laurence Pountney-lane, Cannon-street, London, E.C.; Alley and Maclellan, Sentinel Works, Old Polmadie-road, Glasgow; G. H. Williamson and Co., 13 and 15, Lightbody-street, Liverpool; Tingle and Co., Cinderford, Glos.; J. Spencer, Limited, Tower-chambers, Manchester.

Paddington.—The Vestry have received the following tenders for alterations to electric lighting arrangements at the public baths, Queen's-road:

Alterations.			
A. C. Harnden (accepted)	£104	0	0
W. Adams	103	0	0
Concentric and General Contract Company	125	13	6
Alwyn and Craven	132	0	0
G. F. Ratcliffe and Co.	205	0	0
Smeeton and Page	207	4	0
Fryer and Co.	230	0	0
J. Buckingham and Sons	242	0	0
F. Troy and Co.	318	17	1
Peto and Radford, Limited	350	0	0
J. R. Reedman and Co.	5.0	0	0
Extra only if steel tubing is used throughout in lieu of wood casing.			
A. C. Harnden (accepted)	10	0	0
W. Adams	15	0	0
Concentric and General Contract Company	2	0	0
Alwyn and Craven	10	0	0
G. F. Ratcliffe and Co.	9	10	0
Smeeton and Page	40	0	0
Fryer and Co.	30	0	0
F. Troy and Co	20	16	0
Peto and Radford, Limited	100	0	0
J. R. Reedman and Co.	250	0	0
Provisional amounts—Extra only for voltmeter.			
A. C. Harnden (accepted)	7	0	0
W. Adams	12	12	0
Concentric and General Contract Company	10	10	0
Alwyn and Craven	10	10	0
G. F. Ratcliffe and Co.	12	10	0
Smeeton and Page	13	10	0
Fryer and Co.	8	10	0
F. Troy and Co.	13	0	0
Peto and Radford, Limited	12	12	0
J. R. Reedman and Co.	1)	0	0
Extra only for ampere-meter.			
A. C. Harnden (accepted)	7	0	0
W. Adams	6	0	0
Concentric and General Contract Company	6	2	6
Alwyn and Craven	6	10	0
G. F. Ratcliffe and Co.	11	10	0
Smeeton and Page	18	10	0
Fryer and Co.	7	10	0
F. Troy and Co.	13	3	6
Peto and Radford, Limited	10	10	0
J. R. Reedman and Co.	10	0	0
Extra only for voltmeter and ampere-meter.			
J. Buckingham and Sons	22	10	0
Provide and fix two electroliers, p.c. £15.			
A. C. Harnden (accepted)	15	0	0
W. Adams	17	0	0
Concentric and General Contract Company	21	10	0
Alwyn and Craven	23	0	0
G. F. Ratcliffe and Co.	20	10	0
Smeeton and Page	20	0	0
Fryer and Co.	15	0	0
J. Buckingham and Sons	15	0	0
F. Troy and Co.	18	9	0
Peto and Radford, Limited	25	0	0
J. R. Reedman and Co.	15	0	0
Provide for additional works, £10.			
A. C. Harnden (accepted)	10	0	0
W. Adams	10	0	0
Concentric and General Contract Company	10	0	0
Alwyn and Craven	10	0	0
G. F. Ratcliffe and Co.	15	10	0
Smeeton and Page	10	0	0
Fryer and Co.	10	0	0
J. Buckingham and Sons	10	0	0
F. Troy and Co.	10	0	0
Peto and Radford, Limited	10	0	0
J. R. Reedman and Co.	10	0	0

London, S.W.—The Fulham Vestry have received the following tenders for the wiring of their electric lighting works:

Birmingham Installation Company	£487	0	0
T. L. Hellyar	618	7	6
Concentric and General Contract Company	740	0	0
A. R. Gifkins and Co.	753	0	0
F. Troy and Co.	762	0	0
P. S. Tasker	781	10	0
Newsome, Pinching, and Walton	795	0	0
National Electric Wiring Company, Limited	812	0	0
National Electric Wiring Company	840	0	0
Foote and Milne	874	0	0
F. G. Edey and Co.	975	10	0
F. G. Edey and Co.	1,025	10	0
G. Stegman	980	0	0
Alwyn and Craven	1.000	0	0
Hailey and Co.	1,100	10	0
Pyke, Harris, and Co., Limited	1,181	0	0

BUSINESS NOTES.

TRACTION.

Bolton.—During May 1,238,639 passengers were carried on the Corporation's tramways.

Norden.—The tramways agreement between the Corporation and the District Council has been confirmed.

Northfleet.—The Council are endeavouring to move the electric tramway syndicate to proceed with their order.

Central London Railway.—It is stated that the Prince of Wales has promised to open this line on the 27th inst.

Electric Traction on the Metropolitan Railway.—It is stated that the experimental train now running will not be taken over by the railway company until October.

New Brancepeth.—The Urban District Council are favourably considering a circular from the British Electric Traction Company re the construction of light railways in the district.

Birkenhead.—The Poole and District Light Railway Company have been asked to place the pillars carrying the electric wires along the south side of the Ashley-road the same as in Poole-road.

Folkestone.—The Corporation have asked the sub-committee which was appointed some time ago to consider the tramway question to draw up a scheme, and bring up a report at an early date.

Swansea.—The stopping places of the new electric trams are to be fixed by the Corporation. An alteration in the plan of the Corporation tramways scheme, involving an extra expenditure of £168, has also been agreed to.

Cheriton.—The Urban District Council, who have up to now deferred their decision with regard to tramways, have decided to ask the Folkestone authorities what they proposed to do with regard to municipal tramways.

Earl's Court.—We learn that one of the cars built for the Thanet Light Railways is to be sent for exhibition to Earl's Court. The cars are of the most modern design, and are painted in purple brown with primrose-coloured panels.

Bacup.—A letter from Mr. Jerrold Barker, an electrical engineer, of London, suggesting the consideration of the question of a light railway from Bacup to Todmorden for passenger and light goods traffic is before the Electricity Committee of the Council.

Newcastle.—The Town Council have, after much discussion, passed a resolution as follows: "That the tramway company be requested to run all trams to the terminus at the top of London-road, in accordance with the undertaking given to the Council."

Darwen.—The Parliamentary Committee have resolved to enter into negotiations with the owners of certain property along the proposed tramway line to Sough for the purpose of acquiring such property. The borough surveyor is preparing the detailed plans.

Gateshead.—On the 12th inst. the pulling up of the road was started to make way for the new tramways sanctioned on Aug. 9. It is expected that the old sections will be finished in about February next year, and six or eight months after the new sections will be ready.

Hamilton.—The Town Council have withdrawn their opposition to the Bill to connect Wishaw, Motherwell, Larkhall, Hamilton, and Blantyre by means of an electric railway conditional upon receiving an additional £1,500, making £11,500 in all, for street improvements on the proposed route.

Liverpool.—Mr. Brodie, the city engineer, has now made an effective start in the reconstruction of the Wavertree tramline. The whole of the old tram routes have been relaid, with the exception of the Wavertree, and the lines from the top of James-street to the Pierhead and up to the town hall.

Derby.—The paragraph stating that the Tramways Committee did not think it desirable to discontinue the running of tramcars on Sundays has been eliminated from their report. The sum of £3,850 has been granted for the purchase of land and buildings in Victoria-street now used as tramway offices.

Huddersfield.—The receipts from the Corporation tramways during last week established a record. The receipts for the six days ending on Saturday night last were £953. 14s. 6d., against £720. 14s. 11d. in the corresponding week of last year, and against £853. 19s. 6d. in Easter week this year, and £788. 9s. 2d. for Easter, 1899. In the meantime two new lengths of line have been opened.

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Darlaston.—The District Council offer to settle the points of difference between the South Staffordshire Tramway Company and the Council with respect to running powers by accepting a rental of 5½ per cent. upon the purchase money, and the grant of an extension of the term of the lease to 28 years, with the option for the Council or their successors to determine the lease at the end of the first 21 years of the term.

Aberdeen Tramways.—The following traffic return for week ending June 2 shows the progress made in this undertaking: Traffic receipts, £645. 14s. 5d.; corresponding week last year, £627. 12s. 5d.; increase, £18. 2s. Number of passengers for week, 158,013; corresponding week last year, 139,276. 52 weeks' passenger fares this year, £30.781. 13s. 9d.; 52 weeks corresponding period last year, £26 576. 4s. 10d; increase, £4,205 8s. 11d.

Leamington.—The Tramways Committee's last report states that they had received a letter from Messrs. Heath and Blenkinsop submitting certain proposals for the consideration of the committee with reference to acquiring the tramway, and enclosing a copy of the agreement between the tramway company and the Warwick Corporation. A deputation of Council members has been appointed to confer with the representatives of the tramway company.

Kinver.—The matters in dispute between the British Electric Traction Company and the Staffordshire County Council have been settled. The principal matter at issue was as to the track followed on the road between the Ridge, Wollaston, and the Stewpony. Colonel Yorke last week met representatives of the Staffordshire County Council and of the company, and also of Mr. P. H. Foley, and we learn that there is now every prospect of finishing the line in two months' time.

Plymouth.—The tramway returns for the year have begun satisfactorily, as up to six weeks since the increased receipts were £427, of which £297 was in respect of the Prince Rock electrical section, and £130 of the horse traction section. It is reported that the weekly receipts exceed the average weekly expenditure, so that so far the trams have been paying from the beginning of the year. The minute referring to site and construction of depôt and workshops has been referred back for consideration.

Leyton.—A meeting of representatives of the North Metropolitan Tramways Company, the West Ham Corporation, the London County Council, and the Leyton District Council has been held with reference to the terms upon which the granaries, depôts, and car works within West Ham and Leyton should be taken over. The question as to the car works in Leyton was left in abeyance. After arguments on behalf of the West Ham Corporation and the tramway company had been heard, the Board of Trade has reserved its decision.

Ayr.—The Town Council have instructed a sub-committee to consider whether the electric tramway scheme between Ayr and Prestwick, which is to be laid down at a cost of about £60,000, should be supplied with motive power from the present electric station or from an independent station, and as to the site for the car station. The construction of the work will be under the supervision of Mr. Young, the town surveyor, whose salary has been increased by £100 a year. Additional assistants at £150 and at £60 will be engaged.

Bradford.—The minutes of the Tramways Committee, adopted on Tuesday, included a recommendation advancing the salary of Mr. C. J. Spencer, electric tramway manager, by £100 per annum from June 1, with an annual increase of £100 until his salary reaches the sum of £500 per annum, on condition that Mr. Spencer enters into an agreement to remain in the service of the Corporation during the next five years. The Cleansing Committee have resolved to invite tenders for the erection of five additional destructors in various parts of the city.

Isle of Man Tramways.—The Douglas correspondent of the *Financial Times* telegraphs that it is stated on the best authority that all the directors of the Isle of Man Tramways and Electric Traction Company, Limited, with the exception of Mr. John A. Mylrea, have sold their shares and are no longer qualified. A petition is to be presented to the Deemster in Chambers this week to have the company wound up, and asking for the appointment of Mr. Wm. H. Walker, one of the liquidators of Dumbell's Bank, as liquidator. An adjourned meeting of shareholders is to be held to-day.

Dudley.—The Railway, etc., Committee have decided that the Dudley and Wolverhampton Tramway Company should lay their cables under the footpath from Springsmire, through Wellington-road, Stafford-street, Snow-hill, and Salop street, and on the same system as that on which the Corporation electric light mains are now being laid, and not in iron pipes. The tramway company asked for permission to erect their trolley wire on bracket arms on the east side of Salop-street, and on the south side of Wolverhampton-street and Snow-hill. The committee have decided to grant the application.

Eccles.—At the last meeting of the Town Council, the Parliamentary Committee reported, in regard to the South Lancashire tramways scheme, that an agreement had been come to between the promoters of the tramway scheme and the Corporation, whereby the latter should, either by a provisional order or an omnibus Bill, seek powers to construct that portion of the proposed South Lancashire tramways from the boundary of the township of Eccles in Worsley-road, Winton, to the junction of the existing tramways at Peel Green. The company had obtained no powers over the roads. This was adopted.

Rhondda.—At the meeting of the Urban District Council a letter was read from the British Electric Traction Company stating that the cost of widening the roads in the district, as suggested, would amount to £14,000, which was very much greater than the company could afford to spend in connection with the proposed light railway. It was decided that a committee of the Council should meet the company to further consider the matter. It was proposed that the Council apply for a provisional order under the Light Railway Act of 1896. The work of constructing a tramway or a light railway throughout the valley is estimated at about £80,000 or £100,000. The question was adjourned for a month.

Cardiff.—Twenty-nine applications for the position of electrical engineer for traction purposes have been considered. The following were selected to come before the committee at a future meeting: Messrs. Nelson Graburn, M.I.E.E., superintendent of rolling-stock Glasgow tramways; H. E. M. Kensit, British Westinghouse Electric and Manufacturing Company; Arthur Ellis, M.I.E.E., general manager Bolton Corporation tramways; A. S. Barnard, M.I.E.E., city electrical engineer, Hull; H. G. Jeken, assistant electrical engineer Leeds tramways; and W. H. Collis, A.M.I.E.E., assistant electrical engineer Corporation tramways, Liverpool. A special meeting will be held on Monday next, and application will be made to the Council to allow the committee to make the appointment.

London Street Tramways.—The Westminster Vestry have before them a report with regard to the London County Council's proposal to construct tramways from the present terminus in Theobalds road to Piccadilly-circus recommending that the Council be informed that the Vestry is of opinion that a tramway terminus at the Piccadilly-circus end of Shaftesbury-avenue would cause great congestion of traffic, and that the Vestry do not consent to the Council's proposals; and, further, that it be a suggestion to the Council that if the tramways are extended in this direction from Theobalds-road a suitable site for a terminus should be found at Cambridge circus. The County Council have also asked the Vestry for its views on the proposed tramline from Queen Victoria-street to Putney, *vid* the Victoria embankment, Victoria-street, Buckingham Palace-road, Commercial-road, Chelsea-embankment, and King's-road. The letter has been referred to the Works Committee for report.

Sheffield.—A profit of £5,000 has been made on the year's working of the tramways, which, with the *£25,000* in hand (less £5,000 given to the rates), makes £25,000 to the good. The passengers carried last week numbered almost 750,000. Mr. A. L. C. Fell, the electrical engineer, has submitted the following report to the Tramways Committee: "The sample deck car body which has been built at Tinsley is now complete, and will shortly be mounted on a truck ready for the road. The total cost of the car body, including all labour and material, was £233. 5s. 11d. The price we are paying for the single-deck cars which are now being obtained from the Brush Electrical Engineering Company, of Loughborough, is £204 per car. When comparing these figures it is necessary to take into consideration the fact that all the woodwork had to be obtained at retail prices, and had to be cut out in the rough by an outside firm, and we had no suitable machinery. In my opinion it would pay to put down a small woodwork plant, and build car bodies for the further requirements of the Corporation tramways. This plant could be used for cutting and working up all the necessary timber required for repairing the cars now in use."

Colchester.—The Town Council have adopted a report of the Tramway (Special) Committee stating that they had considered a letter dated Aug. 28, 1899, from the British Electric Traction Company stating they desire to continue their endeavours to provide the district with a system of electric tramways, and that their further proposals would be submitted shortly for the approval of the Council, and subsequent correspondence. They had considered also a letter, Nov. 8, 1899, from the manager and secretary Shanghai Tramway Syndicate, Limited, submitting proposals for the establishment of electric tramways in the borough, and a letter of April 30 last from Mr. R. H. Behrend, of Clun House, Surrey-street, Victoria-embankment, W.C., stating that clients of his are proposing this session to make an application under the Tramways Act, 1870, for powers to construct tramways in the district, and asking for an appointment for consultation between his clients' engineer and the borough surveyor and any members of the Corporation who may be interested. The committee resolved unanimously that in their opinion it was desirable the Council should itself make an application as soon as may be for a provisional order authorising it to construct tramways within the borough.

Islington.—The General Purposes Committee have before them a letter from the London County Council with regard to the Tramways No. 1 Bill in Parliament, stating that if the Vestry had no objection in principle to the proposed construction or alteration of the tramways in the district, the Council would be communicating with them on the clauses, and it was hoped they would meet the views of the Vestry. It would be of much convenience if the Vestry generally approved of the proposed construction or alteration, reserving to themselves the right of alteration of clauses. The Highways Committee of the London County Council have written that they had had under consideration the Vestry's application that they should seek powers for extending the existing tramway lines in Ball's Pond-road to join those in Green-lanes. The North Metropolitan Company had been consulted in the matter, and they had suggested as a better arrangement that a junction be made in Ball's Pond-road and thus into Mildmay-road. The Council wished to know whether the Vestry considered this a satisfactory alternative, and were prepared to assent to it. On the proposal for new tramways from Holloway to Hornsey-rise,

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the committee had not yet arrived at a definite conclusion. This matter has been referred to the Works Committee for action.

LIGHTING AND GENERAL.

Cape Electric Tramways.—The transfer registers of debentures will be closed from 17th to 30th inst. inclusive.

Whitby.—The Urban District Council have received sanction to borrow £26,000 for the purposes of electric lighting.

Clacton.—The question of applying for an electric light provisional order has been adjourned for six months.

Edmonton.—The Guardians have adopted the plan of Messrs. Preece and Co. to provide electrical plant at a cost of £1,600.

Hunstanton.—A special meeting of the Urban District Council will be called in August to promote an electric lighting order.

Removal.—Messrs. Robert W. Blackwell and Co., Limited, will remove their stores and offices on June 16 to 59, City-road, E.C.

Fife.—The Lunacy Board have agreed to obtain a report by a practical electrical engineer as to the cost of the lighting of the asylum by electricity.

Chelsea Electricity Supply Co.—The transfer books of the preference and ordinary shares and debenture stock will be closed until the 30th inst. inclusive.

Otley.—The Otley District Council have empowered a committee to make enquiries whether a scheme for supplying electric light to the town could be made successful.

Aberdeen.—Notice of motion has been given to the effect that some steps be taken to include in the plans of the new laundry arrangements for lighting it by electricity.

Greenock.—The Police Board have appointed Mr. W. M. Nelson electrical engineer. Mr. Nelson has acted as assistant to Mr. Fedden during the construction of the works.

Westminster.—We learn that it is proposed shortly to instal the electric light at the Catholic Cathedral. Messrs. O'Gorman and Cozens-Hardy are the consulting engineers.

Preston.—The works of the English Electric Manufacturing Company, Limited, were formally opened yesterday. A full description will appear in our next week's issue.

Hull.—The resignation of Mr. H. Gray, assistant electrical engineer, has been accepted with regret. The vacancy has already been advertised, and 44 applications have been received.

Leamington.—The Electrical Committee's report, recommending that no further steps be taken to oppose the provisional order of the Midland Electric Lighting Company, has been confirmed.

Ossett.—The Town Council have decided to inform the promoters of the Yorkshire electric power supply scheme that the Council will oppose the same, so far as it affects the borough.

New Brancepeth.—The Urban District Council are about to seek advice as to their liabilities and duties under the Electric Lighting Acts in regard to the provision of electric light at New Brancepeth.

Wigan.—The Council have confirmed the agreement with Messrs. F. W. Smith and Co., which contains provisions for either free wiring or for a deferred payment and purchase on the part of the customers.

Volunteers.—Leave for training under canvas has been refused by the Post Office authorities to the 500 telegraph clerks at the central office who are volunteers. Pressure of business is the reason assigned.

Chilian Electric Tramway and Light Co.—The ordinary general meeting will be held at Bishopsgate House on the 21st inst., at 2.30 p.m. The transfer books will be closed from the 18th to the 23rd inst. inclusive.

Hamilton.—The Town Council have instructed Messrs. Buchan and Hogarth, electrical engineers, Edinburgh, to furnish a preliminary report as to the probable cost of an electric lighting scheme for the borough.

Rhondda.—The District Council have agreed to apply for a provisional order in the next session of Parliament under the Electric Lighting Acts of 1882, 1888, and 1899, to supply electricity in the urban district.

Doncaster.—As was to be expected, the electric light is not going to pay all at once. The probable loss for the first year is estimated at nearly £1,000. Still, the Corporation are most sanguine as to ultimate success.

Beverley.—The question of electric lighting has been postponed until the House of Commons enquiry as to the terms on which electric lighting companies should be permitted to lay their mains through the borough is finished.

Bradford.—The Council have decided to enter into a new agreement with the National Telephone Company, Limited, for wayleave facilities, such agreement being subject, among other provisions, to determination on six months' notice.

Bangor.—The walls in the engine-house at the electric light station are to be faced with white glazed tiles at a cost of about £53. The Town Council have decided that a pupil be taken at the electric lighting works at a premium of £50.

Kirkcaldy.—Prof Kennedy, who has hitherto been advising the Town Council regarding the tramways and electric lighting schemes, has now been appointed engineer to carry out the work. The undertaking is to be proceeded with at once.

Mexico Electric Tramways.—The ordinary general meeting of this Company will be held at Winchester House on Wednesday, June 20, at 12 noon. The transfer books of the Company will be closed from June 18 to 23, 1900, both days inclusive.

Charing Cross and City Electric Co.—This Company has been registered with a capital of £300,000 in £5 shares, the object being to carry on business as producers of and suppliers of electricity for the purposes of light, heat, or power, etc.

Bournemouth and Poole Electricity Supply Co.—The transfer books and register of holders of debenture stock of this Company will be closed from the 18th to the 30th inst., both days inclusive, preparatory to payment of the interest due on July 1, 1900.

Nettlefolds, Limited.—The directors of Nettlefolds, Limited, recommend a dividend for the second half-year of 5s. per share on the original preference shares and a dividend of 15s. per share and a bonus of 10s. per share on the ordinary shares, payable 2nd prox.

City of London Electric Lighting Co.—The transfer books and register of holders of debenture stock of this Company will be closed from the 18th to the 30th inst., both days inclusive, for the purpose of preparing the warrants for the interest due July 1, 1900.

Sale of Plant.—Tenders are invited for the plant belonging to the tenants of the Ruchill Chemical Works, Ruchill-street, Glasgow, including Tangyes vertical engine (1½in. cylinder and 7in. stroke), dynamo (115 volts), and electric installation complete.

Barnsley.—The estimates of the expenditure during the current year on account of Locke Park and public lighting, confirmed by the Council last week, contain the following item: electric (three months' consumption), 30 lamps at £5 each, £150; carbons, etc., £10.

Electric Supply of Victoria, Limited.—This Company has been registered with a capital of £200,000 in £1 shares, the object being to carry on in Victoria, Australia, in all or any of their respective branches the businesses of electricians, electrical engineers, etc.

County of London and Brush Provincial Electric Lighting Co. The transfer books and register of holders of debenture stock of this Company will be closed from the 18th to the 30th inst., both days inclusive, preparatory to payment of the interest due on July 1, 1900.

Institution of Electrical Engineers.—The hon. secretary of the Irish section of the Institute at Dublin advises us that Mr. Hammond yesterday (Thursday) gave his address on the proposed Dublin electric light and power scheme at the rooms of the Royal Dublin Society.

Derby.—Ten new Gilbert arc lamps have been purchased at a cost of £9 each, four of which are to be erected on Midland-road. Orders have been given for the London-road main to be extended to the new Corporation stoneyard at the corner of Osborne and Bateman streets.

Rhyl.—The Local Government Board have approved of the scheme for lighting Rhyl with electricity. The scheme will entail an expenditure in the first instance of £19,000, and will be worked in conjunction with a refuse destructor and a new electric tramway along the sea-front.

Leyton.—The number of units generated during April was 41,883, and the total number of lamps connected 21,804. The total number of consumers to the end of the month was 416. Sixty public arc lamps have been erected and lighted, and three similar lamps await allocation.

Eastbourne.—The application for £800 for extension of electric lighting works has been altered into one for the sum of £2,000 for extensions of electric light mains, the purchase of transformers, meters, and electrical instruments. The proposals of the committee, noted in another column, have been agreed to.

Canterbury.—The lamps in the various streets are to be fitted with three-light 8-c.p. fittings. The service cable and cable for public lamps is to be extended 300 yards from its present point in Whitstable-road to the boundary. The salary of the electrical engineer has been increased by £25 per annum.

Accidents.—During the recent storm a man named Abbott was working on the shaft of the new electric light works at Peterborough when he was struck by lightning and knocked senseless. Part of the platform he was on—100ft. high—was carried away. Mrs. Edwards, caretaker at a brewery, was paralysed by a fireball.

Aylesbury.—The various correspondence between the Council, the National Telephone Company, and the Postmaster-General on the subject of a telephone exchange has been referred to the Market Committee. The further consideration of the electric lighting question was postponed for a fuller attendance of members of the committee.

London Gazette.—An adjudication order has been made *re* A. W. Hirst, trading as Hirst and Co., St. Michael's-road West, Croydon, Surrey. The first meeting in this estate will be held on June 21, at 11.30 a.m., at 24, Railway-approach, London Bridge, S.E., and the public examination on July 16, at 11 a.m., at County Court, Park-street, Croydon.

Technical Classes.—The entrance examinations to the Central Technical College of the City and Guilds of London Institute for students not under 16 years of age, and of the institute's Technical College, Finsbury, for students not under 14 years of age, are held in September, and the sessions commence in October. Particulars will be found in another column.

Jedburgh.—The Police Commissioners have approved of a recommendation by Messrs. Crompton and Co. to apply for a provisional order for the installation of electric light in Jedburgh at the expense of Messrs. Crompton, on condition that electric light be used for the public streets, and that the Commissioners have the option of taking over the plant.

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H and H. Accumulator Syndicate.—This Company has been registered with a capital of £10,000, in £1 shares the object being to adopt an agreement with Charles Bright and Co., Limited, and to manufacture and deal in storage and other batteries, motors, locomotives, and all kinds of fittings, apparatus, and appliances connected with the generation or use of electricity.

Telephone Companies.—The *Financial News* states that Mr C. H. Reynolds, C.I E., late Director-General of Telegraphs to the Indian Government, has joined the Board of the Consolidated Telephone Construction and Manufacturing Company, Limited, the Anglo-Portuguese Telephone Company, Limited, and the Edison Gower-Bell Telephone Company of Europe, Limited.

Price-List.—We have received from Messrs. Ashmore, Benson, Pease, and Co., Limited, of Stockton-on-Tees, a price list of their "Invicta" accumulators. The pamphlet gives an illustration of the plates of these cells, and a tabular price-list giving the capacity number of plates, rates of charge and discharge, etc., and the price per cell. This price ranges from £1. 5s. up to £7, according to size.

Scottish Electrical Lumiscriptor Co.—This Company has been registered with a capital of £10,000 in £1 shares, the objects being to purchase the exclusive right throughout Scotland only to sell, work, exhibit, grant licenses in respect of or otherwise use the invention of Walter Claypoole, for improvements in or connected with apparatus for optical projection for advertising and other purposes, patent No. 2,044, etc.

Sheffield.—On Wednesday the City Council adopted the Tramways Committee's recommendation that the management of the department should be reorganised, Mr. A. L. C. Fell, the present electrical engineer, to be made general manager, and his salary increased by £150 per annum, and, under him, Mr. H. E. Yerbury and Mr. J. Dugdale to have charge respectively of the electrical and traffic departments of the system, with increases of salary of £20 and £50 respectively.

Stock Exchange.—The Stock Exchange Committee has appointed June 27 as a special settling day for Nernst Electric Light, Limited, 180,000 vendors' ordinary shares of £1 each, fully paid, Nos 1 to 180,000, and 25,000 vendors' 7 per cent. non-cumulative preference shares of £1 each, fully paid, Nos. 115,001 to 140,000. The committee has also ordered British Insulated Wire Company's further issue of 12,500 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 27,501 to 40,000, to be quoted in the official list.

New Issue.—The St. James's and Pall Mall Electric Light Company, Limited, are making an issue of £150,000 3½ per cent. debenture stock, at a price of £96 per cent. The stock will be transferable in multiples of £1, and redeemable at par on or after Jan. 1, 1931, upon the company giving six months' notice in writing, and subject thereto will be redeemable at 102½ per cent. in either of the following events: (1) the voluntary liquidation of the company; (2) at any time after Jan. 1, 1911, upon the company giving six months' notice in writing.

Company Promoting.—The public examination of J. H. Crawford, financial agent, late of Cannon-street House, E.C., was held on Wednesday. The gross liabilities are returned at £25,645, and the assets are estimated to produce a surplus of £2 545. The debtor stated that he promoted the London Provincial Electrical Company, Limited and the British and Oriental Exploration Company, Limited. He attributed his failure to losses and expenses incurred in promoting companies, interest on borrowed money, law costs, and expenses incurred in exploiting patents.

Leeds.—The Corporation intend to apply for sanction to borrow a further sum of £27,573 for electricity purposes. The Lighting Committee have recommended the formation of a reserve fund, to be called "The Electric Lighting Equalising Fund," into which £8,287 is to be paid from the surplus profit of the electric lighting undertaking. On Wednesday this recommendation was adopted, and the Council also authorised the committee to contract for the supply of two sets of generating plant and one condensing plant for the electric lighting works, at a cost not exceeding £15,000.

Edinburgh.—At a meeting of the Electric Lighting Committee of the Town Council on the 12th inst. it was reported that the electric lighting of the city had been increased between May 24 and June 7 to an extent equivalent to 3 976 8-c.p. lamps including seven motors. At the same meeting the question of providing for maintenance and renewal of the electric lighting undertaking came up for consideration, and the following sub-committee was appointed to deal with the question: Bailie Mackenzie, Councillors Auldjo Jamieson, Sir James Russell, Carmichael, Gibson, and Macpherson.

Newport.—The report of the Electricity Committee is very satisfactory. The deficit for the year ended March, 1899, was £293, but for the year ended March, 1900, there is a net surplus of £403. The gross profit during the year amounted to £4,092, and provision has been made for all loans sanctioned, but not for the new loans. It was stated that, notwithstanding the rise in the price of coal, when the report was presented on Tuesday, there was no intention to rise the price of electricity. It was proposed, as an amendment, to lower the price of the current from 6d. to 4d. This was defeated.

Harrow.—The annual report for 1899 of the Harrow Electric Light and Power Company, Limited, presented at the fourth annual general meeting on the 14th inst. gives the following figures: In 1897, number of 8-c.p. lamps connected in year, 1,540; units supplied to customers in year, 50,109; amount due from customers in year for current meter, rent, etc., £1,730. 3s. 3d.; number of consumers connected in year, 48. In 1898 the figures were respectively: 2,715, 79.419, £2,786. 0s. 4d., and 58; and in 1899, 2,985, 113,551, £3 663: 5s. 7d., and 92. The price of current for lighting purposes has been reduced from 8d. to 7d. from Lady Day.

Tunbridge Wells.—Sir W. H. Preece, in his report on the smoke nuisance at the electric lighting station, recommends the erection of a chimney 180ft. high and 8ft. diameter. This would be sufficient for a plant having a capacity of 2,000 h.p. He attributes the noise complained of entirely to the exhaust steam. As regards the plant in general, he strongly recommends that a second 400-kw. Willans set be ordered without delay. The present Ferranti engine and dynamo should be used as a stand-by or an emergency set. The cost of the additions is estimated as follows: chimney, £2 000; new Willans Ferranti set, £4,600; contingencies, £500—total. £7,100.

Legal.—In the Chancery Division on Wednesday, Mr. Justice Cozens-Hardy heard the case of Bright *v* River Plate Electric Light and Traction Construction Company. Mr. R. F. MacSwinney represented the defendant company, with which Messrs. James Capel and Co., of Throgmorton street, E.C., were joined. It was stated that there was a scheme of reconstruction in hand under which all the creditors would be paid. His Lordship, in giving judgment, said that the matter came within Section 4 of the Arbitration Act, and made the usual order to stay proceedings in the action, except for the purpose of any application which the plaintiff might make for the purpose of a commission to take evidence, any summons for that purpose to be taken out within 10 days from that date. Leave to appeal was given.

Halesworth.—At the last meeting of the District Council on Monday the subject of electric lighting for the town was discussed. It was stated that the directors of the Colchester Brewing Company, who were about to put down an installation for lighting the brewery with electricity, had received many applications to supply other premises. They were prepared to put down a larger plant, so as to light the whole town if desired, but before doing so they would be obliged to obtain an order from the Local Government Board to enable them to put down a few posts to carry their overhead wire to different parts of the town. Finally, consideration of the question was adjourned, and a small committee appointed to ascertain what the result of acceding to the application would be, and how far the proposed order would bind the Council in any future action they might wish to take.

The General Electric Co.—We have received from the General Electric Company a list of their multipolar dynamos and motors. The catalogue gives illustrations of the various portions of their multipolar continuous current machines, and also a good description of these parts. The prices of various sizes of machines are given, and a table of outputs, weights, etc. Efficiency curves for different sizes are also given. In addition to this list we have received one from the same company dealing with electric fan motors for continuous and alternating currents. The list opens with the enclosed type of desk or table fans supplied by the company, after which is an illustration showing the various parts of the fan by themselves. These parts are all catalogued and priced separately according to their number. Ceiling fans and column fans come next, the parts of these being also separately catalogued. The list concludes with illustrations and descriptions of continuous and alternating current fans, fan motors, ventilators, etc.

Personal.—On Thursday evening, May 31, Mr. D'Alton, who has been for nine years engineer-in-chief to the London Electric Supply Corporation, was entertained at a complimentary dinner given by the engineers past and present of the company. The chair was taken by Mr. Ferranti, with the new "chief," Mr. G. W. Partridge, as vice-chairman. The Chairman proposed the toast of "Mr. D'Alton," and presented him at the conclusion of his speech with a gold hunting watch, and with a piece of jewelry for Mrs. D'Alton, who is also well known to the members of the staff. The feature of the evening was the sale by auction of signed menus, a large sum of money being realised for the soldier's widow and orphan fund. The first menu put up was purchased for 5s., the prices rising as high as 35s. On the following day Mr. D'Alton said good-bye to all his old comrades and friends at the Deptford station, when he was presented with a pocket-book, well lined with notes, on behalf of the chairman, directors, and staff of the corporation. Mr. Stewart Main made the offering. Mr. D'Alton suitably replied, after which he left Deptford with the good wishes for his success in Victoria street of those who had been associated with him.

Appointments Vacant.—The directors of the London Exhibitions, Limited, invite applications for the post of chief electrical engineer.—Applications for an appointment of an assistant superintendent in the telegraph department of the Government of India, on a commencing salary of Rs.3,600 a year, will be received by the Secretary, Public Works Department, India Office, Whitehall, London, S.W., up to June 30 next.—The Board of Works for the Poplar District are prepared to receive applications from candidates for the position of chief generating assistant in connection with the electricity works now in course of establishment for the district.—The Leyton Urban District Council require a shift engineer to take charge each day in eight-hours shifts of the running of the plant at the electric light works.—The Doncaster Corporation want an improver.—The Carlisle Electric Lighting Committee have decided to engage an additional driver and switchboard attendant in connection with the extension of the central electric lighting station.—The Rathmines Urban District Council invite applications for the posts of arc lamp trimmer and of engine-driver. Full particulars of these vacancies, and others referring to an assistant tester for enclosed arc lamps, etc., appear in another column.

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Ayr.—A report by Mr. A. J. Fuller, burgh electrical engineer, was submitted at the Council meeting on the 11th inst., in which it is proposed that the system in the centre portion of the town be changed from a low-tension alternating current to a low-tension three-wire continuous-current distribution. The estimated cost of the alteration was £8,730. The matter was deferred.

Fareham.—At the meeting of the Urban District Council on Friday the Lighting Committee reported that it would be convenient to many inhabitants if the system of business and terms of the Southern Electric Free Wiring Company, of Southampton, were adopted in Fareham. It was agreed that the committee be empowered to proceed with negotiations with the company with a view to formal agreements being entered into.

Workington.—At the last meeting of the Town Council it was proposed that the whole of the profits now standing to the credit of the gasworks be used for the purpose of supplying the borough with electric light, and that a small committee be appointed to consider the advisability of adopting this course, and to report to the Council. An amendment that the committee merely consider the advisability of adopting electric lighting for the borough was substituted and carried.

South Shields.—Electric light is making rapid progress in this town, and many of the less important and residential streets are now illuminated by electricity. During the present year the electric light has been introduced into many of the churches and chapels, while very few of the better-class residents are without the electric light in their houses. Electricity has also been utilised for many purposes, as for instance, in connection with the organ in St. Paul's Presbyterian Church.

Islington.—At the last meeting of the Vestry a letter was received from the Vestry of St. Marylebone asking the former to join with the latter and the other parishes of London in opposing confirmation of the electric lighting order sought and obtained by the Marylebone Electric Supply Company. The letter was referred to the Electric Lighting Committee for action. The clerk read a letter from the London County Council stating that they were prepared to sanction the Vestry borrowing £18,261 and £3,200 for electric lighting purposes.

Wrexham.—The Borough Surveyor submitted a special report to the Town Council last week in reference to the proposal of the National Telephone Company to lay underground cables. He said that unless he had further and fuller particulars of the intended works, including a specification, he could not advise the committee. He pointed out that many of the thoroughfares in which it was proposed to lay the cables were very narrow, and in some cases they had something like six lines down at the present time, with the prospect of electric light cables and also postal telegraph cables. The report was adopted.

Bolton.—From the proceedings of the Electricity Committee adopted last week it appears that the last year has been a fairly successful one. Their capital has increased from £67,000 to £117,000, expended in new land round the old works, new buildings, and new machinery. Private lighting increased by £2,511, and the tramways receipts amounted to £1,593. The output is now practically double that of the preceding year, and there are now 751 consumers, 200 of whom have been connected during the last year. Although coal has cost £1.000 more than the previous year, the committee have been able to place £2,000 to the relief of rates.

Electric and General Investment Co.—We are informed that, subject to the completion of the audit, the directors have decided to recommend the payment of the following dividends, etc., for the year ended May 31, 1900: A dividend on the ordinary shares of 5s. per share, of which 2s. per share was paid on account in December last, leaving 3s. per share to be distributed, and a bonus of 4s. per share, making a present distribution of 7s. per share, or a total distribution of 9s. per share for the year; a dividend on the founders' shares for the year ended May 31, 1900, of £30 per share and a bonus of £40 per share, making a present total distribution of £70 per share for the year. The dividends, if sanctioned by the shareholders, will be paid on the 27th inst.

Darlington.—The following scale of charges for supplying electrical energy has been adopted: For lighting purposes—not exceeding a consumption of 1,900 units per annum, 5d. per Board of Trade unit; 1,000 and not exceeding 3,000 units, 4½d. per Board of Trade unit; exceeding 3,000, 4½d. per Board of Trade unit. For motive power purposes—not exceeding 50,000 units per annum, 2d. per Board of Trade unit; exceeding 50,000 units per annum, such terms as may be agreed upon between the Corporation and the consumer. The Streets Committee is to be supplied with all electrical energy required for lighting the streets at cost price. The committee are considering the propriety of adopting the system of free wiring, similar to that in use at Worcester and Hartlepool. They are awaiting Prof Kennedy's report on this subject.

Swansea.—The Electric Lighting Committee have agreed upon a scale of charges for current to private consumers. For lighting the charge will be 6d. per Board of Trade unit for the first 1½ hours' consumption of the maximum demand, and 2d. per unit for all used subsequently; and for motive power at the rate of 6d. per Board of Trade unit for the first hour's average consumption of the maximum demand, and 1½d. per unit for current consumed in excess of this, or, as an alternative, 3d. per unit for all consumed. Sixpence or a shilling-in-the-slot meters are to be provided, the price charged to cover the amount payable to the National Free Wiring Company and expenses of collection, etc. The committee have also decided to extend the lighting area to the extremes of the borough. The resignation of Alderman Aeron Thomas has been accepted, and Messrs. Griff. Davies and David Williams elected to fill the vacancies caused by the retirement of Alderman Thomas and Alderman Viner Leeder.

Brighton.—At a recent meeting of the Lighting Committee a detailed report was submitted from the surveyor as to the result of his having sunk three trial holes in the beach for an electricity station at Southwick. The cost of the work has been £1,515. 7s. 3d. Mr. May stated that, in his opinion, this had been a very wise expenditure of money, and one that would probably be more than saved by a reduction in the amount of the tenders for the construction of the foundations of the buildings, inasmuch as the difficulties connected with this site had been clearly ascertained, so that in the preparation of the specification it would be possible to give all the necessary information to the contractor to enable him to prepare a definite tender, and so to avoid the large margin of unforeseen risks, which the contractor would otherwise have been obliged to add for his own security.

Dudley.—In their last report the Railway, Tramway, and Electric Lighting Committee recommend that the Corporation wire the premises of all consumers of electricity free of charge, but not to include either brackets, pendants, or other fittings. They also recommend that Mr. Wilson be instructed to draw up specifications and conditions and advertise for tenders for the work of wiring consumers' premises. Consumers are to have, until further notice, the option of being supplied at the rate of 5d. per unit throughout or at the rate of 6d. per unit for two hours a day (the said hours to be determined by the Corporation or their engineer from time to time) and 1½d. per unit for the remaining 22 hours, and that no rentals be charged for meters. The town hall buildings will be fitted up with the electric light. Application is to be made for sanction to the borrowing of a loan of £10,000 for the purpose of wiring the premises, free of charge, of all consumers of electricity supplied by the Corporation.

Bristol.—That there is plenty of room for the development of electricity for street-lighting in Bristol, says the *Bristol Times and Mirror*, is shown by the fact that there are still 7 651 gas street lamps in the city, which last quarter consumed 42,028,778 cubic feet of gas, and cost the city for gas at 2s. 1d. per 1,000, and for lighting, cleaning, and repairs, etc., £6,084 3s. 7d. There are 66 oil lamps in use for street lighting, and the cost £1 each for the quarter. They are chiefly in St. George, but a few are in Stapleton and Somerset wards. The average illuminating power of gas during the last quarter was equal to 15 26 sperm candles, burning at the rate of 120 grains of sperm per hour. The highest illuminating power was 15 63 candles, and the lowest 14·80 candles. At the meeting on the 12th inst. the Electrical Committee reported that for the purpose of carrying out the extension of the electrical undertaking it was necessary to provide an exciter switchboard, which would cost £385. 10s. It was agreed that the switchboard be obtained.

Eccles.—At the last meeting of the Town Council the accounts of the electric light undertaking for the past year were discussed. These showed a deficit on the year's working of £789, but of this sum £346 is for the repayment of loans. The figures were regarded as very satisfactory, considering the difficulties the Council had to contend against. The amount overspent and due to the treasurer on the electric lighting account is £7,289, and it was decided to obtain borrowing powers to cover this amount. The tenders received for the supply of an engine and boiler sufficient to deal with the light load in place of the motor-generator and accumulator have been referred to the Works Sub Committee for examination and report as to the probable total cost, and also as to the probable reduction which will be effected in the working expenses by the provision thereof. All reports of the electrical engineer relative to the generating station will be in the first place submitted to the Works Sub-Committee for their consideration and report.

Dalkeith.—The Burgh Commissioners are discussing a draft agreement with Messrs. Crompton and Co., Limited, for the electric lighting of Dalkeith. In their report their committee observed that the installation is to cost the burgh nothing; that the fixed rate of 3d. per unit for public lighting was cheaper than the present cost for gas, and that ratepayers will be under no obligation to use the electric light, whereas they were likely to benefit by the competition. In the whole matter the committee unanimously recommended the Commission to approve of the scheme, and to authorise Messrs. Crompton and Co., Limited, to apply for a provisional order on the draft agreement being satisfactorily adjusted prior to July 1, but they suggested the following alterations in the agreement: (1) that the installation be completed within one year after the commencement of the order; (2) that a nominal way leave or rent be obtained for the use of the streets; (3) that all operations in the streets be done at the sight and to the satisfaction of the burgh surveyor.

Eastbourne.—The statement of the accounts of the Corporation electricity undertaking during the first quarter ending March 31 shows that in that period the revenue amounted to £3,649. 14s. 1d. The sale of electricity, arc lighting, and meter rents realised £3,553. 17s. 7d. The expenditure was £1,677. 14s. 2d., of which sum £1,218. 11s. 2d. was for the generation of electricity. The gross profit made was, therefore, £1,971. 19s. 11d., of which £869. 5s. 6d. was applied to meet the bank interest on the temporary overdraft for the purchase of the undertaking, and £640. 0s. 5d. was appropriated for sinking fund purposes, leaving a net profit of £462. 14s. after the first three months' trading under Corporation auspices. It is proposed that the resolution passed by the Council on March 5, 1900, authorising application to the Local Government Board for power to borrow the sum of

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£800 for extensions of electric light mains be rescinded, and that in lieu thereof application be made to the Local Government Board for power to borrow the sum of £2,000 for extensions of electric light mains, the purchase of transformers, meters, and electrical instruments. The report of the Electric Light Committee states that the men have been consulted and are unanimously in favour of an eight-hour shift, and a trial is to be made. The committee recommend that it be left to Mr. Hawtayne and Mr. Bridges to arrange for a trial in Elms-avenue of incandescent electric lamps, and that the Council adopt Mr. Hawtayne's proposals as set forth in his report for the arc lighting of a number of streets, with the addition of 10 lamps; and, further, that the Council authorise the necessary expenses to allow the committee to visit and inspect the electric light works and public street-lighting of Brighton, Watford, Canterbury, and Harrow before deciding as to the incandescent lamps.

Hereford.—The Electric Lighting Committee's last report states that the result of the quarter's working is even more satisfactory than they had anticipated. The receipts for current, including meter rents, amount to £273. 12s. 6d., and the total payments to £576. 4s. 1d., leaving a deficiency of £302. 11s. 7d., but of this latter sum £200 is a repayment of capital, £46. 10s. is in respect of interest in excess of a quarter's interest on the £10,000 borrowed, and is due to the circumstance that the amount is debited with banker's interest on money advanced pending the payment of the balance of the permanent loan. The account is also debited with a year's insurance premium and some other small payments, properly chargeable to a longer period than a quarter, amounting to over £20. But for these payments the deficiency on the quarter's working would have only been £35 or £36, and having regard to the fact that more than half of the lights now connected were not so connected until long after the commencement of the quarter, the committee are well satisfied with the result. The committee find that it is necessary that some regulations should be made with respect to visits to the works. There is every wish to give facilities to visitors as far as is consistent with the safety of the works. But the machinery is delicate and requires constant attention, and accidents are likely to occur if the attention of the engineer is to be distracted to attend to visitors, especially if there are more parties than one in the premises at the same time. They propose to arrange for a proper system of orders to view being given, and every possible facility will be afforded to persons properly introduced to view the works. But two parties will not be admitted at the same time, and there may be occasions when visitors cannot be admitted at all, as, for instance, in case of any breakdown or repairs or alterations to the plant. Therefore they say not only must regulations as to admittance be made, but there must be some system to ensure their being carried out.

COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY.

An extraordinary general meeting was held on the 12th inst. for the purpose of considering a Bill in Parliament conferring further powers upon the Baker-street and Waterloo Railway Company. It was explained that the Bill sought to extend the Baker-street line as far as Paddington at the one end and to the Elephant and Castle at the other. At the latter place the Baker-street line would connect with the line of this Company. By these means, South London would be brought into direct electric communication with the North and West. A resolution approving the Bill was carried.

BRITISH ELECTRIC TRACTION.

Directors: Sir Charles Rivers Wilson, G.C.M.G., C.B. (chairman); the Right Hon. Lord Rathmore; the Hon. Sir Charles William Fremantle, K.C.B.; Charles Sinclair Drummond; John Smith Raworth, M.I.C.E.; Emile Garcke, M.I.E.E. (managing director). Secretary: George Stevens.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the fourth ordinary general meeting of the Company, to be held at Donington House, Norfolk-street, Strand, London, W.C., on June 18, 1900:

The profits, including £35,451. 13s. 8d. brought forward from last year (but without taking into account the premiums, £160,529. 15s. 3d., received in respect of new share and debenture capital), amount to £159,122. 15s., and after deducting the proportion of general expenses chargeable to revenue, and also the expenses incurred in connection with schemes not proceeded with and written off, and interest on debenture stock, there remains a net profit of £130,174. 16s. 2d., which the directors propose should be applied as follows: reduction of goodwill account, £5,000; addition to reserve, £20,000; reduction of furniture account, £469. 1s. 9d.; dividend at the rate of 6 per cent. per annum on preference shares for the 15 months ended March 31, 1900, on account of which interim dividends have been paid to Feb. 15, 1900, £23,051. 18s. 9d.; dividend at the rate of 8 per cent. per annum on the ordinary shares for the 15 months ended March 31, 1900, on account of which an interim dividend at the rate of 6 per cent. per annum has been paid for the nine months ended Sept. 30, 1899, leaving a balance dividend payable of 11s. per share, Nos. 1-30,000, and 8s. 7½d. per share, Nos. 60,001-75,000, £37,869. 16s. 10d.; carried forward to next account, £43,783. 18s. 10d. Since Dec. 31, 1898, the directors have issued 40,000 6 per cent. cumulative preference shares of £10 each at £12 per share, and 15,000 ordinary shares of £10 each have been allotted to the shareholders at £15 per share. There has also been issued £250,000 5 per cent. perpetual debenture stock at an average price of £120⅛ per cent. The total premiums received in respect of these issues, after deducting the expenses, amount to £160,529. 15s. 3d., and the whole of this amount has been added to reserve. The subscribed share and debenture capital is now: £450,000 in ordinary shares of £10 each; 500,000 in 6 per cent. cumulative preference shares of £10 each; 350,000 5 per cent. perpetual debenture stock—total, £1,300,000. Of the authorised share capital there is at present unissued 15,000 ordinary shares of £10 each and 10,000 preference shares of £10 each, which the directors propose at an early date to allot to the shareholders on terms to be announced. The whole of the present authorised share capital of the Company will then be issued, and the directors recommend that powers be taken to increase the nominal capital of the Company by the creation of 80,000 shares of £10 each; and notice is given herewith of an extraordinary general meeting of the shareholders to consider, and, if deemed advisable, to pass, the necessary resolution. The total amount expended on contracts and undertakings, after deducting the costs of undertakings transferred, and after writing off expenses incurred in respect of schemes not proceeded with, but including a proportion of general expenses, is £543,246. 12s. 4d., made up as follows: expenditure and profit on works and undertakings for account of other companies, £277,148. 19s. 3d.; expenditure on works and undertakings owned, leased, or controlled by the British Electric Traction Company, and for general stores, £234,019. 15s. 8d.; expenditure on negotiations, etc., in connection with new schemes in course of development, and on Acts of Parliament, provisional orders, light railway orders, and other rights and powers in course of promotion, £32,077. 17s. 5d. The total expenditure on investments, after deducting cost of securities sold or written off, is £950,280. 0s. 1d., and is made up as follows: Consols (cost), £61,296. 2s. 8d.; National War Loan (£6,000, paid-up), £510; parliamentary and other deposits in cash and Consols (cost), £31,658. 11s. 6d.; loans and advances to associated companies and others, £60,023. 7s. 9d.; mortgages and debenture stocks of associated and other companies (cost), £75 611. 17s. 10d.; shares of associated and other companies (including £24,940 in the British Electric Traction (Pioneer) Company, Limited (cost), £721,180. 0s. 4d. (There are certain contingent liabilities in respect of some of these investments.) The directors have had under consideration the desire expressed by officers of the Company and of the associated companies that a superannuation fund should be established, and a proposal will be made to the meeting that a sum of £25 should be subscribed by the Company in respect of each official now in the employ of the Company who elects to become a subscriber to the fund, and that the Company should make certain annual contributions to the fund. Mr. Charles S. Drummond has been appointed a director of the Company. The directors who retire this year are Sir Charles Rivers Wilson, G.C.M.G., C.B., and the Hon. Sir Charles W. Fremantle, K.C.B., and both are eligible for re-election. Mr. Fred. W. Smith, F.C.A., retires, and his firm, Messrs. Fred. W. Smith and Co., offer themselves for re election.

Dr. PROFIT AND LOSS ACCOUNT.

	£ s. d.
General expenses—proportion of these not chargeable to contracts and undertakings, including expenditure on undertakings not proceeded with, and written off	15,185 5 4
Debenture stock interest, £8,466. 15s. 9d.; add proportion of interest accrued to date, £5,295. 17s. 9d.	13,762 13 6
Balance carried down	130,174 16 2
	£159,122 15 0
Goodwill account—amount written off	5,000 0 0
Reserve—amount added	20,000 0 0
Furniture and fittings—amount written off (20 per cent.)	469 1 9
Preference share dividend paid to Feb. 15, 1900	19,435 9 0
Ordinary share interim dividend paid Sept. 30, 1899	14,901 1 10
Proportion of dividend accrued to date, £3,616. 9s. 9d.; proposed dividend on ordinary shares at the rate of 8 per cent. per annum for 15 months, £37,869. 16s. 10d.; less interim dividend paid, £14,901. 1s. 10d.—£22,968. 15s.; balance carried forward to next account, £43,783. 18s. 10d.	70,369 3 7
	£130,174 16 2

Cr.

	£ s. d.
Balance brought forward from Dec. 31, 1898	35,451 13 8
Profits on contracts and undertakings, commissions, sale of investments, management, transfer, and other fees, interests and dividends, etc., subject to the shares which have been received in part payment realising par value	123,671 1 4
	£159,122 15 0
Balance brought down	£130,174 16 2
	£130,174 16 2

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BALANCE SHEET.

Liabilities.	£	s.	d.
Capital—60,000 6 per cent. cumulative preference shares of £10 each, and 60,000 ordinary shares of £10 each	1,200,000	0	0
Issued: 50,000 6 per cent. cumulative preference shares of £10 each, fully paid, £500,000; less instalments in arrear, £1,256	498,744	0	0
45,000 ordinary shares of £10 each, fully paid, £450,000; less instalments in arrear, £96; and three shares forfeited £30	449,874	0	0
	£948,618	0	0
Debenture stock: £350,000 5 per cent. perpetual debenture stock, £350,000; deduct instalments not yet due or in arrear, less amount paid in advance, £47,676	302 324	0	0
Reserve: premiums on issues of shares and debentures as at Dec. 31, 1898, £29.135. 15s. 8d.; premiums in respect of subsequent issues, less expenses, £160,529. 15s. 3d.	189,665	10	11
Amount transferred from profit and loss account at March 31, 1900	20,000	0	0
Creditors (including £25,000 owing to the British Electric Traction (Pioneer) Company, Limited, in respect of the purchase of its undertaking), £118,067. 19s. 8d.; and temporary loan at bankers, £45,000	163 067	19	8
Profit and loss account: proportion of dividend due Aug. 15, 1900, accrued to date, £3,616. 9s. 9d.; proposed dividend on ordinary shares at the rate of 8 per cent. per annum for 15 months, £37,869. 16s. 10d.; less interim dividend paid Sept. 30, 1899, £14,901. 1s. 10d.; balance carried forward to next account, £43,783. 18s. 10d.	70,369	3	7
	£1,694,044	14	2

Assets.	£	s.	d.
Contracts and undertakings—lands, buildings, permanent ways, electrical equipments, rolling-stock, general stores, parliamentary and other rights, surveys, etc.	543,246	12	4
Investments—Consols, National War Loan, mortgages, loans and advances to associated companies and others, debentures and shares in associated and other companies (including £24,940 shares in British Electric Traction (Pioneer) Company, Limited), parliamentary and other deposits	950,280	0	1
Sundry debtors	162,429	7	2
Goodwill accounts reduced at Dec. 31, 1898, to £10,000; amount written off at March 31, £5,000	5,000	0	0
Cost of licences and of testing and developing new systems of traction as at Dec. 31, 1898, £7,986. 15s. 9d; expended since, £124. 2s.	8,110	17	9
Office furniture and fittings as at Dec. 31, 1898, £1,325; expended since, £1,020. 8s. 7d.; less written off at March 31, 1900, £469. 1s. 9d.	1 876	6	10
Cash—on current account and in hand	23,101	10	0
	£1,694,044	14	2

SUSSMANN ELECTRIC MINERS' LAMP.

The report of the directors for 1899, to be submitted to the meeting on 18th inst., shows a balance at debit of profit and loss of £3,827. The directors state that either further capital must be found or that the Company must suspend operations and go into liquidation, and they believe that the work accomplished warrants an issue of debentures to the extent of £5,000, for which they will ask authority.

PROVISIONAL PATENTS, 1900.

MAY 31.

10065. Improvements in automatic magnetic circuit-breakers. William Robert Lake, 45, Southampton-buildings, Chancery-lane, London. (William Maxwell Scott, United States.)

10074. Improvements in electric brakes. Frank Clarence Newell, 322, High Holborn, London.

10075. Improvements in or in connection with trolley or like current collectors for electric railways and tramways. James Wilson Martin, 6, Lord-street, Liverpool.

10081. Electric fuse. Isidor Kitsee, 11, Queen Victoria-street-London.

JUNE 1.

10133. Improvements in and relating to electric meters. Thomas Duncan, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10134. Improvements in electric meters. Thomas Duncan, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10121. Improvements in electrically-propelled velocipedes, carriages, and other like vehicles. Charles Adams-Randall, 98, Prince of Wales-mansions, Prince of Wales-road, London.

10124. Calling appliances for telephone switchboards. John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.)

10137. Improvements in or connected with electric lamps. Robert Krayn, 36, Chancery-lane, London. (Complete specification.)

10141. Improvements in or relating to electric switches. George Bennett Bowell, 322, High Holborn, London.

10142. Improvements in printing telegraph apparatus. Donald Murray, 322, High Holborn, London. (Complete specification.)

JUNE 2.

10172. Improvements in apparatus for starting and controlling electric motors. Thomas Preece, 4, Cheltenham-street, Leamington-road, Blackburn.

10181 Electrical steam-boiler. Charles Edward Griffing, 154, St. Vincent-road, Glasgow. (Complete specification.)

10197. Improvements in electrodes. Karl Adolf Wilde, 22, Southampton-buildings, Chancery-lane, London.

10210. Improved electrical apparatus for closing steam supply valves from a distance and giving an audible signal. Eduard Gustav Dahl, 40, Chancery-lane, London. (Complete specification.)

10214 Improvements relating to electrical ignition devices applicable to internal-combustion and like engines, and to other purposes. John Alexander McMullen, 323, High Holborn, London.

10219. Improvements in electricity meters. William Lloyd Wise, 46, Lincoln's-inn-fields, London. (Lux'sche Industriewerke-Actiengesellschaft, Germany.) (Complete specification.)

10221. Electrical alarm for automatic fire-extinguishing sprinkler installations. Edmund Chadwick, 8, Quality-court, Chancery-lane, London. (Harry Tetlow, Russia.)

10230. An improved arrangement of underground mercury contact for electric railways and tramways. Léo Bachelin, 4, South-street, Finsbury, London.

JUNE 5.

10270. Improved low-tension exploder or electric shot-firing battery. Gwilym Evans, 46, Gadlys-road, Aberdare, South Wales.

10273. Improvements in controller regulators for electric motors. Herbert John Haddan, 18, Buckingham-street, Strand, London. (The Garton Daniels Company, United States of America.) (Complete specification.)

10312. Improvements in and connected with wireless telegraphy. Charles Edwin Wilson, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10313. Improvements in electric storage batteries and conducting plates therefor. John Corry Fell, 1, Queen Victoria-street, London. (S. Lloyd Wiegand, United States.) (Complete specification.)

10319 Improvements in electric storage batteries. John Corry Fell, 1, Queen Victoria-street, London. (S. Lloyd Wiegand, United States.) (Complete specification.)

10323. Improvements in telephone cables and in apparatus for producing same. Hugo Cassirer, 18, Buckingham-street, Strand, London. (Complete specification.)

JUNE 6.

10348 Electromagnetic machine. Jansma Van der Ploeg, 62, St. Vincent street, Glasgow. (Complete specification.)

10357. Improvements in and relating to electrical apparatus for surgical and other purposes. John Joseph Hynes and Purdy Myron Randall, 70, Chancery-lane, London. (Complete specification.)

10361. An improved flexible electrical conductor from any point of which a current may be taken. Julian Adolphe Halford, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

10363 Improvements in electric contacts. Julian Adolphe Halford, Birkbeck Bank chambers, Southampton-buildings, Chancery-lane, London

10375. Improvements in the construction of plates for accumulators or secondary batteries discharging heavy currents. Jean Garassino, 73, Cheapside, London.

JUNE 7.

10437. Improvements in or relating to electrodes for batteries. Alexander Mackenzie, 111, Hatton-garden, London.

10444 Improvements in or connected with electric incandescent lamps of the refractory conductor type. Gabriel Patrouilleau, 26, Norfolk-street, Strand, London. (Complete specification.)

JUNE 8.

10451. A containing box for electrical resistance material Alfred Herbert Mayes, 40, Walsingham-road, Hove Sussex.

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10460. Improvements in or connected with electric cars. Augustine Ried, 157, Bedford-street, Liverpool.

10476. An improved adjustable electric igniter or spark producer. August Braun, trading as August Braun and Co., and the Erste Osterreichische Motorfahrzeuge-Fabrik, 72, Cannon-street, London. (Complete specification.)

10502. Improvements in telephone systems. Georg Ritter, 6, Lord-street, Liverpool. (Complete specification.)

10509. Improvements in electrical switches. Noel Newall Haigh and Benjamin Shore, 18, Southampton-buildings, Chancery-lane, London.

10511. Improvements in the manufacture of negative or spongy-lead plates or elements for secondary batteries or electrical accumulators. The Electrical Power Storage Company, Limited, Herbert William Butler, and Joseph Horsnell May, 47, Lincoln's-inn fields, London.

JUNE 9.

10542. Improvements in and connected with electric wall plugs. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

10543. Arrangement for limiting the length of the fuse of electric cut-outs. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

10544. Improvements in and connected with quick-break switches. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

10545. Improvements in and connected with switches or keys for electric lampholders. Hermann Oppenheimer, 55, Redcross-street, Barbican, London. (Actiengesellschaft Mix und Genest, Germany.)

10550. Improvement in and relating to ammeters. William Edward Evans, 27, Chancery-lane, London. (Gans und Goldschmidt, Germany.)

10579. Improvements in and relating to electrically-controlled apparatus for shifting and locking railway points. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Actien-Gesellschaft, Germany.) (Complete specification.)

10580. Improvements in electric furnaces of great power. Oliver Imray, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Fausto Morani, Italy.)

10587. Improvements in feeding and regulating mechanism for electric arc lamps. William Henry Arundell, 22, Glasshouse-street, Regent-street, London.

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on June 30.

1899.

15967. Electric arc projecting lanterns. Kamm.

23377. Electric gas lighters. De Thiersant and Norballe.

1900.

7084. Electric meters. Boult. (Pieper and Pieper.)

8239. Electricity meters constructed on the Ferraris principle. Siemens Bros. and Co., Limited. (Siemens und Halske Aktien-Gesellschaft.)

8299. Two-liquid primary batteries and regenerating the same. Johnson. (Dercum.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	June 2	645	527	+ 18	30,781	26,576
Birmingham Tramways Co.	,, 2	4,500	4,232	+ 268	91,225	86,497
Blackburn Corp'rat'n	,, 9	752	477	+ 275	9,646	8,304
Blackpool Corporatn.	,, 7	1,316	523	+ 793	4,587	4,204
Blackpool-Fleetwood	,, 9	1,833	640	+1,193	7,728	8,011
Bolton Corporation..	—	—	—	—	—	—
Bradford City Trams	,, 10	788	400	+ 388	4,921*a*	3,734
Bristol Tramways Co.	,, 8	4,708	3,159	+1,548	—	—
City & South London	,, 10	1,501	888	+ 613	29,253	24,081
Dover Tramways ...	,, 9	270	182	+ 87	3,857	3,629
Dublin U.T., elec. cars	,, 8	4,276	1,411	+2,865	—	—
Dublin S.D. Electric	,, 8	1,254	1,095	+ 159	—	—
Halifax Corporation	,, 9	1,040	626	+ 414	7,122	4,918
Hull Corporat'n E.S.	,, 7	1,124	1,569	—	11,455*a*	—
Liverpool Corporat'n	,, 2*b*	7,829	7,778	+ 51	155,287	136,541
Liverpool Overhead	,, 10	1,781	1,469	+ 312	32,790	31,795
Sheffield Corporation	,, 10	2,828	—	—	—	—
South Staffordshire	,, 8	1,225	644	+ 581	15,560	14,528

a Since April 1. *b* Partly electrical.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	¾-¾
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6-6½
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	¾-1
—— 6 per cent. Cum. Pref., 1-50,000	1	..	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	100	..	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4½-5
Brush Electrical Engineering, Ordinary	2	—	1½-2
—— Non. Cum., 6 per cent. Pref.	2	—	2-2½
—— 4½ per cent. Debenture Stock	100	..	109-114
—— 4½ per cent. 2nd Debenture Stock	100	—	103-105
Callender's Cable, Debentures	100	—	112-116
—— Ordinary	5	—	13½-14½
—— 5 per cent. Pref.	5	—	5½-6
Crompton and Co.	3	—	3½ 4
—— 5 per cent. Debentures	—	—	100-103
Edison and Swan United, Ordinary	3	—	2-2½
—— 5 per cent. Debentures	5	—	3½-4½
—— 4 per cent. Deb. Stock, Red.	100	..	93-95
Electric Construction	2	—	2-2½
—— 7 per cent. Cumulative Pref.	2	..	2½-2¾
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	103-106
W. T. Henley's Telegraph Works, Ordinary	5	—	13-14
—— 4½ per cent. Preference	5	..	5½-5¾
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	..	100-103
Telegraph Construction and Maintenance	12	..	34-38
—— 5 per cent. Bonds	100	..	102-105
Telegraph Manufacturing, Ordinary	5	—	11½-12½
—— 5 per cent. Cum. Pref.	5	..	5½-6
Willans and Robinson, Ordinary 1-80,000	5	..	11-12
—— 6 per cent. Cum. Pref., 80,001-60,000	5	..	6¾-7½
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-¾
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	..	8½-9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6¾-7½
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	—	5½-6
Chelsea Electricity Supply	5	—	6¾-7½
—— 4½ per cent. Debentures	100	—	109-112
City of London, Ordinary	10	..	9-10
—— 6 per cent. Cumulative Pref.	10	..	12½-13½
—— 5 per cent. Debenture Stock	100	..	124-130
County of London and Brush Provincial, Ordinary	10	..	9-10
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	110-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	*101-104*
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9½-*10*
London Electric, Ordinary	3	..	1½-2
—— 6 per cent. Pref.	5	..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	100-102
Metropolitan, Ordinary	10	..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	113-116
—— 3½ per cent. Mortgage Debenture, Red	100	..	97-99
Notting Hill Electric Lighting	10	..	15½-16½
Oriental, 1879	1	..	1-1¼
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	6¼-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6-6½
River Plate Electric Light and Traction, Deb.	100	..	76-80
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	86-90
South London, Ordinary	3	..	3¾-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	9½-9¾
Westminster, Ordinary	5	..	3 14
Electric Railways.—			
Central London, Ordinary	10	..	10-10½
—— Pref. Half-shares	5	..	4¾-5¼
—— " " deferred	5	..	5-5½
City and South London, Consolidated Ordinary	100	..	65 68
—— Ordinary	10	—	6-7
—— 4 per cent. Debenture Stock	100	—	128 128
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— " " " '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	—	13½-13¾
Waterloo and City, Ordinary	100	..	100-103
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17½-18½
Brisbane Tramway	100	..	102-104
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10½-10¾
British Electric Traction, Ordinary, 1-80,000	10	..	15½-16½
—— 60,001-75,000	10	..	15½-16½
—— 6 per cent. Cm. Pf. 80,001-60,000	10	..	13-13
—— 5 per cent. Perpetual Debenture Stock	100	..	124-127
—— " " " 1900	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	103-106
Isle of Man Electric Power, 1-95,000	1	..	1-3/16
—— 6 per cent. Preference, 100,001-170,000	1	..	1-5/16
Kidderminster and District Lighting and Traction, Pref.	10	..	9½-10
New General Traction, Ordinary	5	—	3½-3¾
—— 6 per cent. Cum. Pref	5	..	4½-5½
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— Preference	10	..	10¾-11½
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9½-10½
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	½-¾
National Telephone, Ordinary	5	..	4½-5¼
—— 6 per cent. Cum. First Pref.	10	..	15-15
—— 6 per cent. Cum. Second Pref.	10	..	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	—	5-5½
—— 2½ per cent. Deb. Stock, Red.	100	..	98-101
Oriental Telephone and Electric Company	1	—	15/16-1 1/16

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NOTES.

Canadian Electrical Association.—We notice, what we had already expected, that the convention of the Canadian Electrical Association, which was to have been held at Ottawa this month, has been postponed until September on account of the great fire which recently took place in that town.

Institution of Electrical Engineers.—We have received from the secretary an original communication by Mr. Alexander Russell to the *Journal* of the Institution of Electrical Engineers, entitled "How Condenser and Choking Coil Currents Vary with the Shape of the Wave of the Applied E.M.F." We shall comment more fully on the paper at a later date.

Our Volunteers.—The first mention which we have noticed of the Electrical Engineers Volunteers since they left Bloemfontein is found in Wednesday's paper, where we find in the list of casualties which occurred in the attack on the construction train at Leeuwspruit on June 14 the names of Corporals 6191 Charlton, 6264 Sellon, 6210 Charlton, 6194 Colson, 6185 Pearl, 6201 Landon, all reported as missing.

Wireless Telegraphy.—Experiments, we learn, are being made with wireless telegraphy between Ilfracombe and the Mumbles, a distance of about 21 miles across the Bristol Channel. The experiments are being carried out under the direction of experts from the staff of the electrical department of the General Post Office, and are a continuation of the series of experiments made some time back between Lavernock and Weston.

Motorcar Race.—The race for the Gordon Bennett Motor Challenge Cup took place on Thursday, June 14, the course being from Paris to Lyons, a distance of some 350 miles. The competitors represented four countries—France, Belgium, Germany, and the United States. The time taken was nine hours and eight minutes, and the race was won by M. Charron, the French competitor. We are pleased to note that during the race no serious accident occurred.

Model Engineers.—The third monthly meeting of the Liverpool branch of the Society of Model Engineers was held on June 12, when the chief feature of the meeting was an exhibition of models, amongst which was a model of the White Star liner "Majestic," by Mr. Rimmer. This model, which was over 7ft. long, was shown under steam during the evening. The next meeting will be held on July 4, when another exhibition of models is to take place, and Mr. Hastings will read a paper on the engine of his new torpedo boat.

St. Lawrence Lighting.—We notice that the St. Lawrence International Electric Company, which has recently been reorganised, has secured a contract for lighting the village of Alexandria Bay for five years. An interesting feature of this contract, is that the numerous islands in the vicinity are to be lighted electrically by means of submarine cables from the power station. In order to complete this contract the company will have to increase the capacity of its lighting plant to the extent of 6,000 lights, which will make a total capacity of the plant sufficient for the lighting of 8,000 lamps.

Fox-Hunting by Electricity.—A Portuguese paper gives details of an invention which is to greatly facilitate fox and badger hunting. The device consists of a small electric lamp fixed on to the collar of the dog who is to enter a burrow. The effect of this light, which is to be coloured, is expected to have the effect of frightening the animal, which is used to living in its dark hole. It then tries to escape out of the burrow, and the hunter bags him. The invention has, we hear, been patented, but we should not think the inventor would obtain sufficient money from the sale of the article to warrant its production in large quantities.

Argentine Telegraph Difficulties.—A peculiar difficulty is met with in respect to the telegraph lines in Argentina. The difficulty arises from the quantities of fine web that float through the air, and which, settling on the lines, cause short-circuits the moment the dew falls, or when the weather is at all damp. Everything has been done to remedy the evil, but without avail, and it is now proposed to run an underground cable between Buenos Ayres and Rosario. The difficulty is a very serious one, as it almost puts a stop at times to the work of the telegraph department in Buenos Ayres—the number of messages being reduced from 300 to 400 an hour to only 30 to 40.

Electric Railways in Hungary.—Some interesting statistics concerning the electric railways in Hungary are given in the *Zeitschrift für Elektrotechnik*. From these we learn that the total length of lines constructed at the end of 1899 was about 89 miles for street railways and about 10½ miles in country districts. Of the latter, practically all was actually in operation at the end of 1899, and of the former all but about half a mile. Of the street railways, 58½ miles were double lines. The above figures compare very favourably with those of 1898, in which the total length of the lines in operation was about 76¼ miles. The average interest paid on the lines was in 1898 6·95 per cent. as against 6·72 per cent. in 1897.

English Telephones.—We gather from returns just issued that the number of calls and replies on the instruments of the National Telephone Company for the year ended April 12 amounted to 615,000,000, or on the average about 1,700,000 per day. In commenting on the figures, the *Financial Times* remarks that assuming the number of interruptions by the exchange to each of these conversations as only three, the phrase "Are you finished?" was used 1,845,000,000 times during the twelvemonth. Our contemporary shrinks from making any calculation of the extent to which profanity has been fomented during the same period and by the same means, but is quite sure that the advent of the telephone has indefinitely postponed the millennium.

Light Railways Exhibition.—We notice that to-day Mr. H. Dickinson, of the London County Council, is to open in the Agricultural Hall an international exhibition of tramways and light railways. This is the first exhibition of the kind to be held in London, although similar ones have taken place in America. In addition to Mr. Dickinson (the president), the committee of the exhibition includes members from the London County Council Tramways, the Liverpool Corporation Tramways, Central London Railway, Dublin United Tramways, Belfast Street Tramways, Edinburgh and District Tramways, Leeds Corporation Tramways, and Glasgow Corporation Tramways. The opening is to take place at 12 noon, and the exhibition will continue until July 4.

New Brighton Tower.—The management of the New Brighton Tower have made great preparations in order to induce the visitors to that town to come to their entertainment. Amongst the novelties just introduced is a patent Himalaya electric railway. This consists of a combination of the old switchback railway and an electric railway, the rails being laid as in the latter, and the track having the peculiar up and down grades of the former. The passengers are conveyed in miniature carriages, which go twice round

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the course. Another novelty, which reminds one of South Africa, are Kruger's monkeys. These interesting creatures are worked by electricity, and are made to climb trees, etc. It is interesting also to note that the grounds and buildings are illuminated, over 20,000 incandescent electric lamps being used for this purpose.

Society of Arts Conversazione.—The National History Museum was dedicated to the use of the above on Wednesday evening, when Sir John Wolfe Barry, K.C.B., F.R.S., assisted by the members of the council, received professordom and those who desire to enter the same. The professor has a wife and more frequently a daughter, and he brought them along. They ranged from the quite recent and comely to the pliocene and schistose periods, and, clad in raiment which Solomon in all his glory did most assuredly not match, they sat in cosy corners or wandered about to the strains of the excellent bands of the Coldstream Guards and of the Royal Engineers, dividing their attention between fearsome skeletons of huge prehistoric mammalia and the more modern discoveries of ice cream and champagne cup.

The Gas Institute.—At the annual general meeting of the Gas Institute, held last week, the question of the amalgamation of the Gas Institute and Gas Institution was submitted, and a resolution was passed that this was desirable. The question of the compulsory resignation of members who were only connected in an entirely commercial way with the gas industry was raised, and letters read from such members. There were three of these who refused to resign, and the way which suggested itself to overcome the difficulty was to dissolve the two institutions and reconstruct, under the name of the Society of Gas Engineers and Managers. After considerable discussion on the matter, however, on a ballot being taken, 86 members voted for the amalgamation and 64 against. As there had to be a three-fourths majority, the proposal to amalgamate fell through.

Electric Pumps in Mines.—At the meeting of the Institution of Mining Engineers last week, a paper was read by Mr. Emerson Bainbridge, M.P., dealing with electric underground pumping. In the course of the discussion on the paper, Mr. Henry Hall, one of her Majesty's inspectors, said that Mr. Bainbridge had said nothing of the dangers of sparking in pumping underground with electricity. There was no doubt that very great benefits would be derived from the use of electricity in mines, but there was this danger from sparks which would have to be guarded against. Another speaker stated that some French Government experts had dealt with this matter, and had eliminated any fear of danger from sparks. Another inspector said the use of electricity in mines was cheap and very convenient, but he endorsed Mr. Hall's remarks about the dangers from sparks, which should, he thought, be treated as open lights.

Post Office Telephones.—The work for the construction of the Post Office telephones has now begun in earnest, and persons in the City are having all the delights of roads only half of which can be used. However, when once constructed, these underground lines should not cause much trouble, and the temporary inconvenience will be well paid for. The first portion of the system extends from the City to Richmond, Wimbledon, and Kingston, and is expected to be completed in the early part of 1901. For this portion of the work alone contracts amounting to over £500,000 are said to have been entered into. The rates to be charged on these Post Office lines are still a matter for speculation, but we feel sure that they will undoubtedly be a great reduction on the rates charged by the National Telephone Company. If the service only proves to be a good one, it must be of enormous commercial value to persons all over the country.

German Electrical Undertakings. — We are informed from a reliable source that there is a great likelihood of an amalgamation taking place between the two big German electrical undertakings of Siemens and Halske and the Allgemeine Elektricitäts-Gesellschaft. This is not very surprising, as they both work with very large capital, and are really to a great extent only competing between themselves. The former firm has quite recently erected enormous works at Nonnendamm, which is near Berlin, and, in fact, the works had to be built near a large town or city, as they give employment to over 6,000 workmen and officials, and the question of the housing of this number had to be considered. The whole of the property which has been acquired has not yet been built over, as the company intend at a future date to remove their dynamo works from Charlottenburg, and plans are in preparation for the works to be built for this purpose at Nonnendamm.

Royal Institution.—A general monthly meeting of this institution was held on the 11th inst., Sir James Crichton-Browne, treasurer and vice-president, in the chair, when the following were elected members: Mr. C. E. Baxter, Mr. C. Coward, Mr. A. Dupré, Mr. L. V. Harcourt, Mr. W. C. Prescott, and Mrs. M. F. Thorne. The managers reported that at their meeting held on the same day a resolution was unanimously agreed to to the effect that the managers of the Royal Institution of Great Britain, on the occasion of the retirement of Sir Frederick Bramwell from the office of honorary secretary, desired to place on permanent record an expression of their high appreciation of the admirable way in which he had performed the duties of that office and of his signal services to the institution generally. Sir Frederick has been a member of the institution since 1876, has held the office of hon. secretary since 1885, and has delivered seven Friday evening discourses.

Electricity in Egypt.—A telephone system is in operation in Egypt, with headquarters at Cairo, and branches at Alexandria, Port Said, and other towns. The company has a trunk line running from Cairo to within a few miles of Alexandria, but has been unable to complete it on account of Government opposition, which is based on the ground that the telephone line would diminish the State receipts from the telegraph system. The telephone company employs male operators only, and these are required to be expert linguists, having to speak Englisb, French, Italian, modern Greek, and Arabic. There is also in Cairo an electric lighting central station supplying the very respectable output of 35,000 10-c.p. lamps. Brown-Boveri alternators, giving 2,000 volts at 40 cycles, are direct driven by Sulzer engines, and the distribution is through concentric cables. There are 90 transformer sub-stations, at which the current is stepped down from 2,000 to 100 volts.

International Scientific Catalogue.—The third biennial conference in connection with the Royal Society's scheme for the publication of an international catalogue of scientific literature, was held last week at Burlington House. The meeting was presided over by Sir John Gorst, and representatives of many foreign nations were present. The catalogue is to be arranged according to both subject matter and authors' names, and regard will, in the first instance, be had to the requirements of scientific investigators. It is also intended that the great work shall comprise all published original contributions to the various branches of science, such as mathematics, mechanics, physics, chemistry, astronomy, meteorology (including terrestrial magnetism), mineralogy,

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including petrology and crystallography), geology, geography, etc. The delegates were afterwards entertained at dinner at the Whitehall Rooms by the Royal Society. The toasts were in many instances given in foreign languages.

Earl's Court Exhibition.—The exhibition at Earl's Court does not this year present any really new feature from an electrical point of view. Messrs. Maskelyne and Cooke, however, show some very fine war pictures, and also show an actual collision between trains. We do not know how they obtained this, as one would scarcely think they would know when a collision was going to happen. The electrophone is still a feature of the exhibition, and one can hear anything which is at the time being given at the principal theatres and music halls. An interesting show is one which represents a boat trip through the Bay of Naples. In this show a small electric motor of 4 h.p. works not only the scenery, but also the section of the ship on which the passengers are sitting. A small switchboard with five levers is used in operating the scenery and for switching on and off the lights, which are made to give one the impression of leaving the bay. Electric lights are also used to illustrate the scenic effects of morning and night. The illumination of the exhibition grounds is much the same as in previous years.

Society of Arts.—We are informed that in future the Society of Arts examinations are to consist of three grades—preliminary or junior, general or intermediate, and senior. The standard for Grade II. will be similar to that now used, and the junior and senior grades proportionately easier or harder. The subjects dealt with are all, however, of the commercial type of general information. We also learn that the society's silver medal for papers read during the session 1899-1900 has been awarded, amongst others, to Mr. Edmund Wilson for his paper on "The Housing of the Poor"; Prof. R. W. Wood for his paper on "The Diffraction Process of Colour Photography"; Prof. W. M. Flinders Petrie, D.C.L., for his paper on "A National Repository of Science and Art." The Albert medal for the present year has also been awarded to Mr. Henry Wilde, F.R.S., for "The Discovery and Practical Demonstration of the Indefinite Increase of the Magnetic and Electric Forces from Quantities Indefinitely Small." This principle is the one on which the invention of the modern dynamo machine is based, and is employed in all modern dynamos.

Iron and Steel Institute.—We have received a circular informing us that the autumn meeting of this institute is to be held at Paris on Sept. 18 and 19, under the auspices of the Société d'Encouragement pour L'Industrie National. Arrangements are to be made to visit the various sections of metallurgy, mining, machinery, and railway plant at the exhibition under expert guidance, and after the meeting a visit is to be paid to the works of M. Henry de Wendel, at Jouef and Hayange. Other arrangements are to be made, and members will receive further notice of the same. The secretary, Mr. Bennett H. Brough, desires that all members intending to take part in the meeting will inform him at an early date of their intention. Messrs. H. Gaze and Sons have charge of the travelling arrangements, which will be at special rates. The cost for the seven days from Sept. 15, including first-class railway, hotel accommodation, a drive to places of interest in Paris and one to Versailles, and also three admissions to the exhibition, will be £10. The arrangements must be made individually by members, and not by the institution.

Track Construction.—The *Street Railway Journal* gives a full description of the construction of some heavy railway tracks laid down during the past year by the New Orleans and Carrollton Railroad Company. In this case 100lb. T rails are used, 5¾in. high. Owing to the spongy nature of the soil in New Orleans, practically all the track is laid on a plank flooring. Over this is placed an 8in. layer of stone ballast, on which the stone sleepers rest. An excavation about 2ft. in depth and 12ft. wide was made for each track. The bottom of this trench was then covered with 1¼in. long leaf yellow pine planking. The layer of stones on this was broken to pass through a 1½in. ring. The sleepers supporting the T rails are 6in. by 8in. in section, and 8ft. long. These are all creosoted yellow pine, and are placed at 2ft. intervals. Under a good part of the track a layer of gravel was placed over the stone and a layer of soil, which is sown with grass. This not only gives a pleasing effect, but also eliminates entirely the raising of dust as the cars pass. In this case, of course, the space round the track is not used as a roadway for ordinary traffic.

Institution of Civil Engineers.—The Institution of Civil Engineers, in view of the large number of American engineers visiting Europe this summer, will in the first week in July receive a party of about 200. It has also, we learn, been decided by the American Society of Civil Engineers to hold its thirty-second annual convention in London at that time, which convention is to be held in the English institute's rooms in Great George-street. The meeting will open on July 2, at 4 p.m., with an official reception of the party by Mr. J. F. Wallace, president of the society, who will then give an address in the theatre of the institution. At 8 p.m., on the same evening, Mr. T. Purdey will open a discussion on the "Height of Buildings." On July 3, at 10 a.m., Mr. R. W. Hunt will read a paper on "Recent Progress in Rails," and Mr. R. Hering will also introduce the subject of "The Filtration of Water for Public Use." On Tuesday afternoon the castle and grounds at Windsor will be thrown open to the party. On Thursday, July 5, the visitors and members are to be received by the president and council at the Guildhall, and on the following day an excursion to Stratford-on-Avon and Warwick is to be arranged.

Medical Electricity.—In a paper read before the British Dental Association recently, Mr. T. S. Carter described an electrical motor for drilling holes in the jawbones in order that wires may be used to keep a fracture in place. The motors were made at the author's suggestion by Messrs. Cutriss and Wallace, and could be constructed for use either with continuous or alternating current. He then described various operations for fractured jawbones in which the motor had been used, and stated that he considered that it might be used with very great advantage in trephining and other operations now done by hand. Where current is not to be obtained first hand, he recommends the use of an accumulator set. There should also, he thinks, be a cutting-off gear in the hand set, so that when the surgeon lessens his grip the apparatus will stop working, much in the same way as a telephone receiver. There was not at present much demand for this kind of apparatus, but he thought that if it were placed on the market surgeons would soon take it up, and a large demand would soon arise, and he thought the time was not far distant when no surgery would be complete without an electric motor.

French Medical Quacks.—The question of the illegal practice of medicine at present remains in abeyance in France, as the courts in the different departments have given judgments both for and against it. A correspondent of the *Lancet* states that in the department of Sarthe this illegal practice remains unchecked, the courts actually giving

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encouragement to magnetisers and masseurs. The Court de Cassation has just decided to consider the matter, but medical men in France fear that the above disastrous decisions may be upheld. Thus the magnetisers or bone-setters are useful to county electors at elections, and consequently these latter have some reason for their not being declared illegal practitioners. These magnetisers, we learn, are growing more numerous, and make a good thing out of public credulity. Thus they hold consultations, stop treatment already recommended, and prescribe magnetised water, this being magnetised by themselves. The whole matter is one which it seems to us could only have happened in France, where the prevailing ideas of justice are varied and peculiar. Meanwhile we presume these magnetisers will go about the country undoing the work of qualified medical men, and have the full consent of the French law to do so.

Waterfalls on the Dneiper.—A company, with a very large capital, has been promoted in the Jekaterinaslaw mining district in Russia. This district is mostly worked by Belgians, who have invested in it about £1,250,000. We notice, however, amongst the names of the directors of the present company one English name. The preliminary capital is over £900,000, and the object of the promoters is to render the Dneiper navigable between the Jekaterinaslaw district and Alexandrovisk. At the same time the waterfalls on the Dneiper are to be harnessed on to a large number of power stations which are to be erected along the banks of the river. It may be remembered that about a couple of years ago a similar project was brought forward by an English syndicate, who, however, did not meet with much encouragement, mostly, we believe, on account of the attitude of the Russian Press in connection with the scheme. The Russian journalists seemed to be much incensed at the idea of giving the least amount of control in the district into the hands of any English syndicate, and probably if the majority of the members of the present company had not jaw-breaking Russian names it would meet with the same fate as its predecessor. The Russian Government, however, under the new circumstances, is said to be considering the proposal seriously.

Arc Works Sports.—The annual sports in connection with Messrs. Crompton's Arc Works were held on Saturday, and proved a great success. Several reserved saloons brought a goodly number of guests from London, who were taken in drags to the new works, where the machinery was set going for their edification. A luncheon at a part of the old works (now used as a recreation room for the employés) followed, and after a short drive the grounds were reached. Here a programme of 32 events provided entertainment for the competitors, all taken from the works, and for a very large assembly of spectators. The meeting was interesting from two special points. First, it showed the excellent relations existing between employer and employé, and, second, those between both the former and the Corporation. The Mayor and Mayoress attended at the luncheon, and not the least handsome amongst the race trophies was a silver cup presented by the Chelmsford people. The speeches were few, short, and concise. The Chairman referred especially to the necessity which exists amongst English manufacturers to keep pace with the foreign competitors. However much had been done lately, it was a mere nothing in comparison to the work done in electrical engineering on the Continent. This is quite true, and there is no reason why English works should not expand in the same way, except that our banking institutions are more conservative than those found abroad, who back up electrical undertakings by the tens of millions sterling.

Northern Society of Electrical Engineers.—We have received what we presume will be the last volume of the *Proceedings* of this society, as it is now incorporated with the Institution of Electrical Engineers. The volume is rather late coming to hand, and contains papers read between November, 1898, to December, 1899. It is, however, probable that the length of time which has elapsed since the reading of the papers and the publishing of the *Proceedings* was caused to a great extent by the above-mentioned change. The papers which are included in this volume, and of which we have published many in full, are as follows: The first is on "The Rapid Development of Electrical Engineering during the Present Year" (1898), by Mr. J. S. Raworth, president. The others include "Superheated Steam and its Application on Steam-Engines," by Mr. P. Schou; "Commercial Instruments for Indicating Electric Quantities," by Mr. E. S. Shoult; "Some General Observations on Electric Traction," by Mr. H. F. Parshall; "Miscellaneous Notes on the Cheltenham Mains," by Mr. H. Kilgour; inaugural address on "Electric Lighting in London Ten Years Ago," by Mr. S. Z. de Ferranti; "Methods of Suppressing Arcs in Switches, Fuses, etc.," by Mr. E. K. Scott; and a discussion on "Some Points Connected with a Combined System of Multiphase and Continuous Currents for Tramway Work." The volume is well worth obtaining, and much can be learned from both the papers and discussions.

An Hermetically-Sealed Standard Cell.—In the June number of the *Physical Review* we notice some notes on a hermetically-sealed type of Clark's standard cell. The cell described is designed after the type known as the B.O.T. crystal cell, but it avoids the use of an amalgam button for the negative electrodes, which usually causes the cell to split at the point where the negative terminal is fused through the glass, owing to the amalgam creeping along the wire. An important fact, also, with this cell is that the bulb containing the sensitive parts may be placed in a water-bath or other thermostat, and at the same time is insulated thermally from the outer electrodes by the thick glass neck. In this cell the positive electrode is a platinum wire flattened at one end and amalgamated. The wire is enclosed in a glass capillary drawn from a small glass tube as the mercury-cup. The negative electrode is a small zinc rod cast around a platinum wire and its enclosing glass capillary. This wire passes through the main point of fusion, and ends in the negative mercury-cup. When the ingredients have been placed in the cell through the open end, the final sealing takes place at the opposite end from the electrodes. The cell is filled with a certain amount of zinc-sulphate crystals, which are pushed through the narrow end, these being shaken into place until the zinc rod in the cell is well covered. A paste composed of pure washed mercurous sulphate and zinc-sulphate crystals is also pushed through until it covers the flattened platinum wire. When this is done, the final sealing takes place. The author gives tables of results obtained with these cells which show that they can be relied upon, and he also points out that they are very easily carried about.

Thames Steamboat Service.—The question of the taking over by the London County Council of the Thames pleasure steamer service is at present being largely discussed. In this connection a correspondent writes to the *Times*, and gives his opinion that the difficulty which faces the satisfactory working of the Thames steamboats is not one of pier dues, but arises from the inconveniently placed points at which passengers take and leave the boats. These piers are remote from the busy parts of the Strand and Fleet-street and the City generally, and to get in touch with these busy thoroughfares one has to climb up steep

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and narrow side streets, which are generally blocked by carts. The remedy is to provide stations here and there at the top of these inclines, and within easy access of the main thoroughfares. A subway with cars worked by electric power might be constructed right down to the pier, and the one ticket should clear the steamboat and subway charges. The steamboats should be of moderate size, and run at close intervals, and should be closed in by fixed awnings, and worked by electricity. He suggests as a model the steamers which ply in the neighbourhood of Stockholm. We quite agree with him that a service of fair-sized electric launches would be a very great improvement over the boats which have until recently run between the City and up-river piers, but we think that his suggestion of a subway to the piers from the Strand and the City streets is not practicable. The business man also who travels on the District Railway, to reach either of these places, has exactly the same walk in most cases as he would have from the steamboat piers, and we are not aware that he has up to the present complained to any extent of the situation of these stations. Such subways as the *Times* correspondent suggests would cost a very large sum to construct and equip, and it is doubtful whether the smaller trouble in reaching the boats would compensate for such a large outlay.

Spark-Length of an Electrical Machine.—We notice in the last issue of the *Physical Review* a note by Mr. W. J. Humphreys on the spark-length of an electrical influence machine, as modified by a small spark from the negative side. In this contribution the author states that about 10 years ago he noticed that the discharging distance between the pole of an ordinary Toepler machine could be greatly increased by the aid of small sparks taken by the hand or otherwise from the negative pole, and also that this property was peculiar to the negative side. He made some experiments on the matter, and gives the results obtained. The experiments were tried on several machines and under several conditions. Thus with a machine with a roughened negative pole no good results were obtained, the negative pole losing its discharge so rapidly in the form of a brush that no long sparks were obtained. With a machine with a polished negative pole, however, the results were usually very good. The use of condensers did not give much increase in the spark gap, and the atmospheric conditions also affected the length of spark but little. When the poles were widely separated no discharge passed, but on a slight spark being taken from the negative side a discharge passed from the positive pole and lost itself in the air. Nothing of the kind happened at the negative pole when a spark was taken from the positive. The author thinks that in a very modified form the electrical oscillations and surges would be the cause of the above phenomena. There are also other indications of the superior sensitiveness of the positive over the negative pole, and this is supported by the experiments of Faraday, MacFarlane, and others. Thus Prof. J. J. Thomson says of this that "we may express this result by saying that when the electrical field is not uniform the gas does not break down so easily when the greatest electromotive intensity is at the cathode as it does when it is at the anode."

An Incandescent Lamp Regulator.—We notice in the *Electrical Review* of New York an illustrated article describing a device for regulating the intensity of single incandescent electric lamps. One of the great disadvantages of the ordinary incandescent lamp for lighting purposes as compared with gas is that it cannot be turned low or full to suit the taste of the user. The Electric Regulator Company, of New York, have, however, patented a device which is said to effect this. The device consists of a small rheostat located in the canopy of a side wall bracket or of a fixture depending from the ceiling, or it may be used in a special separate switch located in any convenient place, and connected with a lamp on the ceiling or elsewhere, as in halls or vestibules, or in the staterooms of steamers. By an operation of the hand it can be operated independently of the regular lamp-socket key. The regulator contains a resistance tube surrounding the standard of the fixture, with a switch on the under side connected with the different steps of resistance. Both the switch and the tube are mounted on a base, which serves to support them, and has legs by which it can be fastened to the wall and the canopy also be held in place. When the key is turned the light is reduced by several steps to the merest glimmer, with a saving of current from one-third on the first step to three-fourths on the last, where it gives the faintest possible light without danger of being extinguished, as so often happens with low-turned gas jets. The switch itself consists of alternate layers of metal and mica riveted together. From the metal plates fingers are turned up and arranged in a circular path, so as to be readily touched by a contact spring attached to the key-shaft and revolved by the movement of the key. The whole device is very strong and compact, and furnishes a cheap and efficient means of controlling the steps of a small rheostat for giving graduations of electric current for either light, heat, or power.

Surface-Contact Traction.—In the issue of *Electricity* of New York for June 6 we notice an illustrated article by Mr. F. C. Perkins on "Surface Electromagnetic Traction Systems." The system he describes, the "surface contact," or "electromagnetic" traction system, employs surface contacts entirely, the connection between the cars and main feeders being accomplished by electromagnetic switches. These particular switches are designed for 100 and 300 amperes, and consist of three parts, the bell, pan, and electromagnetic switch gear. The switches are enclosed in moisture-proof iron cases, and are each connected on one contact permanently with the positive main or feeder, which is located parallel with the back. There are cast-iron contact plates or buttons, two in each group, placed between the rails, and electrically connected to the switches. A separate switch is employed for each group of buttons. The conductor forming the positive main or feeder is completely enclosed in wrought-iron pipe, and is connected to the various switches. Under each electric locomotive or car is suspended metal contact shoes or bars. Two bars are suspended to the trucks and a small storage battery is carried on the car, which is required to lift the first switch, and after that has been closed the contact shoes bridge the main voltage over from one set of studs to another, thus closing the successive switches without further attention from the motorman. The battery is kept charged from the main line by closing certain switches by the motorman. It is claimed for this system that for street railway work it possesses all the advantages of the overhead trolley as well as the underground open-conduit systems, while avoiding the disadvantages. The switch boxes are, for preference, installed outside the track, while the buttons are placed between the rails and mounted on a light metal tie. For double track work the switches are placed between the two tracks, and the boxes may be built to hold two switches, one for each track. The cost of this system is said to be only about one-half that of cable or open conduit systems, and it is also claimed that the system is perfectly safe, it being impossible for anyone on the street to receive a shock.

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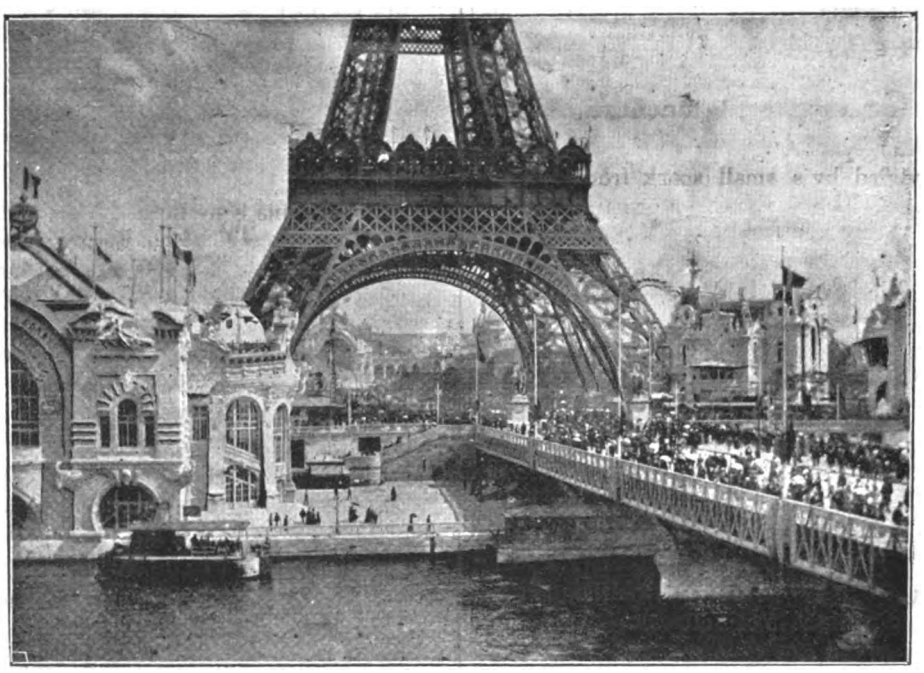
THE PARIS EXHIBITION.

[BY OUR SPECIAL CORRESPONDENT.]

(Continued from page 838.)

At the end of last week's article a description was given of the dynamo exhibited by Messrs. Siemens Bros. and Co., of Woolwich, which is direct-coupled to a Willans and Robinson high-speed steam-engine. It will be remembered that the output of this machine was 1,340 kw. An interesting comparison can be made on the spot between it and the one made by the allied firm of Messrs. Siemens and Halske, which is coupled to an engine made by the well-known engine builders, A. Borsig and Co. The points of difference between the two machines are exceedingly numerous, and may give some indication as to the different lines on which the designers of steam dynamos have worked in Germany and England respectively. To give a *résumé*, firstly, of the engines, the Willans runs at the comparatively high speed of 200 revolutions per minute, and consists virtually of three triple-expansion single-acting engines connected on to three cranks at angles of 120deg. to each other. The result is an exceedingly even turning movement and a comparatively compact engine, which runs without vibration when the necessary steam connections have been made to it. The engine made by the German firm of A. Borsig and Co. towers above the Willans engine, and completely dwarfs it from the untechnical man's point of view, and the overall dimensions are about double. In spite of this the output of the machine is slightly less than that of the English set, being only 1,250 kw. The engine is also triple-expansion, having one high-pressure cylinder, one intermediate cylinder, and two low-pressure cylinders. The high-pressure cylinder and one of the low-pressures are arranged in tandem, as are also the intermediate cylinder and the other low-pressure. These are coupled on to cranks which are directly opposite each other—*i.e.*, 180deg. apart. The resulting turning moment cannot, of course, be nearly so good as that of the Willans engine. It is, however, in the valve gearing that one notes the greatest difference. While the Willans engine is exceedingly simple in this respect, having a variable expansion which can be moved by hand in connection with a governor, the Borsig engine contains innumerable valves. For instance, there are independent admission valves for each end of each cylinder, and also independent exhaust valves. All these valves are worked by separate gear, which is driven by one common shaft. The high-pressure cylinder has its expansion automatically controlled by a governor, but the cut-offs in the other cylinders can only be varied by hand. As a result, the distribution of the power developed is not any too uniform, and we should be inclined to think that advantage would be gained in the crank effort diagram by placing the two cranks at 90deg. apart. The diameters of the cylinders are as follows: high-pressure 30in., intermediate 50in., each of the low-pressure cylinders being 53in. in diameter. The stroke is 43¼in. The gear is of the well-known Coleman type, and the engine is designed to run at 83½ revolutions per minute. The iron stairs leading up to the various driving appliances are most magnificent in their design, and remind one somewhat of those of a baronial mansion, as the first flight would allow of at least four people walking up abreast. To anyone used to the vertical high-speed engines in this country, the apparent complication of the valve gearing in the Borsig engine is very striking. An English mechanic engaged in the exhibition informed me, for instance, that 13 men were required to drive the engine; but, of course, allowance must be made for insular prejudice. Unfortunately, up to the present time no tests have made with this engine, and we are doubtful whether the condition of things in the Exhibition will allow of comparative steam trials being made with the engines while they are running. Otherwise interesting tests could be carried out to see if the economy of the engine, which would certainly be great, is sufficiently higher than what we might call the English type to warrant the application of the increased supervision thereby entailed. Needless to say that the workmanship of this engine is of the highest order, as would be expected from the maker's name. As regards the alternator, this does not differ essentially from alternators which are manufactured in this country, but it is remarkable for the exceeding neatness of its armature windings, and for the perfect insulation which is provided for the high-voltage circuit. The following is a description of this dynamo as supplied by the makers: The dynamo is designed for a maximum output of 2,000 kw.; the voltage was fixed by the administration of the Exhibition at 2,000 to 2,500 volts, and the number of periods at 50 per second. The principle adopted is that of a fixed armature with the field magnet revolving inside. The field magnet consists of a cast-iron ring made in two parts and connected with the hub by spokes which are cast with the ring. The poles are made of laminated iron bolted together with three bolts. A steel key of square section passes through the laminations and contains the female thread for the screws which are put through from the inside of the rim, and which connect the poles with the same. To take the tangential forces, the plates are keyed into the ring. The winding of the field magnets consists of flat copper strip wound edgewise. The section of the copper is 4mm. by 23mm.



View of that part of the Paris Exhibition round the Base of Eiffel Tower.

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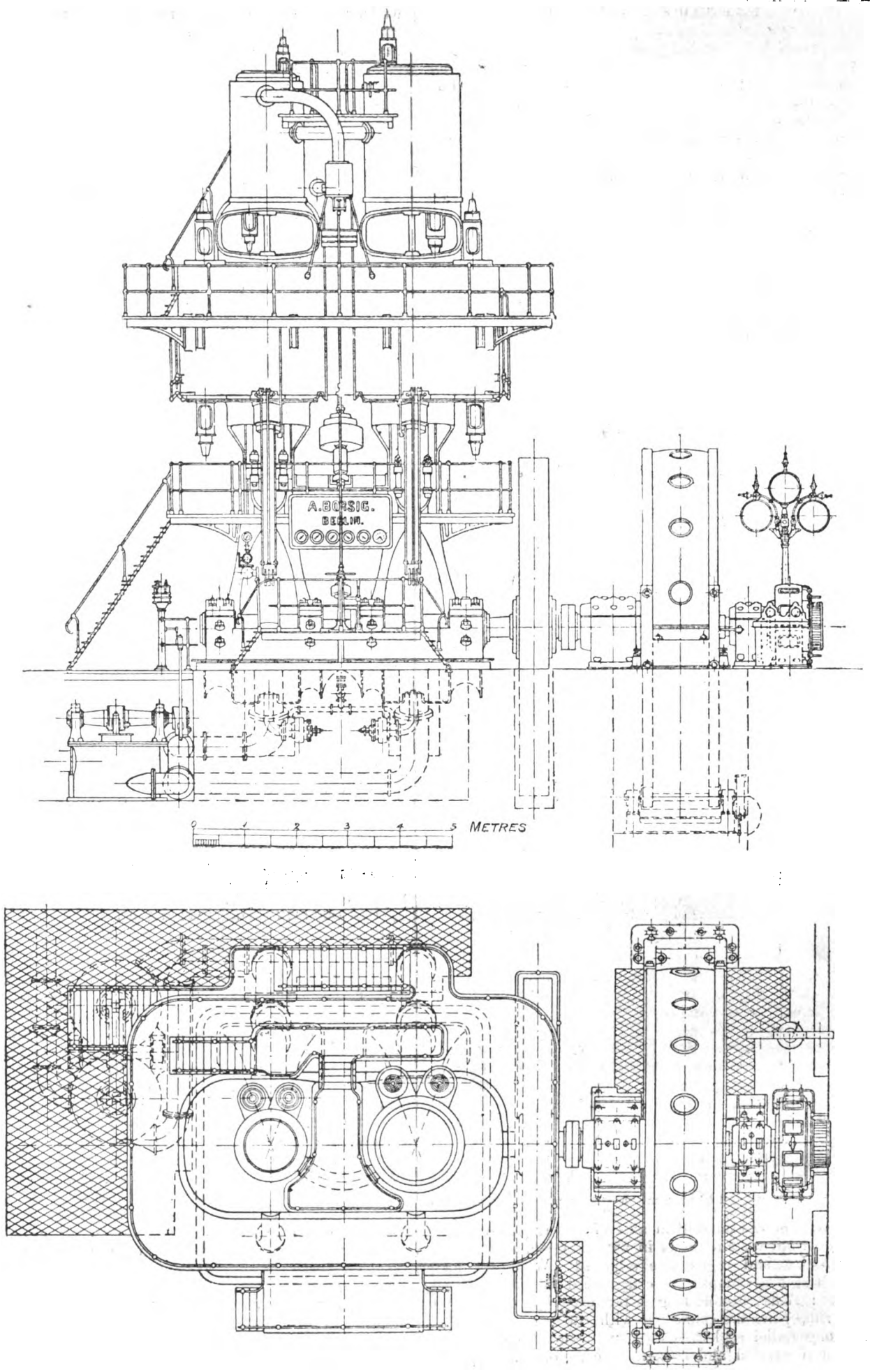

Plan and Elevation of Siemens and Halske and Borsig Steam Dynamo.

There are 40 turns on each pole. The total weight of the copper on the field magnets is 8,800lb. On both sides of each magnet pole hollow castings of bronze are provided, which act as curved formers for the copper strip, and also as air channels. The motion of the magnets induces a draught up these radial spaces, which thus carries off the heat generated. With the same object an air-slit has been placed in the centre of the field magnet core; by these

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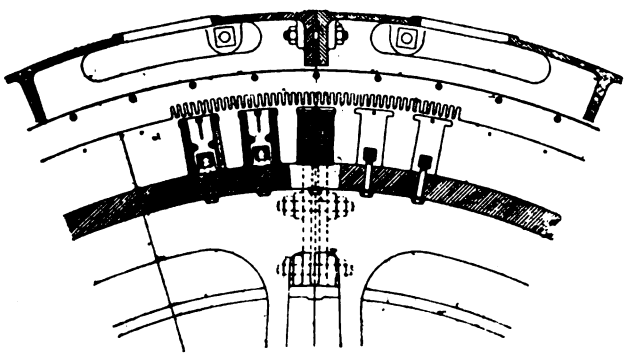
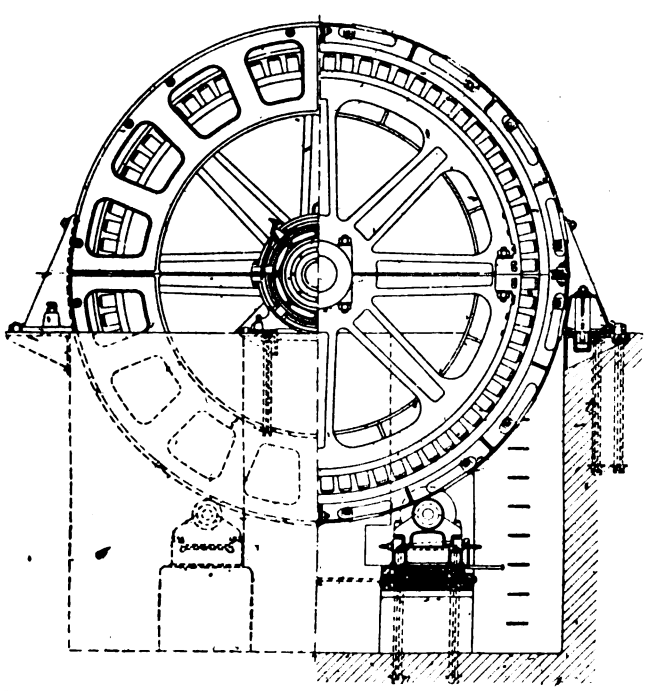
means fresh air is constantly introduced between the armature and iron frame. For the excitation of the field-magnets a maximum of 210 volts is required and about 200 amperes. The total resistance of the field-magnet winding is just about one ohm; the average amount of energy used for excitation is 28,000 watts—the maximum is 42,500 watts. The mechanical parts of the armature construction are very interesting. The aim in view was to give the simplest possible form to the armature, while at the same time providing the means for placing the armature in the exact centre when mounting the same, and also to facilitate, as



Section of Armature and Field of Siemens and Halske Dynamo.

far as it might be required by a change of the support, an easy way of altering its position afterwards. In order to accomplish this the following methods were applied. The reader is supposed to imagine a short hollow ring, which rests on two rollers placed at a convenient distance from each other, and which rests on a bed-plate. These rollers can be lifted or lowered either singly or both at the same time, consequently it is apparent that the lifting or lowering of both these rollers produces a corresponding vertical displacement of the ring resting on the same. By moving only one of the rollers, a horizontal displacement of the central axis of the ring is effected. By



Elevation of Siemens and Halske Dynamo, showing Centreing Gear and Rollers.

this simple means the central axis of the ring may be displaced within certain limits in any direction, vertically or horizontally, and the centre adjusted. What we have called the ring simply, is constructed in the following manner: A flat double ring is produced by an inner and outer rim, which are connected with each other by means of strong radial spokes. Two such similar contrivances are placed parallel and coaxial to each other, and joined with the armature, which lays between them, into one solid mass. Each of these two rings rests in the manner above described upon two rollers. In order to avoid a sideward movement of this big roller, which is formed by the two rings, blocks have been placed at each side, to which the rings are screwed on after the proper centering has been ascertained. These blocks prevent at the same time the turning of the armature in the direction of the shaft. Of course it is necessary to unscrew the blocks when it is required to use the centering gear. The armature core between these two rings consists of iron sheets of a thickness of ·5mm., kept together and supported by cast-iron pieces. We note that the armature as well as the supporting rings are built up of four equal segments. The proportions of the rings have been chosen in such a manner that no appreciable bending is possible. The armature is provided for the reception of the winding with 648 deep grooves. These are 13mm. wide and 55mm deep, and in each a copper bar of 7mm. and 44mm. is placed. These teeth are cut out in such a manner as to allow of the insertion of an insulating cover at their open end after the copper bars have been put in place. The insulation of the copper bars consists of mica, which is pressed directly upon the metal. All the copper bars of each phase are placed in series, and the three phases are connected with each in star fashion. The total weight of the armature copper is 5,280lb., the total resistance of the winding when hot is 0·057 ohm, and the $C^2 R$ loss is about 15,000 watts. The exciter, with an eight-pole direct-current dynamo, is coupled on an extension of the shaft.

(To be continued.)

THE MUNICIPAL ELECTRICAL ASSOCIATION.

HUDDERSFIELD CONVENTION.

The fifth annual convention of the Municipal Electrical Association was opened on Wednesday last at Huddersfield under the presidency of Mr. A. B. Mountain, the electrical engineer of that town. At 10 a.m. on that day the members gathered in the technical college, when the Mayor cordially welcomed all present. He expressed the hope that the meeting would be a most successful one, and that those present would find it both a profit to them and a pleasure.

Mr. A. B. MOUNTAIN then presented prizes of books to Mr. J. R. P. Lunn and Mr. P. S. Thompson for papers contributed by them as associates. He believed that the fact of the prizes being awarded to them would help these two gentlemen in their future careers, as electric lighting committees would recognise in these prizes the fact that they had been the authors of valuable contributions on electrical matters.

Mr. MOUNTAIN then delivered the following presidential address:

Presidential Address.

In presenting to you my presidential address, I avail myself of the opportunity of very sincerely thanking you for the great honour you have done me in electing me your president. I would remind you that this is the fifth convention the association has held, and while reminding you that the association is only five years old, I feel it will interest you if I briefly give you its history, and review some of the work it has already accomplished. Many present may remember that the Board of Trade proposed in 1895 to issue new regulations for controlling the supply of electricity; the engineers of the various municipalities affected met together, and by combined efforts were enabled to persuade the Board of Trade to modify considerably the regulations, which were finally issued in 1896. The engineers who were in consultation while the Board of Trade regulations were under consideration decided to form this association, feeling that by combination they would be stronger and better able to bring those interested in municipal electricity supply undertakings together for the purpose of interchanging ideas and experiences, and, if necessary, take action to further or protect the interests of the undertakings in their charge. The association at its first meeting had only 24 members who were electrical engineers, being permanent officials of municipalities. Mr. Arthur Wright was elected the first president, and the address he delivered to the association at its first convention, held in London in 1896, clearly outlined a programme

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of most useful work which the association had before it. Many of the subjects mentioned in that address have had your consideration, and I believe that the discussion of these matters by the engineers, chairmen and other members of electricity committees has very largely assisted to promote the progress and achieve the results which have been obtained. But since the association was first formed it has grown year by year in the most satisfactory manner. There are now 74 committees and 84 electrical engineer members, three associate members, and 57 associates. The work accomplished by the association in the past has, I feel certain, been very much appreciated by the local authorities interested, and although we may with a certain amount of pride look back upon past achievements, yet the future work of the association must be of still more importance to all those interested in electricity supply works owned by local authorities.

One of the first subjects discussed by the association was the control of both the gas and electricity undertakings by one committee. In 1896, several corporations owning both undertakings had placed them under the charge of one committee, although it was even then recognised that the work was quite of a different character, and that the departments must be in a manner competitors. Now, with very few exceptions, the electricity supply is controlled by a special committee, and, judging by the progress of both departments during the last few years, it would seem conclusive that the healthy competition has been in the interest of both undertakings. At our first convention two or three corporations had attempted to increase the pressure of supply to consumers, and the pressure usually delivered was 100 or 110 volts; now it is quite unusual to find any three-wire system delivering a supply with a less pressure than 200 or 220 volts, in some cases the declared pressure is 250 volts. It is interesting to think of the enormous saving in copper which this increase in pressure has effected; indeed, it would have been impossible for many of the municipalities to have extended their undertakings to any great extent without the alteration of pressure, and the saving of capital has no doubt in a great measure assisted the achievement of the magnificent results which have been obtained.

One of the subjects discussed by the association in 1896 was the question of extension to outlying districts. It largely influenced those members who attended our first convention to appreciate the fact that the residential lighting was worth cultivating, and that the best way to obtain it was to extend mains as rapidly as possible to all the outlying residential sections of a town; and I consider the rapid increase in the demand for electricity is largely due to the spirit of enterprise exhibited by municipalities in encouraging a demand, rather than waiting until the demand necessitated the extensions. The consideration of wiring regulations which would be applicable to the whole of Great Britain was discussed at our first meeting, and has since occupied the time of the association considerably. The rules which have been prepared by the Institution of Electrical Engineers, embodying the views of this association, are of very great value. Time has not, however, removed the man who does jerry work; indeed, it seems as if those workmen who are fit for nothing else become infatuated with wiring, and are really the cause of the bad work which is being done in so many towns. One way out of the difficulty would be to organise a system of examination in connection with our association, so that good men with a knowledge of their work could obtain a certificate. This would, I am inclined to think, check the engagement of unqualified men, and if the certificate could be withdrawn upon conclusive evidence of bad workmanship it would add to its value. I believe this system would be much appreciated by the better class of workmen, and there would be no great difficulty in organising a system, such as that suggested, which would weed out the incapable men. Perhaps, however, some may think it necessary to go further and weed out some of the incapable wiring contractors.

Another subject which has been very freely discussed by the association is the supply of electrical energy for tramways and the advantages of combination over separation. The conclusion of the association was that, if municipalities could combine, such combination would tend to reduce the cost of production of energy for both lighting and traction. Although it is perhaps early to draw conclusions, it is interesting to notice that the cost of production in those works where a combined supply is generated is enormously reduced, and that the committees have in some cases been enabled to materially reduce the price of energy to the consumer of electricity; and although there are three municipalities who, having had the opportunity of combination, have preferred entirely separate works, on the other hand it is pleasing to find that 45 have accepted the views of the association. As an instance of the value of combination, I would remind you of the special meeting of the association held in January, 1897, to consider the subject of fire risks. Owing to fires taking place at two of the London companies' works, the fire insurance companies increased the rate of insurance throughout the country from about 5s. per cent. to about 15s. It was pointed out at the meeting that our works consisted of brick and iron, and that fire insurance was unnecessary; therefore, the result of our meeting was that many corporations who had insured discontinued to do so, and the companies very soon afterwards reduced their premiums. The formation of the defence fund for resisting the patent action brought by Mr. Rucker against the London Electric Supply Corporation for the use of the alternating-current system of electricity supply, is another instance of the success of combination; individual action would almost certainly have resulted in failure.

To endeavour to touch upon even all the important work of the association during the last five years would be impossible in the time at my disposal, but when one contemplates the progress of the various undertakings, the questions and difficulties involved can more easily be appreciated. When we held our first convention, there were very few engineers responsible for works having 50,000 lamps connected to the mains, and the output of very few generators exceeded 300 kw. Owing, however, to the constantly increasing number of lamps connected year after year, it has become necessary to adopt larger units of plant, and now generators having an output of 1,000 kw. are quite usual; in fact, in many towns it has been found best to take out generators of small size and replace them with plants of very much greater capacity. This has entailed a large waste of capital, and I am inclined to think the association might well devote its time to the consideration of the size of plant which should be adopted for new works and extension of existing ones. Unfortunately, we are very much in the same position as gasworks were 25 years ago: we are constantly extending without being able to form any very correct idea of the ultimate size of our works; but with the experience we have had, and with the history of gas before us, it cannot be very difficult to arrive at some useful figures. I would suggest as a moderate figure 15 8-c.p. lamps per head of the population of the area supplied; this would mean that a town having a population of 100,000 would ultimately have approximately 1,500,000 8-c.p. lamps connected to its electricity works. If we disregard for the moment the energy which will be required for driving motors, tramcars, and for many other purposes, which we should largely depend upon to find employment for our machinery during the daytime, and which would not materially increase our maximum load, we find that to supply energy to these lights, assuming one-third to be in use at the same time, we shall require, including spare plant, not less than 20 1,000-kw. generators; this would be an unnecessarily large number of generators, and undoubtedly much more economical results would be obtained by employing 10 generators having an output of 2,000 kw. each. One can only earnestly hope that, when the demand for larger units arises, our manufacturers of electrical plant will be in the position to supply thoroughly reliable machinery.

You will agree, I feel sure, that I have not in any way magnified the work before us, and I hope that we shall be able, by careful consideration and mutual exchange of facts and experience, to so arrange our works that extensions will not again necessitate the radical alterations which have had to be made in the past at such great expense. When we consider the probable growth of our works, one is forced to think seriously of the various systems in operation, and

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endeavour to ascertain the probable alteration or extension which will be necessary to meet the demand for energy in the future. Simplicity is, I think, the important point we should keep in view: it means reduced capital expenditure, reduced works costs, and reliability of supply. I think the future demand in any town having a population exceeding 75,000 will necessitate the erection of generating works outside the central or densely populated portion of the town, and that such works will, if the town has a continuous-current supply, generate alternating current, either single, two, or three phase, which will be converted to continuous current in suitably situated sub-stations; if, however, the town has a single-phase alternating-current system, I think it will have a distinct advantage over its neighbours having continuous current in the fact that it will have a less complicated system, the capital expenditure upon which should be less, the cost of distribution due to the saving of labour should be lower, and the reliability of the system greater unless accumulators are employed upon a large scale. The facts and figures at present obtainable relative to two and three phase alternating-current systems are not in my opinion sufficiently proved to be of much value, and we should watch with the greatest interest the results of some of the systems now being installed. In my opinion the complications completely outweigh any advantage which two or three phase systems may have over single-phase. We are, I think, too much inclined to follow fashions which can usually be traced to individuals who are in some way interested, and as engineers we should think for ourselves and apply the facts and figures we may obtain to the local conditions we have to deal with, and must not let our engineering enthusiasm make us forget that we have to put down works for distributing electrical energy suitable for all purposes, at the lowest possible cost to the consumer.

During the last and present year much has been heard upon the subject of municipal trading, and the welfare of our electricity supply undertakings is largely involved. It would seem, however, that the sins of local authorities are those of omission. When one considers that provisional orders for electric lighting have been granted to above 300 local authorities, and that only about half are beyond the period of consideration, it must be granted that enterprise is being seriously retarded, and that the idea of obtaining an order and then waiting, Micawber-like, for something to turn up, is neither in the interest of the would-be consumers or the industry; and it can scarcely be surprising to find Parliament considering the granting of powers to companies to supply over large areas, and also contemplating competition. There are, however, two strong factors impeding electrical enterprise in the areas of small local authorities, both of which are having the attention of the council of this association. The first is that no period being allowed for the construction of works necessitates an immediate payment of interest on capital and sinking fund contributions; the second point is that the period of 25 years allowed for the repayment of capital is unnecessarily short, and increases the annual proportion of the sinking fund. The consequence is that some local authorities, anticipating loss by the department during the first year or two, are anxious to avoid the risk of adding a burden to the rates. I am, of course, aware that this is an excuse, and not a solid reason for delaying the commencement of the work for years, and one can scarcely understand why the smaller local authorities who have obtained powers at considerable expense should not have proceeded with the work. Their want of enterprise has, in my opinion, brought into existence the larger companies who propose supplying electricity over extended areas. A combined effort to alter the present regulations of the Local Government Board and obtain, if possible, a longer period for the repayment of loans, and also a period for construction of works, can only be productive of good results, and will certainly enable many councils who are now hesitating to at once put down works and develop the supply of electrical energy for all purposes; it would also have another beneficial result in the fact that it would remove the temptation to reduce the initial capital expenditure by putting in very small plant unsuitable for the works in a few years' time, but by the employment of which it may be possible to avoid a loss at the commencement.

While one is forced to the conclusion that the want of energy of many of the smaller local authorities is likely to produce unfortunate results, it is a pleasure to review the general progress made by electricity supply undertakings, and the following figures representing the capital expended upon municipal and companies' works in the United Kingdom are most interesting:

	1895.	1896.	1897.	1898.
Municipal.....	£1,772,323	3,392 229	4,662 909	6,979,150
Companies ...	4,335,357	5,370,134	6,338,744	7,996,591

I am sure our consumers will be interested to hear that the average cost of producing the unit of electrical energy exclusive of capital charges is being reduced year by year, and in municipal works was, during 1898, 2·12d. per unit as against 2·7d. per unit in companies' works, and that the average price obtained by municipalities during the same year was 4·35d. per unit as against 5·51d. per unit obtained by companies. These results must be considered highly satisfactory, and it is interesting to notice the causes of the reduction in the average works costs. The chief reason for the reduction of costs is due to the reduction in the selling price. This has induced consumers to use more energy per lamps fixed. The second important factor is the more general use of electric motors, which has helped very largely to increase the quantity of energy sold, and has found employment for a portion of our plant during the daytime. The supply of electricity for tramway purposes has also materially assisted the load factor, and has consequently reduced the average cost of production, and as the demand for energy for motive power and tramway purposes is developed, so will the cost of production be reduced. Another opportunity of improving the load factor seems fairly near realisation—that is, the charging of accumulators for motorcars. When considering the various types of motorcars at present upon the market, one is inclined hastily to imagine that electricity is of little use, because with accumulators the length of run is limited to about 40 miles with one charge, and that the difficulties of charging will impede its application. These difficulties disappear if one thinks of the real commercial use which will certainly be made of motorcars. Tradesmen require something reliable for conveying their commodities to various points usually within a few miles of their premises, and do not require to cover more than about 20 miles per day. For these purposes the electric motorcar is most suitable, and the fact that its propelling machinery has no reciprocating parts should add to its reliability and reduce repairs; and if municipalities will arrange charging stations in convenient positions such cars should be speedily adopted, and if the charging is done during the night and early morning the energy used could be supplied at an exceedingly low price, and would still further reduce the average cost of production. The long-distance motorcars using petroleum would still for the present appear to have an advantage over electricity, owing to the difficulty of charging in out-of-the-way places. In Edinburgh, and in other places, motorcars are running in competition with tramways, and one is bound to consider what competition will mean. Motorcars running upon the ordinary road escape the heavy expenditure required for the permanent way of an electric or steam system of tramways, and, consequently, in a district having a scattered population unable to support a frequent service of cars would have an immense advantage, in the fact that the capital charges would be very much reduced. This is, in my opinion, an extremely important point, as the financial charges upon a tramway undertaking frequently represent from 25 to 40 per cent. of the total expenses, and it is not at all unusual to find this important item neglected when the cost per car mile is being discussed.

The last subject I will mention is the municipalisation of the telephone system. The association and the council have devoted considerable time to the consideration of this subject, and now that Parliament has granted powers to local authorities to municipalise the local system, there should be an immediate effort made to make the telephone more popular. This can, I think, only be done successfully by the local authorities, who cannot help being keenly interested in anything which aids commerce or adds to the convenience of

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its residents. They would undoubtedly be able to give a more efficient and cheaper service than at present in existence. It is sincerely to be hoped that corporations will assist the Post Office to develop the service, and will not be either dismayed or delayed by the difficulties which may appear, and which will vanish as soon as a few corporations have their systems in operation.

In conclusion, I regret that owing to the amount of work before the association it is impossible for me to touch upon many very interesting subjects which I should otherwise, had time allowed, have thought it desirable to bring before your notice.

Alderman R. RICHARDS, of Bedford, proposed that the thanks of the meeting be given to Mr. Mountain for his excellent address, and that he be asked to allow the same to be printed in the *Minutes* of the association. In a short speech Alderman Richards referred to the advantages the association derived from having chairmen of electric lighting committees as members, and to the good work done by the association on the insurance question.

Alderman W. POTTER, of Taunton, then read an abstract of the following paper:

Means of Stimulating the Demand for an Electricity Supply.

BY ALDERMAN POTTER, J.P., CHAIRMAN OF ELECTRICAL COMMITTEE, TAUNTON.

What are the hindrances and difficulties in the way of an extension of electricity supply? And by what means may they be overcome so as to sweep away any lingering prejudices, and to create within the public mind a preference for electricity over every other kind of illuminant? These are questions not only of great interest to all who are in any manner concerned in its financial success, but which have been from time to time answered in various ways, with more or less beneficial results.

In acceding to the request of the council to write a paper on this subject, I wish it to be clearly understood that I disclaim all idea of being able to bring forward any new or original suggestion, but having seen the results attending some of the suggestions which have from time to time been made, I am hopeful that my experience may be of some use, especially to those who are connected with small electrical undertakings in poor districts which have not attained a profit-making stage. In the earlier stages of electric lighting one of the most serious hindrances to its extension was its extremely erratic character and unreliability—*e.g.*, it so frequently went out at most inconvenient times, causing such confusion and annoyance that many persons otherwise favourably disposed would have nothing to do with it; but this uncertainty has become a thing of the past. The improvements that have taken place in electrical machinery, and the increased efficiency of electricians generally, are so great that where a generating station is equipped with modern plant, worked by a competent staff, anything beyond a very occasional, partial, or temporary failure is unknown, and its intermittent character no longer operates on the public mind as a hindrance to its growing demand. At the present time the initial difficulty that has to be overcome in order to stimulate the demand for an electricity supply by securing additional customers is that relating to the cost of electricity as compared with gas or oil. The advantages claimed for the electric light over every other kind of artificial illuminant, such as being more conducive to health, its cleanliness, convenience, and the saving effected through its use in painters' and paperhangers' bills may not be denied, but they will fail in accomplishing the desired end unless it can also be shown that these advantages can be obtained with little or no additional increase in the light bill. Persons who have become accustomed to the use of electricity learn to appreciate its undoubted advantages so highly as to be willing to pay more for it than they formerly did for gas or oil, but in the case of a new consumer the advantages often appear somewhat mythical or remote, whilst the cost is present and real. The only way of meeting this difficulty appears to be that of charging as low a price per unit as possible, after providing for all necessary expenses.

In most instances it is found necessary to receive some assistance from the rates for the first year or so of an undertaking; but the aim of those having the management of municipal works should be to do without such assistance as speedily as possible. The wisdom of doing what some corporations do, charging one price for private lighting and a much lower price for public lighting, supplementing it year by year by a contribution from the rates, is very questionable; better charge both public and private lighting with its fair share of costs, and make the undertaking self-supporting. There is but little for a municipal undertaking to accomplish beyond this; there is nothing really gained to the ratepayers by making large profits if the price charged is high. Its aim should be, especially in the earlier years of the undertaking, not so much to realise a profit to be applied to a reduction of the rates as to supply the light, both public and private, at the lowest possible price, after meeting all expenses and providing for all contingencies. By so doing not only are the ratepayers directly benefited, but it is a means of stimulating the demand for an electricity supply, as also does the giving of rebate after the current has been used a specified time, if care be taken to fix the time limit so as to include all who use the light for any reasonable time within its sweep. The public do not understand the impractibility of taking a graduated discount off an electricity account, as is done off water or gas; therefore, when a consumer, who having a large number of lamps installed, but uses them only a short time, finds that he gets no rebate, though the amount of his bill be larger than that of his neighbour, who with fewer lamps installed, yet using them a greater number of hours, gets a rebate, he is dissatisfied and feels aggrieved. At Taunton the system first adopted was that of giving a discount according to the amount of the consumer's bill, but finding that that was a wrong principle to go upon, the demand indicator system was adopted, charging 6d. per unit for the first two hours' demand and 3½d. after, the result being that few of the principal shopkeepers, living away from their business premises, exceeded the two hours' average, and therefore got no rebate; this gave rise to a great deal of dissatisfaction, and many threatened to give up the light. Some 18 months ago the Electrical Committee saw their way to reduce this time limit from two hours to one, with this result: that nearly all charged under this system get a rebate; all grievance is removed, and there has been a large increase in the number of lamps installed, not only through an increase in the number of consumers, but also by reason of the extension of the light in premises in which only a few lamps had been previously installed.

Another difficulty is connected with the cost of installation, especially in premises which are held for a short tenancy only, and in which gas is already laid on. Though the cost of installation has been very much reduced within the last few years, still many find themselves unable to bear the expense, and others are, not without reason, reluctant to do so when they are only tenants of the premises they occupy. But this difficulty is effectually met by adopting the system of free wiring, which is also often the means of securing a most desirable class of consumers, small shopkeepers and householders, whose means are such that they could not afford the expense of having their premises wired. The National Electric Wiring Company have gone in extensively for this. Although they do a large amount of contracting work, the backbone of their business is free wiring, and in this direction have been of immense service to many a struggling electrical undertaking, as under the terms of their agreement any person can have his premises wired and fitted up for the supply of electricity without any initial charge whatever, the corporation or supply authority agreeing to pay to the wiring company so much (generally 1d. per unit) on all electricity supplied through their wires and fittings. In some cases this penny is added to the price charged per unit, and is paid by the consumer, but this, which is perfectly fair and reasonable, is open to the objection that such consumers are apt to imagine that they have a grievance, that they are unfairly treated in having to pay more per unit than other persons. It is better to have one uniform price and charge all alike per unit, but to explain to those who apply to have their premises free wired that no rebate will be allowed them whatever their consumption, and that the rebate they would have received if the installation had been made at their cost goes to pay the company. This cannot be regarded other than fair by all concerned. Taking Taunton as an example, it is fair to the Corporation, because the amount received from all our consumers is 5d. per unit. This is the average amount we receive under the rebate system, and also the net amount we receive from those whose premises have been free wired. It is fair also to those who have installed the light at their own cost, as in the amount of the rebate they have some return for the capital expended. It does not press unfairly on those whose premises have been free wired, because if they find that their consumption is such that the rebate would be a good return on the cost of the installation, they can, if desirous of so doing, buy the company out by the payment of the cost price of the installation, plus 20 per cent., less 1½ per cent. per annum depreciation. If further proof be necessary to show the valuable help the free wiring company is in stimulating the demand for an electricity supply, it will surely be seen in the following statement, showing the number of lamps installed by the company up to the end of 1899 under contract and free wiring:

	8 c.p. equiv.
Lincoln	4,233
Prescot	2,506
Worcester	1,745
Blackpool	6,410
Taunton	4,903

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Shoreditch	3,236
South London Supply Corporation	3,319
Wallasey	11,910
Crystal Palace Electric Supply Company, Limited (since July, 1899), over	3,000

In Lincoln not a single application for current had been received by the Corporation before the company entered into a contract. They were, however, able by the time the plant was ready to provide such a number of lights as to render it necessary for the Council to take steps to increase the plant. At Taunton, during the first year of the contract, upwards of 3,000 lights had been installed. In Wallasey, at the end of 1898, over 70 per cent. of the consumers connected with the supply had been obtained by the company, and they were taking over 80 per cent. of the output. As, however, the company require to be paid the minimum sum of 1s. for every 8-c.p. lamp, care must be taken to see that their agents do not instal lamps of greater candle-power than is actually required. Closely allied to the question of free wiring is that of prepayment or slot meters, which finds favour with consumers in poor and weekly wage-earning districts, many of whom would find it a difficult matter to pay a quarterly account, but prefer to pay as they go. Further, by the use of slot meters there is no dispute about the amount of the bill, nor any bad debts.

Often the supply creates the demand. This is so in connection with electric lighting; the demand is stimulated by the supply undertakers adopting a bold-spirited policy in laying mains in likely districts, even though they do not succeed in getting such a number of promises to use the light as in the opinion of the over-cautious would justify the expenditure. It is frequently the case that persons who, when canvassed for this purpose, object to give a definite promise are amongst the first to become consumers when the mains are laid, and it is only a question of joining them up. Some three years or so ago the Taunton Corporation were asked to lay mains in order to light up two private residences in opposite directions, one a mile and the other nearly two miles from the generating station, the owners agreeing to pay 5 per cent. on the outlay until such time as the revenue from these mains should reach a certain amount. Notwithstanding this agreement, there was opposition to carry the mains so far, it was said, for one house, but the mains were laid, and the results have fully justified such a course, for, with the exception of the principal business portions of the borough, these two lengths of main are the most remunerative. The application of electricity for power and heating purposes presents many opportunities for stimulating the demand, and in stations having a day load for lighting purposes such an addition is very profitable.

In conclusion, it may be stated that Taunton is not a large, rich manufacturing town, but a small agricultural town, at a great distance from the coalfields. There are no large consumers connected with its mains, such as theatres, large hotels, and public rooms, but principally short-hour shopkeepers and middle-class residences. But working more or less on the lines indicated in this paper, the loss of over £900 a year on the revenue account up to 1893 (when taken over by the Corporation) has been converted into a profit of over £2,000 a year, with every prospect of an increased and continued success.

Mr. H. C. BISHOP, electrical engineer of Wigan, then briefly described his views on the same subject, which are fully set forth in the paper below:

Means of Stimulating the Demand for Electricity.

BY H. COLLINGS BISHOP, BOROUGH ELECTRICAL AND TRAMWAYS ENGINEER, WIGAN.

The subject of this paper is one which has, I think, received far too little attention from most central-station engineers—the chief engineer of a central station cannot be fully conversant with the best means of inducing people to use electricity unless he is also the leading spirit in the accountants' department. He should have at his finger ends the whole of the business side of the station, as much as the engineering side, as without this he will have a difficulty in accomplishing his purpose—viz., to obtain a high load factor and an increased demand for current. To stimulate the demand for electricity means to increase the sales and to lower the costs, and there are many ways of doing this. Some of these methods, of course, are already in use, among which are some that are not as satisfactory as at first sight they appear. The following are some of the means which seem to promise well: (1) low price; (2) sliding scale, giving long-hour consumers a lower rate; (3) free use of meters; (4) free connection of services; (5) a free-wiring system; (6) a system of wiring on the instalment plan; (7) a specially low rate for current used for motive power, heating, or manufacturing purposes; (8) the hiring out of motors, arc lamps, heating and cooking apparatus, including inspection and repairs; (9) to enable short-hour consumers with a large number of lamps connected to obtain the current they require at a lower rate than the maximum, and to reduce at the same time the load demanded from the station.

Each of the above methods may be considered acceptable to the consumer, and I now propose to consider what would be the probable effect of them on the output of the station, and to show how the consumer would be benefited by their adoption. The first four speak for themselves, and require no explanation, so we may proceed to the fifth—viz.:

Free Wiring.—It is difficult to understand why this system should be thus named, as there is very little that is free about it. It may be of great benefit to one consumer and of no use to another, as the charges are made on the number of units used, with a minimum payment of 10 per cent. on the cost of the installation with trade profit added. The consumer who is most benefited by the use of "free wiring" is the one who uses the smallest number of units, and therefore does not have to pay more than 10 per cent. minimum charge for the use of the wiring and fittings.

Instalment Plan.—This should be very popular with all classes of consumers, and I would suggest the following prices as both profitable to the wiring syndicate and acceptable to the consumer. The consumer should be allowed to have any kind or class of fitting that he prefers, the price of the installation to be ascertained in the following way: the prime cost of the work plus 15 per cent. for standing charges, plus 20 per cent. for trade profit, plus 2½ per cent. for inspection by the "undertakers." The total amount to be paid as follows: 10 per cent. on the completion of the work and the balance in 16 quarterly payments plus 5 per cent. per annum on the portions remaining unpaid, the installation becoming the property of the consumer on payment of the last instalment. It may be of interest to see how these two systems compare with each other and with a cash payment. We will suppose these three instances apply to the same building. Current is assumed to be supplied at the following rates: 7d. per unit for the first hour's daily average use, and 2d. per unit for all used beyond that time.

Cash.—A instals in his shop 15 lights. The cost works out as follows:

Prime cost	£11	5	0
Standing charges	1	13	9
Trade profit	2	5	0
Total	£15	3	9

During a four years' use of the light the consumer will have paid the following amounts, including interest, on his outlay: Number of units used, 3,800; and the average demand four amperes at 230 volts:

Current at 7d. per unit	£39	3	5
Current at 2d. per unit	20	9	6
Interest on capital at 5 per cent.	3	0	8
Renewal of lamps	2	0	0
Depreciation 2½ per cent. per annum	1	10	4
Capital cost of fitting up premises	15	3	9
Total	£81	7	8

Free Wiring.—I have taken the charges to be as follows: ¾d. per unit extra for all current used at the 7d. rate and ½d. per unit for all current used at the 2d. rate, with a minimum charge of 10 per cent. per annum on the capital cost, the consumer having the option of purchasing the installation at the end of four years on paying the capital outlay less 10 per cent. for depreciation. Taking the same case as in the last instance the cost will be as follows:

Current at 7d. per unit	£39	3	5
Current at 2d. per unit	20	9	6
¾d. per unit on the 7d. rate	4	3	11
½d. per unit on the 2d. rate	5	2	4
Renewal of lamps	2	0	0
Total	£70	19	0

Now let us assume that at the end of the four years this consumer decided to purchase the installation, the cost would then be as follows:

Brought forward from last account	£70	19	2
Cost of installation, £15. 3s. 9d.; less 10 per cent. depreciation, £1. 10s. 4d.	13	13	5
Interest on the amount paid extra per unit, the whole being averaged	1	2	6
Total	£85	15	1

Instalment Plan.—Taking the same case again, the cost will be as follows:

Current at 7d. per unit	£39	3	5
Current at 2d. per unit	20	9	6
Renewal of lamps	2	0	0
2½ per cent. for supervision of "undertakers"	0	7	7
10 per cent. of capital paid on completion	1	10	4
16 quarterly payments of the remainder	13	13	5
Interest on unpaid portions at 5 per cent.	1	8	4
Interest on paid portions as accumulated	1	11	0
Depreciation at 2½ per cent. per annum	1	10	0
Total	£81	13	11

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A comparison of the three systems shows the following result:

Free wiring	£85	15	1
Instalment plan	81	13	11
Cash payment	81	7	8

In each case the installation is the property of the consumer at the end of the four years. This, I think, shows that the consumer is a distinct gainer by adopting the instalment plan. Who would pay cash when such a means is open to him of having his premises fitted up and inspected for such a small extra payment? The above instances show that in the majority of cases the instalment plan of payment is by far the most beneficial to the consumer, although it does happen that in some cases when a consumer is a short-hour user and does not desire to purchase, that the free-wiring plan is the best for him. Although the helping of a consumer to lighten the first cost of fitting-up is a good means of stimulating a demand for electricity, at the same time it is necessary that a low tariff should be adopted, and that such a tariff can be made profitable is easily proved by a glance at the annual returns of lighting stations. Street-lighting is also a department that requires special inducements to ensure its adoption, and this end is most easily obtained by a low tariff of, say, 2½d. per unit, inclusive of all charges of maintenance.

Tramways.—This department is an important one, and one that every municipal electrical engineer should try and combine with a lighting system if possible. The bogey one so often hears of now—the putting forward of the benefits of having a separate supply station—can generally be traced to self-seeking on the part of a tramway committee and, perhaps, of an official as well, who, forgetting that both departments belong to the same body, wish to be able to say that their department is separate from all others. Would they talk in the same way if it were a question of supplying a company with current for the running of their cars? If a separate station can generate current cheaply, the combined station can do so equally well, for, although on paper it may be supplying at a lower rate than it is costing to produce, the benefit of the extra long-hour load is cheapening the whole cost of production, and therefore enabling an extra profit to be made on the lighting supply. This can be done without any extra cost to the tramway department. The acquisition of a 16-hour load is a variable adjunct, and even this can be increased by utilising the track at night time for running cars for removing the town's refuse that has been collected during the day, and thus save the corporation a large amount of carting costs.

Stationary Motors.—By offering current on a low sliding scale of from, say, 2d. to ¾d. per unit—coupled with a system of hiring motors—a very profitable demand should be obtained. There is a class of consumer very difficult to obtain, as it comes under the maximum lighting rate, and which I have often heard engineers say they are better without—I refer to the large consumer with a short-hour demand, whose lighting is required only at the peak of the load. Why should not this lighting be turned into a long-hour demand with a small demand in kilowatts? I venture to give an instance of how this might be brought about—at any rate, in continuous stations—with the aid of a storage battery and a motor-generator. For example—a mill or factory using, say, 1,000 16-c.p. lamps at 100 volts. I would instal a battery of about 1,000 ampere-hours and a motor-generator of about 6 kw. The capital cost of this, with switch gear, would cost, say, £630. Assuming the daily average demand to be 1½ hours, the current required per annum would be 27,375 units, which at a charge of 7d. and 2d. would amount to £608. 6s. 8d. In place of supplying current direct at the above prices, suppose we do so on the following plan, using the battery and motor-generator mentioned above. The cost per annum should then work out as follows:

Interest on capital outlay at 5 per cent.	£31	10	0
Maintenance of battery at 6 per cent. per annum (taking the cost of battery at £500)	30	0	0
Depreciation on remaining portion of capital, 2½ per cent.	3	15	0
Proportion of labour looking after plant	30	0	0
Oil, water, waste, etc.	5	0	0
Units used by motor-generator in keeping battery charged, assuming a 50 per cent. efficiency, 54,750 units at, say, 1d. per unit	228	2	0
Total	£328	7	0

It will be seen that a saving of £279. 19s. 8d. is made, and the central station obtains a large demand in current at a very small demand in kilowatts. What follows may perhaps seem irrelevant to the subject of this paper, but I venture to give an idea of the profits that might be derived if—a big if—consumers could be brought to the same way of thinking as the engineer. I am taking my own town as an example, and I instance only existing cases and those promised. The capital cost will be very close to the figures given, all contracts having been let and an ample amount allowed for contingencies.

Kilowatt capacity of the station	1,800
Deducted for reserve	300
Net amount available for use	1,500

Capital cost per kilowatt	£60
40,000 30-watt lamps connected to the mains, each using 20 units per annum, at the average price of 4½d. per unit—800,000 units	15,000
120 arc lamps, 500 watts each, burning 3,700 hours per annum, and using 222,000 units at 2½d. per unit, inclusive of maintenance	2,312
300 kw. in motors, including six mills and factories for lighting purposes, and 70 kw. in motors in a cold storage running 24 hours per day. The average demand is taken at 10 hours and the average price per unit is 1¼d.—1,095,000 units	5,703
26 miles of tramways running 1,226,000 car miles per annum, and using one unit per car mile at 1½d. per unit	7,665
Total	£30,680

The load factor works out at 25·44, and with so high a one no difficulty should be found in obtaining a total cost per unit of not more than 1·25d. per unit. This would give a total cost on the above output of £17,420. A profit of about 12 per cent. is made before setting aside interest and depreciation and about 7 per cent. after paying all charges. I have endeavoured to place all the figures on a safe basis; at the same time I can see no reason why the total costs should not be brought down to 1d. per unit. I trust this short paper may be the means of obtaining many suggestions for increasing the demand for electricity, especially that class which will increase the load factor.

Mr. H. FARADAY PROCTOR, of Bristol, in opening the discussion, complimented the two authors on their papers. He thought that one great step in the direction of stimulating the demand would be attained if they could make the public more conversant with the qualities of the electric incandescent lamp. Most people bought lamps taking 3½ watts per candle-power, whereas with current at 5d. per unit lamps using two watts per candle-power should be employed. (Mr. Proctor did not state where these lamps were to be purchased.) As regards Mr. Potter's remarks on the repurchase of free-wiring apparatus, he had found that the National Free Wiring Company did not charge cost price, as was stated, but that the so-called cost price included incidentals, office expenses, and profit. The figure thus arrived at, with 20 per cent. added, was high. The 1½ per cent. per annum for depreciation corresponded to a life for the wiring of 66 years. He believed that economy would result in service work from having house-to-house connections made so that only one service box would be required for three or four houses. He had found that the best consumers were in the poorer districts, where the lights were used for a large number of hours, and not the high-class shops, which closed early. The principle of the charges of the National Free Wiring Company seemed to him to be at fault, and he thought an instalment system, with option of repurchase, would be preferable. Long-hour consumers were discouraged by an additional charge per unit. He also deprecated running the charge for upkeep of public lamps into the charge for current. Thus, at Bristol, it appeared from the accounts that private motors were supplied at a lower rate per unit than the public arc lamps, owing to the inclusion of the labour and maintenance in the charge for current. Mr. Proctor disagreed with Mr. Bishop's figures for the use of accumulators for a short-hour load, and stated that from the figures given a charging of 30 hours per day would be required to get the accumulator charged up to take the day's load. The plant suggested by the author was too small for the average load, and hence was very much too small for winter load.

Mr. T. P. WILMSHURST, of Derby, said the subject before them was of great interest to all. He endorsed what Alderman Potter had said about low costs and low prices. He did not favour the arrangements made by the National Wiring Company, but approved generally of the maximum demand system of charging. He noted the good result obtained in certain places where some 5,000 additional lamps were obtained by free wiring, but would ask Alderman Potter if the units sold per lamp with these was not less than the units per lamp fixed in the usual way. It was a good plan to take over the street-lighting wherever mains were laid, and the street lamps were an advertisement of the fact that a supply could be obtained. Also the electric lighting committee were in this way assured of one good customer at least for their extensions. At Derby they had permission to replace all gas lamps at

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previous cost, which worked out to 2¼d. per unit, and paid all right. They had also taken up the supply of motors on hire, and in three months had let out 250 h.p. in the aggregate. This enabled full load to be obtained in the daytime for a 300-h.p. steam-engine.

Mr. F. NEWINGTON, of Edinburgh, remarked that he had had no need to stimulate a demand for the electric light, and the actual demand in the ordinary way had grown so rapidly that they had difficulties in coping with it. He did not agree with Alderman Potter over public lighting; that should be supplied at the lowest possible price. He believed in hiring out motors. The maximum demand system of charging made no allowance for the time at which the maximum demand occurred. A two rate meter would be much better in this respect, and he (Mr. Newington) would like to hear of a good two-rate meter which discriminated between night and day loads. Public lighting was not so good as a motor load in improving the load factor of a station, as it was required over the peak, while motors were not.

Mr. G. H. NESBITT, of the British Insulated Wire Company, said that Alderman Potter's paper showed that the business side of the Taunton undertaking was in good hands. He was partly responsible for the name of the National Free Wiring Company, and agreed that it was wrong; it should be the National Free of Initial Expense Wiring Company, Limited. The instalment system proposed by Mr. Bishop did not meet the requirements of the tenants who held a yearly or three-yearly lease. Such occupiers naturally objected to incurring expenses which would be wasted if they gave up their premises, and for such the free-wiring principle was better. Also, if Mr. Bishop's comparison had been made for eight years instead of four, the free-wiring principle would have shown better results than the instalment plan.

Alderman R. RICHARDS, of Bedford, considered that to cheapen the public lighting was better than to charge high rates and make a profit. He argued that, owing to the short period of repayment, the electric lighting undertaking were being worked for the benefit of posterity, and they were justified in drawing a sum annually from the rates in consequence.

Alderman W. BRUCE, of Sunderland, thought it would be better for the corporation to engage the National Free Wiring Company to do the installation work and to pay them for it. The consumers should then be charged two separate accounts, one for current supplied and the other for interest on the cost of wiring. The present method stopped the extension of the electric light into the bedroom, which gave a load late at night after the peak had passed. Such a load was to be encouraged. The maximum demand system also, in Alderman Bruce's opinion, tended to restrict the extension of lighting to the private rooms over the shops. He did not hold with the author's proposal to debar those who had their premises free wired from all discounts.

Councillor BRAND, of Brighton, believed that, with the Wright maximum demand system, 7d. for the first hour's average supply was none too much. As regards street-lighting on extensions of mains, they found they could give three times the light for the same cost. They preferred, however, to give twice the light when replacing gas lamps by incandescent electric lamps. The charge of 1d. per unit extra for electric energy consumed in lamps "free wired" was not fair. Councillor Brand proceeded to misquote Alderman Potter's paper, and to prove that the misquoted ideas of that author were unfair.

Mr. J. E. EDGCOME, of Kingston-on-Thames, stated that the Kingston Corporation had recently received the Royal assent to their Bill authorising the expenditure of £10,000 on wiring work, but they had not decided how to proceed with the same. The Bill, which was primarily a "Tramway Bill," became an "omnibus Bill" by the introduction of the wiring or municipal trading clauses.

Mr. W. A. CHAMEN, of Glasgow, did not quite see why manufacturing companies should not let out motors on hire to be used on corporation mains. The corporation certainly could not stop them. Also there was no reason against the National Free Wiring Company making their agreements direct with the consumers, leaving out the corporations as third parties. In Glasgow they had found it unnecessary to stimulate the demand. New buildings and new flats were all laid out with wiring, so that electric light was their sole illuminant, and this would force the landlords of older buildings to wire them for their tenants. As regards rates of charges, it was not fairly evident that undertakers might make discriminating charges. He did not see why flat rates could not be devised to do what the maximum demand indicators did. Thus, at Glasgow, all domestic users were to be charged 3½d. per unit. A domestic user was defined as being the occupier of premises in which people sleep. It was argued that a church came under this definition, but churches were charged 3d. per unit. Offices, which were such poor consumers, should, he thought, be charged 6d. per unit, and public-houses, clubs, etc., 2d. to 1½d. They had no special rates for motors, but charged 1½d. per unit to all consumers taking a supply for five hours per day of their maximum demand. It made no difference whether these were used for generating light or power.

Councillor C. WEST, of Coventry, referred to the good work done by the National Free Wiring Company in that town, as shown by the figures in Alderman Potter's paper. The canvassing of the company had stirred up the other contractors in the town, with the result that they obtained many more consumers for the Corporation station than they otherwise would have done.

Alderman POTTER, in reply, thanked those who had taken part in the discussion for the kind way they had referred to his paper. He thought the speakers had answered each other on many points. At Taunton they had felt the benefit of the energetic canvass by the National Free Wiring Company. He did not advocate high charges for street-lighting, but that its actual cost should be paid to the electrical department. He proceeded to quote from a series of letters in a Taunton paper to show that many towns charged too low prices for street-lighting, and then had to call up money from the rates at the end of the year. They in Taunton had found coin-in-the-slot meters to be a success. There were now some 15 or 16 radiators on the Taunton mains, and the heating load from these tended to level up the curve of output.

Owing to limited time, Mr. H. COLLINGS BISHOP said he would send his reply in in writing.

Mr. C. S. VESEY BROWN then gave a *résumé* of the following paper:

Electricity Supply for Small Towns.

BY C. S VESEY BROWN, CITY ELECTRICAL ENGINEER, LINCOLN.

The subject of the paper, as suggested by the council of this association was "The Best System of Supplying Small Towns," but the above title was substituted, the object aimed at being to elicit, by discussion, the experiences and ideas of those members of the association who have given the matter their attention. There is no doubt that the rapid advances which have been made in electricity supply in the larger towns of Great Britain, coupled with the facilities which modern legislation has provided for the purpose of municipal ownership of such undertakings as gas, water, electricity, and tramways, has prompted the smaller and possibly less densely-populated and prosperous districts to apply for statutory powers under the Electric Lighting Acts. For the purposes of this paper, the author has chosen those towns and districts with a population not exceeding 40,000. At the end of 1899 there were in operation six towns under this size: 56 works (28 owned by local authorities and 28 by limited companies); there were also 161 local authorities and 23 limited companies who had acquired statutory powers, of which number 50 local authorities and 16 companies were reported to have completed arrangements for equipping works, thus leaving 111 local authorities and seven companies who had not made up their minds what to do. Of these 111 local authorities, the following obtained their provisional orders on the dates given—viz.: one in 1890; two in 1891; four in 1892; two in 1893; and two in 1894; and of the remainder, the larger proportion were granted in 1897, 1898, and 1899. There are also a large number of applications during the present session, of which it is difficult to give an exact account until the orders are granted. The analysis of the works in operation, as regards system of distribution, is as follows.

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Local authorities		Limited companies	
High-tension alternating.	Low-tension continuous current.	High-tension alternating.	Low-tension continuous current
11	17	12	16

and the capital expenditure and results from those in operation for more than one year is as follows :

	Local authorities. 14 towns.	Limited companies. Nine towns.
Capital invested	£406,175	£332,490
Average profit after payment of working expenses	4½ per cent.	4½ per cent. (average dividend)
Kilowatts installed	5,240	3,065
Average price per B.T.U. obtained	5·1d.	6 4d.

It will be seen that to a certain extent the local authorities have been obliged to subsidise their works with contributions by the general body of ratepayers, for in order to pay interest and sinking fund on the capital invested at 3 per cent., and repayable in 25 years, a return of at least 5¾ per cent. is needed. The author tried to investigate the corresponding gas returns for these towns, but owing to the involved accounts of new and old capital, different rates of interest, and also the fact that, as a rule, the gas companies supply outside the local authorities' area, the figures would not have been of any real value as a comparison.

Having obtained the necessary powers, the local authority's attention is at once directed to a number of questions, of which the following are the more important : a choice of system ; a selection of a site ; the question of an expert to advise on what is to be done, and how to do it ; the capacity of the generating plant ; the extent of the area of supply to start with ; whether or not street-lighting should be undertaken ; the price of supply, and on what terms there should be a rebate, according to the consumption of electricity ; are "free-wiring" contracts to be entered into, etc.

It is one of the good fortunes of this country that the municipal government, as a rule, is carried on with the firm desire to do what is best for the "citizens," and the author makes no exception to this rule in the case of electricity supply, and begs respectfully to point out to the local authorities in question the advantages of sinking all differences of opinion in politics, etc., when dealing as trustees to a commercial undertaking for the benefit of the general public. If the expert's advice can be depended upon, the local authority can leave all technical details alone, and exercise in a greater degree those commercial and managerial qualifications which it is presumed have placed them where they are. The choice of an engineer to advise and superintend the scheme is a knotty point to solve in some places. At times the surveyor is asked to carry out the works. Other places depend on a scheme propounded by manufacturers, and, again, some authorities appoint an engineer, after considerable expense in advertising, at a wage of a first-class foreman, who is supposed to be competent to advise on all the intricate questions in the maintenance and construction of the undertaking, which, though small in size and area, yet has principles involved which require the same consideration as if the undertaking was to supply a greater district ; and not only is he called upon to carry out this undertaking, but to draw plans and specifications, and in contracts provide himself as sole arbiter in cases of dispute with manufacturers, who may have in their employ engineers and experts of world-wide fame.

The author's suggestion to small local authorities is that they should employ a competent expert to advise and initiate a policy and system, and for the first stage of the undertaking pay him the usual fees ; that then they should engage a resident manager, whose duties would be to manage both commercially and technically the whole undertaking, and that as extensions are required the consulting expert should be called in to advise, he being paid an annual retainer to cover the advice given. In this manner the local authority would obtain the maximum of expert advice with the minimum of expense, and, in connection with this suggestion, the author would point to the very magnificent results which have been obtained by gas, water, and railway undertakings where somewhat similar arrangements have been made. The site for an electricity works should be, if possible, near to a stream of water, and adjacent to a coal depôt. If preference is to be given to either situation, that where easy arrangements can be made for condensing the exhaust steam is preferable. In the author's opinion it would be a difficult matter to find a better system than the three-wire continuous current, supplying consumers at a pressure of 200 to 250 volts, the choice of pressure being determined by the probable extension of the feeder cables. The generating plant should be of a simple and yet efficient character ; nothing should be installed which has not stood the test of time and experience. Lancashire boilers, or, where it is possible that foggy weather may be experienced, water-tube boilers are equally suitable ; 125lb. to 130lb. steam pressure seems to be the most suitable standard to adopt. The addition of an "economiser" or feed-water heater is distinctly an advantage, and should not be omitted, especially where the character of the feed water necessitates some depositing apparatus to soften it. The steam and feed pipe arrangements should be of the best character. There should be no possibility of joints failing or valves leaking, and in the whole of the system of electricity supply there is no policy more penny wise or pound foolish than that if the substitution of inferior material or curtailment of expense in this part of the generating plant. The engines and dynamos should be direct coupled to each other, and as far as possible should be arranged in standard sizes. By "standard" sizes is meant the standard size of any manufacturer, as near to the expert's "standard" as possible ; if the expert's "standard" is insisted on, additional expense is incurred, which in the author's opinion is not warranted.

At the first stage of the undertaking it is probable that two or three sets of from 50 kw. to 100 kw. each would be installed, and that as extensions are required 150 kw. to 250-kw. machines would be added, the sizes depending on the probable demand to be made for power and traction, as well as for lighting. Compound two or three crank engines appear to be the most useful type. The dynamos, for the first stage, should be so arranged that they will balance the three-wire system, if necessary, without the assistance of a storage battery. A storage battery should be provided of sufficient capacity to take all the lighting that may be required between midnight and some time in the afternoon of the next day, for, say, two years, after which time it acts only as a "safety valve" to the supply pressure. The switchboard should be so arranged as to be easily extended, and at the same time confined to as small a limit as is consistent with safety and ease of controlling the supply. Recording instruments for various purposes should be used. There is nothing more annoying than to be assailed occasionally with the statement that the supply is or was unsteady at some specified time, and there should be recording voltmeters to refute or confirm such statements. Each dynamo should be provided with a recording instrument to enable its output to be calculated.

Sufficient attention is not paid to the necessity for keeping accurate records of everything in an electricity works. The author has had occasion lately to examine the accounts and records of most of the undertakings at work in the country, and is surprised to find that, for example, records as to the number of units generated, or the amount of cable laid, and other details essential to the good order of such an establishment are not kept. In the minor details of the works the author is inclined to use motors for driving the various pumps, economiser scrapers, and cranes that may be required, but would make an exception in the case of providing a reserve steam feed pump.

With regard to the distributing system, concentric and triple-concentric cables are most suitable. These should be laid on what is known as the "solid" system, which serves the double advantage of forming a mechanical protection against picks and water, and also against electrolytic effects, which may be deleterious to armoured cables buried direct in the ground where tramways are in operation. The author prefers to adopt one standard size of cable (say, ·075 square inch to ·125 square inch sectional area) throughout the distributing network, and to throw out feeders of different sectional areas to different parts of the network as the demand increases, and by a judicious selection of the size of feeders it should be possible at some future date, if the district which is being supplied increases in value or importance, to use the feeder cables already laid as distributors, and relay larger feeder cables ; for just as the gas and water companies commenced operations with small pipes, etc., so does the electricity undertaking commence operations with small plant and cables. The meters used in consumers' premises should be well tested before being put on the circuit.

With regard to the price of supply, the author is inclined to the adoption of a price which will require little variation in the future. If a high price is fixed to start with, it is certain to have the effect of restricting the output, even though a profit may be made, and the intention of the Legislature in granting the local authority powers (which amount to an absolute monopoly), is undoubtedly not that electricity should be for the rich, but for those who desire to avail themselves of it ; and in connection with these remarks the author would add that a broad policy of extending the network cables over a considerable area of the district each successive year will have the effect in the long run of establishing a good connection amongst all classes of inhabitants.

In concluding this paper, the author would refer to the supply of electricity in those towns where the gas undertaking is carried on by the local authority, and would suggest the following possible solutions of the difficulty which may occur in these cases : (1) if the town is within the area of supply of one of the large power-distributing companies, who are, or will shortly be operating, then a cheap and efficient way would be to lay down a network of distributing mains, and allow the company to supply "in bulk" what electricity is required, the local authority retaining the distribution of the energy and the collection of the accounts in their own hands ; (2) to lay down a network of distributing mains, and instal a gas-engine plant

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to the extent of probably 150 kw., as a pioneer undertaking, and if the demand requires, then to put up a steam generating plant.

The author has felt some diffidence in going beyond the bare outline of the suggested arrangement for dealing with this problem of supplying these small towns (on account of the many varied conditions which obtain, say, for example, in towns in Devonshire, Staffordshire, Durham County, or in the North of Scotland), and hopes that the discussion will elicit information which will be useful to guide the powers that be into the right groove towards the establishment of efficient and successful electricity works all over the United Kingdom.

Mr. G. M. HARRIS followed with another paper on the same subject, which reads as follows:

The Lighting of Small Towns.

BY C. M. HARRIS, ELECTRICAL ENGINEER, BRAY, IRELAND.

The lighting of small towns is a problem requiring very careful consideration, not by reason of any engineering difficulties, but by reason of the difficulty of making such an undertaking pay. On account of the profits being necessarily small, the lighting of small towns will continue to receive little attention from private companies, except they be very plucky ones. The matter will, therefore, be left for the consideration of the local authority, who will be content, or, at all events, should be, if at a reasonable cost they are enabled to carry out the public lighting of the town, and at the same time place a supply of electricity at the disposal of its inhabitants. The measure of the success of such an undertaking should then be judged, not by actual return made in the shape of profit shown, but upon truly municipal lines—*i.e.*, by the efficiency and cost of the public lighting and the rate at which a supply of electricity is obtainable for private use. Small towns mean small consumers and usually a scattered area. The distributing charges will be heavy, so that if there is to be any hope of success the generating charges must be light, which means that the site for a generating station must have very special natural advantages, such as good water power, or facilities for cheap fuel, or a combination of the two. Where there are no such advantages, there appears to be no alternative but to wait for the great power companies to pick up such small areas as may be within their reach or upon the direct line of route of their mains to larger ones.

Assuming that the conditions are favourable for generating or obtaining a supply at a low cost—at the commencement the public lighting should be provided for and taken over, and provision only made for private consumers where such are certain to come on in a reasonable time. The policy of laying the mains for private use well in advance of the demand, though justified in wealthy areas, would not be so in small towns, where the conditions are different. The prospect of profit in supplying small and scattered consumers being very small, there is no room for speculation, and it is of the utmost importance that the capital expenditure be kept as low as possible, and that no capital should be unproductive. It therefore follows that the system of distribution should possess the maximum of flexibility at the minimum of cost. Now that distribution up to 200 volts has been successfully established, there are, of course, many towns where direct current would be feasible and no doubt preferable, but in the majority of cases high-pressure alternating current with transformers in street-pits and occasionally in houses would be better. Where the area comprises a number of private houses and mansions, standing in their own grounds and of necessity widely scattered, but nevertheless desirable to reach, the alternating system is the only one commercially possible. This question, however, will, of course, be governed by the circumstances in any particular district, but the question of the actual cost of mains will always remain– a serious item telling against economical distribution on a small scale.

It is therefore the object of this paper to deal with the matter of cheap mains and mainlaying, that being, I consider, the most important point—the one which lies nearest towards a solution of the problem under consideration. I therefore propose to bring to the notice of this association two cheap and effective methods of mainlaying of which I have had experience at Bray. First, as to the mains in operation at Bray, there have been over six miles of high and twenty-seven miles of low tension laid direct in the ground since 1892, and during that time we have never had a fault on the main line of cables themselves, except where mechanical injury had caused it, and this has very seldom happened. Any trouble we have had has been due to defects in the filling material of the jointing boxes, now overcome, so that this system of laying may claim to have been well tried. In fact, I think the Bray mains are the oldest paper-insulated cables in the kingdom, other than those from Deptford. The cables are concentric lead-covered and unarmoured—they are taped, but this is, in my opinion, a disadvantage. In laying, the bottom of the trench was covered with about 3in. of puddle clay, well wrought, the cables laid in and covered with another 3in. of puddle clay, evenly put on, and a 7in. by 1in. board placed on top, the trench being then filled. Latterly, the timber used for mechanical protection has been larch—being simply the small larch trees, 7in. thick in the butt, sawn in half. This timber stands well in the ground, requiring no special treatment to preserve it, is cheaper than deal boards, and more effective, being thicker. The effect of the puddle clay, impervious to moisture, is to protect the lead covering from any contact with acids or salts in the soil which would attack it, and it has proved so effective that when the cable is now, after eight years, exposed, the lead is absolutely unattacked. The braiding of the cables has rotted, proving to have been an unnecessary expense. It might prove a source of danger if it allowed a passage of water charged with matter which would attack lead, the life of a lead-covered cable being practically the life of the lead. As to the jointing, no clips are used; the inners are married and soldered in the usual way, the outer wires are drawn to one side and soldered together, forming a loop, all soldering being done well clear of the cable insulation. The joint is contained in a cast-iron joint-box divided longitudinally on the line of two bottlenecks for entrance and exit of cable, and having on the top side a large hole for filling (not less than 1in.) and a smaller hole as air vent, closed by screwed plugs. The cables are served with spun yarn up to the diameter of the bottlenecks, and no other packing of the glands is found necessary. The joints having been made and the box screwed up, molten pitch is poured in; the outer side of the bottlenecks beyond the spun yarn serving is also filled in with pitch, hollows being formed in the clay for the purpose, and here fine clay mixed with the pitch forms a cement which effectually seals up the bottlenecks and protects the cable from injury where they enter and leave the box. Such a joint is cheaply made and fulfils every requirement. It demands only care and requires absolutely no special skill, a very important matter in a small town. This, and the fact that it is both electrically and mechanically sound, gives a joint so made advantages which no form of joint made with clips which the writer has seen can claim. Where any transformer pits lie on the route all cables are brought into the pits and are joined there, inners and outers, with loops of rubber-covered single cables; disconnection of any length of cable for tracing a fault is done by snipping these loops, and this works well under our conditions. Of course, in a large scheme where the expense was no object, disconnecting boxes would be preferable, but when used they should certainly be placed in pillars above the ground, and so above the reach of flooding, and not in watertight boxes underground. As far as the writer is aware, the insulation resistance of mains in operation is not usually easily obtainable, but he has reason to believe that the above are more than ordinarily low. This, however, in no way reflects on the cables; it is partly due to the fact that originally oil was used in the joint-boxes, but was soon abandoned, not, however, before the cable ends had suffered, due to water mixing with the oil: the repairing of these ends accounts for the large number of joints. The main cause of the low insulation is due to the large number of joint-boxes, which still contain a mixture of tar and pitch (the tar

PARTICULARS OF THE INSULATION RESISTANCE OF THE HIGH TENSION MAINS.

Number of main.	Size.	Year laid.	Length in miles.	Number of underground joints.	Insulation resistance					
					Number of loops to pits.	Outer to earth.	Inner to earth.	Inner to outer.	With transformers connected.	Equivalent per mile, transformers connected.
1	·0229	1892	·3	17	7	·176	1 37	1 69	·18	·059
2	·0229 / ·0128	1892 / 1893	1·58	41	13	·133	·133	·173	66	1·04
3	·0229	1892	·875	28	8	·4	·8	1·04	·40	·35
4 (Arc circuit)	·0128	1892	2·17	50	4	·44	·314	1·10	·20	·434
5	·0072	1892	·54	14	6	·338	·758	·846	·285	·15
6	·0356 / ·0128	1898	1·16	7	6	1·8	3·42	2·66	1·81	2·09

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having been added as a precaution against cracking of the pitch). This mixture is inferior in every way to the pitch alone, which is now always used. The fact that the resistance from the inner to the outer is in the majority of cases greater than that to the earth is no doubt accounted for at the joints, where the resistance of the pitch has been weakened in the manner indicated, and the surface of the outer is small in comparison to the surrounding box. Their condition, however, causes no anxiety at Bray, as the tests are practically identical with those taken in 1893. The cables have been perfectly steady all along, and have lived to see much of the more elaborate and costly draw-in system placed on the scrap heap. The cost of laying the cable described was under 1s. per yard of trench, made up as follows: opening and filling trench 20in. deep, including mixing of puddle clay, from 3d. to 6d. per yard; puddle clay at 2s. 6d. per ton, sufficient for three cables, 3d. per yard; 7in. by 1in. board, for mechanical protection, 2d. per yard; the average cost of a joint being under 10s., as follows: joint-box complete, 4s. 6d.; pitch, solder, fire, etc., say, 2s. 6d.; labour, 2s. 6d.—total, 9s. 6d.

Sufficient has been said perhaps to show that such a system of laying and jointing mains is cheap and reliable in any case in which no danger from electrolytic action is feared—as where, for instance, a tramline passed through a town, in such a case the lead would need protection, and recourse to some solid system seems inevitable; but a small town cannot afford the luxury of lead-covered cables laid in this way, and the lead seems to me quite unnecessary, serving no purposes which would not be equally served by any cheap covering which would protect the insulation from damp up to the time of being laid, after which it requires no such protection. If the cables are concentric the outer insulation can be reduced to that thickness which, with the filling, suffices for the voltage carried; if the cables are not concentric, then the covering of each may be reduced to that thickness which, with the filling, is good enough. The question is, how much the insulation, other than that of the filling compound, may be reduced? My impression is that, driven by consideration of cost, we shall see this extra insulation year by year reduced in amount till, for low voltage, we come to the bare conductor laid on insulators in the solid filling, and for higher voltage, conductors laid on the same system with very slight extra insulation, relying mainly upon the filling compound. The inevitable result of this will be that we shall, for the conductors, use iron or other metal, or alloy, cheaper than copper, since the prohibitive cost of the increased insulation, due to bigger cross-section for the same conductivity for such metals, will not have to be faced. At Bray we tested, some years ago, 80 yards of bare copper mains laid on the solid system, and although roughly laid and badly insulated, the filling compound being a mixture of bitumen, tar, and sawdust, this nevertheless stood 1,000 volts for 12 months, and 100 volts for two years afterwards, and was then only taken up on account of building extensions. From that experiment and subsequent experience I believe it is perfectly possible even now for voltage, say, up to 500, covering all low-tension distribution for light and traction, to use wires covered with, say, a few layers of paper and a light braiding varnished, and the whole laid in troughing filled in with plain pitch at 10s. per ton, which, for all sizes of copper above, say, 0·25in. sectional area would be cheaper than any cable in the market. Whatever be the nature of the solid system, the compound for filling both joints and troughing should be ordinary pitch, which has the advantage that it can with ease be chipped out, and is cheap. In most small towns, for the public lighting of outlying country roads, overhead bare wiring might be employed, for doubtless the sanction of the Board of Trade for their use, at all events for the first few years, might be obtained. On the whole, however, the regulation preventing the use of overhead wires does not press very hard upon small towns, where usually labour is cheap and the roads easily opened.

Returning to the general question, it may safely be said that where gas has been well established the outlook for a private consumption of electricity will be in inverse proportion to the price charged for gas; for where a high price prevails, the inhabitants will be found educated to the closest economy in its use, and it is surprising how far this can be carried.

Mr. J. E. EDGCOME disagreed with Mr. Vesey Brown's remarks on the choice of an engineer. He thought it would be well if the smaller corporations and urban district councils were to consult the Municipal Electrical Association on such points as the selection of a suitable man to design and run their station. This would be following the practice of such authorities in consulting the presidents of the Institutes of Civil Engineers and Mechanical Engineers when experts were wanted. A fair salary should, of course, be offered. In certain cases it was better to pay an expert when laying down the plant, and to retain a cheaper man to run the same after completion. Extensions should be in the hands of the resident engineer, and he held that if this engineer was not capable of carrying them out, he must be incapable of running the works properly.

Mr. H. L. P. BOOT, of Tunbridge Wells, said that small towns were most difficult to equip, as such a keen balance between capital expenditure and probable income must be kept. In a small town a 1d. rate produced such a small sum that an over capitalised undertaking might be a heavy burden on the people. He did not consider economisers paid for the capital outlay on them if water-tube boilers were used. In small towns the public lighting was always a good nucleus for the electric lighting load.

Mr. R. QUIN, of Blackpool, did not hold with Mr. Edgcome's suggestion to make the association act as a tout for embryonic consulting engineers. It would pay a small town better to employ a good consulting man at first, in order to get their plant and mains properly laid out. He believed there was one system of supply, which had not yet been described or tried, which had a future before it—it was to work with a refuse destructor and a Dowson gas plant. At light loads the steam would be passed over anthracite, and the gas produced would be stored. This, he thought, would be more economical than electric or thermal storage.

Mr. S. E. FEDDEN, of Greenock, did not like triple-concentric cables; three single cables laid on the solid system was better. He would ask Mr. Harris if the pitch had not attacked the lead on the cables at Bray.

Mr. TREMLETT CARTER said that gas-engine stations were not really so bad as they were represented to be. Mr. Quin's plan, however, would fail, because Dowson gas did not retain its composition if stored. The hydrogen leaked out through the iron plates of the receiver.

Mr. H. C. BISHOP said he had previously had charge of the Leyton station, and considered a gas plant satisfactory if not more than 400 kw. were ever required. For small stations it gave cheaper cost than steam, especially now coal was so dear. The change-over to steam, however, was most costly.

Mr. VESEY BROWN, in reply, briefly referred to the points raised. The argument that the man who lived in a place was best fitted to design the station was a fallacious one. He only suggested that gas might be used in pioneer work in small towns owning gasworks.

Mr. HARRIS also made a few remarks, and said that the lead in the cables at Bray showed no deterioration from the pitch after eight years.

The members then adjourned to the town hall, where, by the hospitality of Alderman Calvert, the chairman of the Huddersfield Electric Lighting Committee, they were entertained to lunch. The following is the menu of the lunch, which was excellently served:

Menu.

CLEAR SOUP.
SALMON. MAYONNAISE SAUCE.
ROAST LAMB, MINT SAUCE. CROP OF BEEF. BRAIZED BEEF.
CHICKEN AND HAM. OX TONGUE.
SALAD. FRUIT TARTS. CHEESE. COFFEE.

The toasts after the lunch were "The Queen," proposed by Alderman CALVERT; Mr. PEARSON, of Bristol, proposed the health of "Our Host"; and Mr. FARADAY PROCTOR, "The Mayor." The acoustic properties of the hall did not equal the excellency of the repast, and only the Mayor succeeded in making himself heard where we sat.

The afternoon attractions were a trip to Bradford and visits to various local works.

(To be continued.)

British Iron Trade Association—The annual conference of this association was held last week at the Westminster Palace Hotel, Sir J. Jenkins, M.P., presiding. The subject of "British Traders and British Railways, with Reference to the Control and Cost of Mineral Transport" was introduced by the president. There was also read at the meeting a paper by Mr. H. J. Skelton on the question of "What is the Competitive Outlook in the World's Iron and Steel Trades, or, more particularly, for the British Iron Trade?"

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E C. Anonymous communications will not be noticed.*

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MR. MOUNTAIN'S ADDRESS.

Among the many good things Mr. Mountain says in his address, and suggestions made, we may perhaps be allowed, in the first place, to disagree with one—a little one—suggestion. With almost everything else we are in accord, but, please, no more examinations. The President of the Municipal Electrical Association says: "Time has not, however, removed the man who does jerry work—indeed, it seems as if those workmen who are fit for nothing else become infatuated with wiring, and are really the cause of the bad work which is being done in so many towns. One way out of the difficulty would be to organise a system of examination in connection with our association, so that good men with a knowledge of their work could obtain a certificate. . . ." Examination means attempting to reduce all the examined to one dead level. In this case it means more: it means that the examiners arrogate a much more perfect knowledge of things electrical than experience in an industry not more than twenty years old would lead us to expect. There may be and are certain details of practical wiring upon which all are agreed, but after these few details there is little or no agreement. Mill, in his essay on "Liberty," said: "Eccentricity has always abounded when and where strength of character has abounded, and the amount of eccentricity in a society has been proportional to the amount of genius, mental vigour, and moral courage it contained." According to the average man, everybody is eccentric who dares to disagree with him; yet unless there was this disagreement there would be no improvement of any kind—a deal level of wiring, uniformity, all work rigidly to one specification. Surely this is not what we want. Jack is as good as his master when both have passed the examination. Slaves to custom are slaves to mediocrity. Individuality, capacity to initiate, are the things wanted, and wanted abundantly. However, let us pass on to another question, with which all will agree that too much discussion upon it cannot take place. Discuss to-day, discuss to-morrow, and next day, and new features will arise, new conditions appear, and in the end we shall admit that time alone will solve the problem. Mr. Mountain says, "We are constantly extending without being able to form any very correct idea of the ultimate size of our works. . . ." That is perfectly true, and the figures he gives are valuable, and should assist in driving home the view that in designing a central station the end as well as the beginning should be kept in sight. No doubt the Local Government Board is answerable for a good many mistakes that have been made, in that authorities are more or less afraid to consider the future, and restrict action to the estimated immediate requirements. Preparatory work can hardly be reproductive, and surely it is within the bounds of practical business to find a method whereby to relieve the debt from unnecessary payment till the apparatus for which it was incurred come into use. Another point emphasised in this inaugural address is that the average charge per unit by municipalities is less

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than that by companies, and this is a very important point when comparing the monetary results of these undertakings. A summation of the units sold by municipalities and by companies will show the loss or gain because of this difference in charge. Lastly, we are glad to see the views we have so often put forward in regard to motor vehicles somewhat corroborated by Mr. Mountain. The object is to replace horses, and to do this vehicles which can compete with railways are not required—only such as can be depended upon to make, say, a maximum of twenty miles per day; and if designers and manufacturers will provide these, a great step will be gained.

THE POWER BILLS.

The committee of the House of Commons presided over by Sir James Kitson on Monday resumed the consideration of the Lancashire Electric Power Bill, when the case of Southport in opposition to the Bill was opened by Mr. J. D. WILLIAMS, who submitted that, having regard to the character of Southport as a high-class watering place, which had its own electrical undertaking, and to the fact that behind Southport were some 250 square miles of purely agricultural land, there was not the slightest probability of the proposed company ever being asked to supply the district. The Corporation could do better than the company would do, and he objected to the company being granted powers which could only be useful for prospectus purposes. As to how a municipality was injured if electric power could not be supplied in its area without its consent, he urged that the municipalities were quite alive to the importance of supplying cheap electricity, and perhaps, he suggested, the true solution of the problem was not the handing over of large areas to a speculative company, but the combination of local authorities themselves.

The MAYOR OF SOUTHPORT (Mr. Griffiths) then gave evidence as to local matters; also, in answer to the question of how they were injured if the company could not supply without their consent, the Mayor stated that Southport would be injured, just as other municipalities would be injured, by having established in one of the wealthiest counties in England a protected company, with which no one could compete except after the promotion of a Bill in Parliament. If, on the principle of water boards, municipalities could combine and distribute electricity within their areas they might be able to confer great advantage on the community—greater than any company could possibly confer. He thought this a most inopportune time to interfere with what was being done. The supply of electricity had hitherto been somewhat of a speculation, and local authorities had been afraid to embark money in such undertakings, but now the question of its supply had been placed on a trading basis, and he believed there were at present some 20 Bills in Parliament promoted by local authorities, the effect of which would be to double the output of electricity within the next 18 months. At a time when the municipalities had shown they appreciated the importance of the matter, Parliament were asked to put a large company in a protected position, and this, he held, would be disastrous to one of the wealthiest portions of Lancashire.

Mr. TAIT, the Southport borough electrical engineer, was also called, and, in cross-examination, said he was not aware that in Germany agriculturists were combining in order to obtain for themselves a cheap supply of electrical power.

On behalf of the municipal boroughs opposing the Bill, which he said were the whole of the boroughs south of the Ribble except Blackburn, Mr. BALFOUR BROWNE, Q.C., agreed to the full with the declaration of the committee as to the value of electrical energy as a means for transmission and application of power, and, further, that its importance to the industries of the country was unquestionable. This, however, was a totally different thing from approving of the present Bill, which, he contended, would not put a supply of cheap electricity within the reach of everybody in the district. The promoters were grasping at a large area of country in order to get a footing for some ulterior object. They sought to supply an area of some 1,100 square miles, and he should show conclusively that the supply of too large an area did not really tend to reduce the cost of production, and that local authorities acting within reasonable areas were able to supply more cheaply than the company would be able to do. He submitted that the Joint Committee of the two Houses of Parliament never contemplated that wayleaves should be granted promiscuously over such a vast area, nor that a company should be allowed to step in where a municipality had been doing its duty. In the present case the municipalities within the area had spent 2¼ millions sterling in the development of their electrical works, and were proposing to spend as much again.

The CHAIRMAN, after the luncheon interval, said that Mr. Balfour Browne had indicated that there was some prejudice in the minds of the committee with regard to Manchester. He was sure no observation had fallen from any member of the committee which would justify such a remark, and, personally, he desired to say that he had met the members of the Manchester Electric Lighting Committee at Leeds, and was much struck with the energy and enterprise of Manchester.

Mr. BALFOUR BROWNE assured the committee that in anything he had said he had no intention whatever of imputing prejudice. What he was anxious to prove was that these great towns in South Lancashire had, as far as possible, done their duty to the public in reference to the supply of electricity. For instance, powers were given to Manchester in 1890 to supply an area of 20 square miles. They were supplying a district of 36 square miles, and he hoped to be able to show the committee that 36 square miles, or a radius of something like 10 miles, was the limit at which electricity could be cheaply supplied. The average price the Manchester Corporation supplied at was 3·33d. per unit and for power 1¼d. per unit. Liverpool, again, was supplying energy for lighting at 3·93d. For street-lighting Liverpool was charging 2·29d. and for tramways ·94d. The whole cost of production in Liverpool was a great deal less than the cost of the mains from the St. Helens generating station. The present scheme was a bad and unfair one. There was no place for this company, and he would ask the committee to reject the Bill.

Alderman HIGGINBOTTOM, chairman of the Electricity Committee of the Manchester Corporation, stated that a conference of Lancashire boroughs had been held to consider this Bill. The boroughs included Liverpool, Warrington, Widnes, Wigan, Southport, St. Helens, Bootle, and Chorley, and a unanimous resolution was passed that the Bill should be opposed. It was then the opinion of those present that the presence of such a company was not necessary in Lancashire, and that the promoters should not be entrusted with the great powers sought by the Bill. There were 27 boroughs in Lancashire, with a population of upwards of three millions and a ratable value of £14,000,000. These boroughs had already expended under provisional orders a sum of £2,136,000, and they had authorised a further expenditure of £2,100,000 in the extension of their electrical undertakings. Manchester alone contemplated an expenditure of £1,250,000 on electrical undertakings. The representatives of the boroughs strongly objected to the promoters having the power they sought to traverse the streets without the consent of the local authority. Any economy effected in the cost of coal carriage by the company would be more than absorbed by the enormous cost of laying the mains over the distances contemplated.

The committee then adjourned till Tuesday.

TUESDAY.

On Tuesday Alderman HIGGINBOTTOM was further examined, and stated that if the cables for the conveyance of the company's electricity were to go through their streets, their nature and the manner of their laying should be under the control of the local authorities. This was promised by Mr. Ritchie on the second reading of the Bill.

Mr. ARTHUR B. HOLMES, borough electrical engineer of

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Liverpool, was then called, and stated that Liverpool was strongly opposed to the Bill. It would inflict great damage and inconvenience, without conferring any public benefit. In his opinion the calculations of the promoters were not sound. He saw no provision in the estimates for the cost of the construction of transforming stations in the area of supply, or for the apparatus that would require to be fixed in these stations, and no provision for duplicating the mains. In his view the proposed load factor of 35 per cent. was purely imaginary, and could not be attained in practice. Electric supply mains were already laid in the principal streets of Liverpool, and they could not get a single wire down in certain of the streets owing to their crowded state. He thought that where compulsory powers were given to a company to lay mains the local authority should have power to supervise the laying of the mains. He did not think the proposals of the Bill satisfactory as regarded the customers. They did not provide that the supply of energy should be of the pressure or form that the consumers might require. The schedule of prices appeared to be too high. An authority applying to the company for a supply was required to give a guarantee to take a supply to the value of 20 per cent. on the cost, not only of the mains, but of everything except the generating plant.

Cross-examined, Mr. Holmes said the promoters could not possibly give the Corporation proper protection, as the Corporation wanted all the room in the streets for themselves. He did not know of any street in which the room would not be required by Liverpool for its own purposes. Questioned by the committee, he said the largest consumers of power in Liverpool were the printing establishments. The largest motor was 50 h.p. The expenditure for electrical purposes was approaching a million, and he thought that would suffice for the next two years, though in future this expenditure might be doubled. So long as this expenditure brought a proper return and supplied a public want he saw no reason why it should be limited. He was not afraid that the progress of improvement might lead to a large loss by plant becoming obsolete. Further questioned, witness said that at present they supplied 800 h.p. for power. If they were called upon to supply the docks with mechanical power, it would amount to several thousand horse-power.

The committee then adjourned till Wednesday.

WEDNESDAY.

On Wednesday, Sir W. H. PREECE, late chief electrical engineer to the Post Office, was examined by Mr. Lewis Coward on behalf of the opposing corporations, and expressed the opinion that the electrical industry was on a sound and well-controlled basis, that the public were well served, and that they got cheap lighting. He knew the industry was well developed in Lancashire, as he had been consulted a good deal in connection with works in that county. He was one of the original engineers consulted by Manchester. His firm was now lighting Warrington, and he was joint engineer for the development of tramways in South Lancashire. The Liverpool Overhead Railway, also one of the earliest undertakings of the kind in this country, was also worked with great success. He was also engaged in other electric work in Lancashire. Generally the use of electrical energy at Liverpool would, he thought, compare with any other portion of the world. St. Helens, again, was a good illustration of this development, it being the first town in the country that had combined the working of the tramways with their electric lighting installation. The company would find most powerful competitors in South Lancashire, and private enterprise was also a big factor in the district.

In reply to other questions, Sir W. Preece said he thought the local authority ought to be consulted as to the route for laying the cables. He would not go so far as to say that no public advantage would be gained by the wholesale granting of wayleaves sought by this Bill, but he thought that the granting of wayleaves should be given with very careful consideration, and that a company like the present one should not be afforded powers which had not been granted to the Postmaster-General and refused to every licensee of the Postmaster-General. To distribute electricity at a distance of more than 20 miles from the generating station would not, in his opinion, be economical. The company's stations were not in the right places.

Cross-examined by Mr. Pollock, Q.C. (for the promoters), he stated that it was true to say that if Widnes had been dependent on municipal enterprise, it would at the present moment be without electric lighting altogether. There was a great difference of opinion amongst engineers as to whether it was better to lay the mains on the solid or the "draw-in" system. That was a question in which he thought the Board of Trade might have the final voice.

Questioned by the Chairman, he said he adhered to his opinion that the development of electrical energy for power purposes in England was far advanced. He knew that Lord Kelvin had expressed a distinctly opposite opinion, but he did not think Lord Kelvin had had as good opportunities of judging as he had.

In answer to the committee, Sir W. Preece said if the municipalities were properly protected in the matter of wayleaves they would not object to the Bill. All they said was that they were distributing power better in their own area than anyone else could, and why admit outsiders to come and interfere? Power of this kind was very much needed in certain parts of the country, but not so much in this part as in others. He advocated the Bill passing, subject to provisions safeguarding certain interests. He considered 10 miles the limit of economic distribution underground.

Major CARDEW, late electrical adviser to the Board of Trade, said he thought the municipalities should direct the route a cable should take and be themselves able to lay the cable. There should be some date after which unexercised powers should be revoked or should lapse.

The TOWN CLERK OF ACCRINGTON (Mr. Aitken) also gave evidence on behalf of the Corporation against the Bill.

The TOWN CLERK OF SALFORD (Mr. Evans) stated that the Bill had been carefully considered by the Parliamentary Committee, and they objected to its provisions on several grounds, especially to the power the company would have of interfering with the streets.

Alderman Sir BOSDIN LEECH, of the Manchester Waterworks Committee, stated that there already was considerable difficulty in laying mains owing to the congested condition of the roads. If the proposed company were to supply these districts with electricity, the difficulties already experienced would be greatly increased.

Mr. T. DE COURCY MEADE, city surveyor of Manchester, explained the crowded conditions of the streets in Manchester in regard to pipes and mains, and the objections there were to the interference of any outside authority. The National Telephone Company, who had made an arrangement with the Corporation for underground wires, had allowed the Corporation to carry out the work. The Corporation themselves had very great difficulty in finding any more room for mains and pipes, and to allow the mains of this company to pass through their streets merely for the purpose of supplying some other district with electricity was, in his opinion, very objectionable.

Mr. T. GEE (Mayor of Wigan) gave similar evidence with regard to the streets of that town.

The committee again adjourned until Thursday.

THE ENGLISH ELECTRIC MANUFACTURING COMPANY'S WORKS.

AN OBJECT LESSON.

It is a long cry from London to Preston, yet the lesson to be learnt is quite worth the journey. To those who cannot take the journey, or who cannot find time to read the lesson, we may try to make it clear, although

> "Another's tongue is rough and overfree;
> Let's call it bluntness and sincerity."

Quite recently the *Times*, in a series of articles on American competition, has been telling some pretty plain truths in an able manner, and in a way that is calculated to do a considerable amount of good. It may be that English business men are not so wholly ignorant of what the *Times* has told. It may even prove that the sketch is a little

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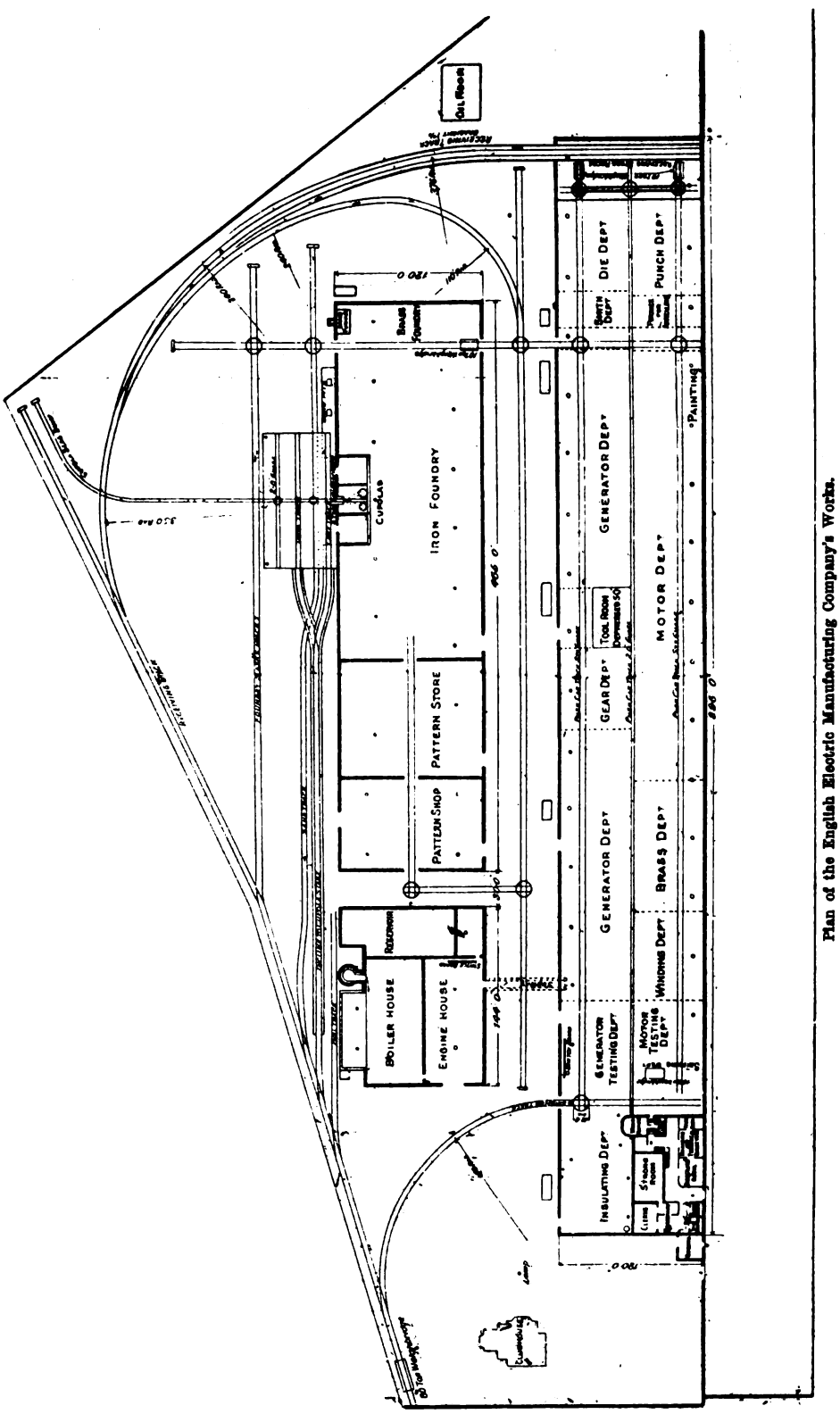
highly coloured, and that the nation is not quite so bad as has in these articles been painted. Assume, however, for the moment that it has lost caste as a nation of shopkeepers, and all that is said to its detriment is true; assume that nothing but a total change of method will revive decaying industry, even then we imagine a visit to these works will go far to prove that the new leaf has been turned, and that the old dog will wag his tail again.

Mr. Skelton, in his paper read before the British Iron Trade Association, tells us that the American is never satisfied till he can get a machine to do the work in hand. The *Times* writer tells us the same thing in different words. Both place a high value upon the extensive use of machinery, especially upon the best types and of the most modern design. Antiquated machines are of little more value than manual labour with the old tools of last century.

Of course, there is nothing new in all this. The writers on political economy long ago told us this and much more, but then the warnings or the suggestions of economists have always fallen flat, probably because, in the first place, there was a large amount of chaff among the wheat, and, in the second place, the time was not ripe to give effect to some, even, of the good suggestions. Be that as it may, undoubtedly America, where every man wants to boss a machine, gave the idea which has resulted in the erection and equipment of the English Electric Manufacturing Company's Works. Tramway work was in the air. A vast development was foreseen. America has taken the lead in this class of work, but English capitalists were not too proud to learn, and to adopt. Limitations of space must excuse us from further comment, and we therefore proceed to a description of the works which we visited last week, and, in a measure, assisted to inaugurate.



Plan of the English Electric Manufacturing Company's Works.

A significant indication of the field which has been waiting for a manufacturing organisation of this kind is found in the fact that these new works start with orders in

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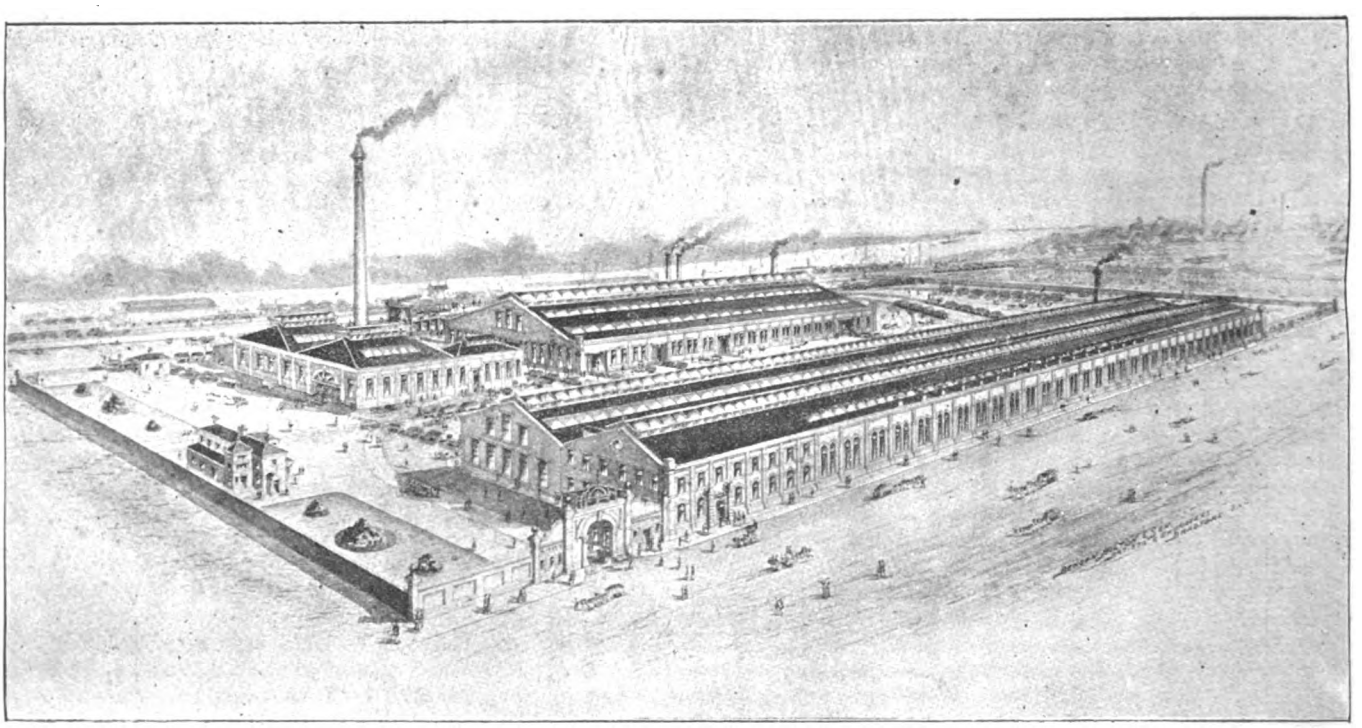
hand which will tax their capacity, large as it is, for close upon a year to come. We propose before entering upon a description in detail of the works themselves to mention briefly the circumstances under which this most important undertaking has come into being, and the reasons which led to the selection of Preston as the site for the new works.

Organisation.—Less than two years ago certain gentlemen closely connected with traction undertakings, foreseeing the extent to which the demand for tramway rolling-stock was likely to exceed the supply from existing shops in this country, even when augmented with American importations, organised the Electric Railway and Tramway Carriage Works, Limited, at Preston, and erected on an excellent available site of 14 acres on the Strand road, near the docks at Preston, a large and thoroughly well-equipped plant for the manufacture of car bodies and trucks. These shops, the equipment and management of which were placed in the hands of the most experienced and competent tramcar builders which could be obtained in America, have been entirely successful both in the quality of their output and in the volume and satisfactory nature of the business done. A number of the shareholders in this undertaking were equally desirous of embarking in the collateral but much more important work of manufacturing the electrical portion of the equipment required for traction work. At the same time it was perfectly realised that to meet the competition of the enormous American electric shops, with their long experience and excellent equipment for the work, it would be necessary to proceed on precisely similar lines to those which had given our Transatlantic competitors their predominate position in this branch of manufacturing. Manifestly, to obtain this result, the first step was to secure the co operation of an American engineer and designer of the first rank, who could supply the manufacturing and engineering experience, unobtainable in this country, which would be essential to the success of the enterprise. It was precisely at this juncture that in the course of one of the periodical manias for amalgamation which take possession of our American cousins, the Walker Company, the third of the three great electrical organisations in America, was "consolidated" with one of its rivals, thus practically completing the formation of the great electrical "pool" which controls the industry in that country. The hands of Mr. S. H. Short, the managing director and technical head of the Walker organisation, whose brilliant work dating from the beginnings of electric traction in America in 1885 is well known, were thus left free to carry out a long-considered project of contributing to the further development of the industry on this side of the Atlantic. At a meeting between Mr. Short and some of the future shareholders of the English Electric Manufacturing Company, Limited, an arrangement was made by which the new company was to commence operations on a large plant for the manufacture of electric traction apparatus from his designs and under his patents, and at the same time that he was to join the Board as technical director to design the manufacturing plant and take full charge of its engineering and manufacturing organisation. At the end of May, 1899, all the plans for the works had been completed, and orders placed for the most complete equipment of tools and machinery which money could buy or experience suggest for the purpose. On June 14 (just one year from the opening of the finished works) excavation for foundations was commenced, and since that time the work has proceeded without a moment's delay.

Site.—For the site of the new works the company secured over 12 acres of level ground situated between the Strand-road and the Preston Corporation Docks on the River Ribble, the factories of the Electric Railway and Tramway Carriage Works being situated immediately across the street. The selection of Preston as the site for the works was finally arrived at after a careful consideration of the relative advantages offered by different localities. Situated in Lancashire, and, therefore, in immediate contact with the great producing centres for coal, iron, and other raw materials required, it possesses exceptionally good facilities for the finished product of the works. It is centrally situated with respect to the home market, with two great railway systems radiating in every direction, and at the same time in a position where advantage can be taken of the proximity of the great port of Liverpool for export trade to the Colonies and abroad. Another and most important reason for the establishment of the works at Preston was the fact that a suitable site could be obtained alongside the Electric Railway and Tramway Carriage Works. The tramcars and trucks manufactured at these works are, therefore, ready to receive the motors and electrical equipments from the shops of the Electric Manufacturing Company, with the advantage of enabling the joint product to be completely equipped and tested before leaving the works.



View of the English Electric Manufacturing Company's Works.

Buildings.—Of the 12 acres of land embraced in the company's manufacturing site, about five acres are under roof. The buildings, which, in accordance with the practice of to-day, are one storey high throughout, except in the offices, are laid out on the lines of the most modern

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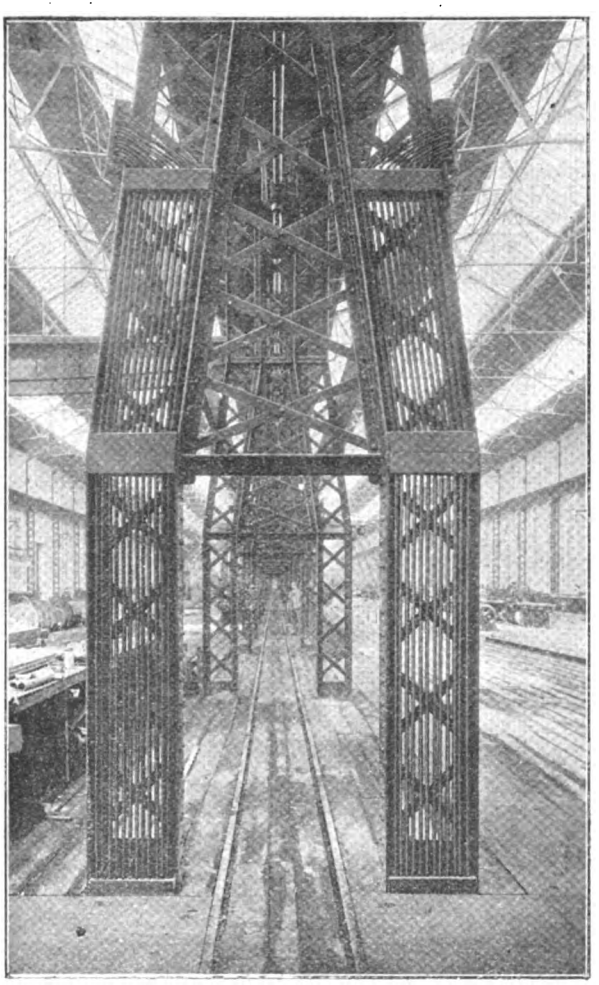
American engineering works, a steel frame being first erected to carry the cranes and roof structure, and the sides and ends independently walled in. The foundations for the steel stanchions for the buildings themselves and for the machinery in the works are much more solid and massive than is usual for work of this kind. The principal buildings are three in number—the machine shop with the offices, the foundry with pattern and pattern storage shops, and the power-house. Before entering in detail into a description of the equipment of the works and the method in which the various operations in the manufacture of traction machinery are carried out, it is essential that we should note the facilities which are provided for receiving, shipping, and handling material.

Receiving and Shipping Tracks.—By a reference to the general plan it will be noted that all incoming and outgoing goods pass in at the railway entrance over an 80-ton weighbridge. The tracks diverging from the weighbridge are, taken in order, first, the machine-shop track over which



Centre Stanchions, showing Line Shaft.

all goods are shipped out; second, the fuel track; third, the inclined track to the elevated foundry cupola staging; fourth, the sand track; fifth, the foundry flask track, which can be used for storage or relief; and finally, the receiving track, on which will be noticed a blind spur for the storage of wagons. Following round the large curve of the receiving track, it will be noticed that it enters the receiving store-room at the rear end of the machine shop, the track at this end being depressed so as to bring the truck platforms level with the machine-shop floors. For the handling of wagons within the yards, as well as to the railway connection, and into the yards of the Electric Railway and Tramway Carriage Works, electric locomotives are provided. The works are connected by sidings with the Lancashire and Yorkshire Railway, the London and North-Western Railway, and the Preston Corporation Docks.

Machine Shop.—The largest and most important of the buildings making up the works is, of course, the machine shop, which is in itself a structure of imposing dimensions, 900ft. in length by 125ft. wide, 35ft. high in the clear, and with 25ft. headroom under the cranes. Throughout the centre of this building, from end to end, passes a line of double lattice-work stanchions, which perform the triple function of supporting the roof, the crane girders, and the line shafting. In the general arrangement of the works, and especially in the detailed plans of the machine shop, it has been Mr. Short's chief object to avoid wherever possible the handling and rehandling of the various parts of the apparatus during the processes of manufacture. Raw materials delivered at one end of the main building pass through the successive operations, always moving in one direction, and emerge at the other end as finished and tested apparatus ready for loading upon the railway trucks waiting to receive it for transportation to any part of the country. Exceptional attention has been paid to the matter of facilitating the progress of the material through the shops by means of powerful high-speed electric cranes supplemented by pneumatic hoists and tracks in every building. Each of the four motor cranes used in the works is arranged to be provided with lifting magnets, in order that all suitable materials and parts of apparatus made of iron or steel may be picked up and carried to any part of the shop without other manipulation than that of the operator handling the crane. By means of jib cranes and pneumatic hoists, the men operating machines will be able to lift into their tools pieces weighing from one to two tons each. Down each bay of the shop is laid a push-car track with an additional track in the centre of the shop running between the stanchions which support the countershafts, cranes, and roofs. It will thus be seen that in addition to the four large cranes provided in the machine shop there are three tracks running its full length, thus giving seven methods of handling material up and down the shop. To facilitate communication between the various parts of the works a telephone system is provided extending from the offices to all departments. Compressed air at 100lb. pressure is distributed to every part of the works and used in the operation of pneumatic drills, hammers, etc., as well as for operating the pneumatic hoists. The whole machinery throughout the works is, of course, operated by electric power from the generating station, which will be described later on. The limits to which the principle of sub-division of power into small units could be advantageously extended has been most carefully considered. The resulting arrangement, in so far as the machine shop is concerned, represents entirely new practice, and is worthy of being described in some detail. As has been stated, a sectional line shaft extending the full length of the machine shop is supported from the line of centre stanchions between the two main bays of the shop. The sections of this shaft are driven by individual 50-h.p. motors direct connected to them by means of a quill shaft and clutch. The 800ft of shaft is divided into eight of these sections with their motors; any section of the shafting can be driven by its own motor, or the whole can be driven by any one or more motors. All of the machine tools used in both bays of the shop are thus driven from the one line shaft except in the case of the larger tools, where individual motors are provided. The machine shop is divided into two enormous bays, one on either side of the centre stanchions. One of these bays will be devoted entirely to the manufacture of traction motors and details of equipment, while the other will be used for the production of heavier machines, such as large dynamos, alternators, rotary transformers, etc. In order to obtain a clear idea of the machine tool equipment of the shops and of the operations which are carried on, the simplest method will probably be to follow the incoming raw material through the various departments through which it passes up to the point of shipment as finished apparatus. The following is a list of these departments proceeding from the south end of the building: receiving and store room, die department, punch department, smith department, annealing department, painting department, motor machine department, brass department, field-winding department, motor-testing department, generator department, toolroom, gear department, generator-testing department, insulating and armature department, and winding department. At the north end of the shop are the receiving and store rooms, into which the receiving truck passes. These rooms are fitted with divisions and bins

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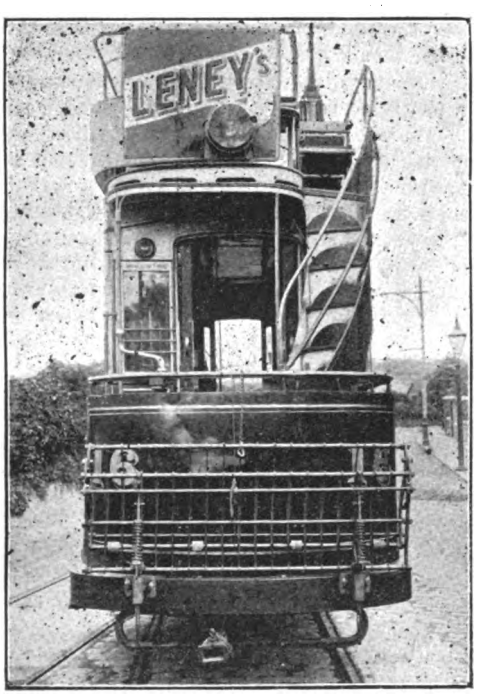
for the reception of the various materials to be used in the manufacture of apparatus. The electric cranes in the two bays unload the materials from the railway trucks and distribute them to the various parts of the storeroom. From this storeroom the materials are distributed to the various departments of the works as required. The first group of tools after leaving the storeroom constitute the punch and die departments, in which the steel discs required for building-up armatures, field-magnet cores, etc., are punched with dies into the required shapes. The machinery used in this department is of the latest pattern and automatic throughout. Immediately convenient to the punch and die department is a completely equipped smiths' shop with power-driven hammers, etc., for shaping the steel from which the dies are made. The delicate process of tempering the dies after completion is also carried on at these forges. This die department is fitted with a full equipment of standard lathes, shapers, and drill pressers.

(To be continued.)

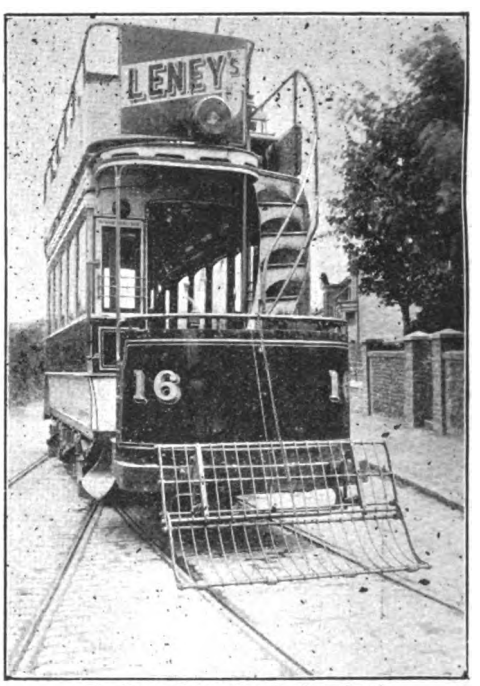
THE DOVER SAFETY CAR FENDER.

In visiting Preston to be present at the opening ceremony of the English Electric Manufacturing Company's works, we naturally visited the large carriage works running parallel to the new works on the opposite side of the road, and under nearly the same directorate. In our issue of May 4 we illustrated a tramcar of the type being largely used at Liverpool, and on the works we saw some cars which will no doubt finish the large order that was obtained for this town, besides a considerable number of other cars in the course of construction, and, in fact, the works were crammed throughout with cars under construction. We were greatly interested, however, in a detail in car construction which comes from Dover. A good many accidents have occurred both in this country and in America, and a variety of car fenders have been designed to avoid fatal injuries. The latest of these has been designed by Mr. H. Stilgoe, the Dover engineer. We give two illustrations of this fender as fixed to the machines, in one case the fender being open, and in the other case folded. It has been designed primarily to protect persons and animals, when knocked down by a tramcar, from being run over or struck by the buffer, drawbar, step, or undergear of the car; to act automatically, to fold, and thereby enable the drawbar to be used, and to economise road space.

On referring to the illustrations it will be seen that the fender is made in two sections, and is so jointed that the lower section only may be folded for trailing, or both sections may be folded against the dashboard—but not touching it—as shown by the illustration. When completely folded, the fender projects only 8in. from the dashboard of the car. The sections are strongly but lightly made of malleable cast iron or wrought sides, with wrought-iron vertical and transverse bars; these are held by two "main ribs," which are pivoted to two supports which fit into cast holders bolted to the beams or angle-iron buffer of the car, as may be best suited to the construction of the same. In the open position the lower section is about 3in. from the track. If a body comes in contact with the lower section it is immediately lowered to the ground, the weight of the body compressing the spiral springs on the saw-tooth links pivoted to the main ribs. The links are held firmly in position by the pawls, which engage in the saw-teeth of the links, and absolutely lock the fender in its lowered position, so that it cannot possibly mount over and mangle the body in contact with it. Moreover, the impact to the body is reduced to a minimum by the spiral springs, which in the ordinary way only act against the weight of the fender. This fender is automatic in its action, and does not require the car driver to use one of the members of his body, which are already sufficiently occupied in operating the controller handle, emergency brake, hand brake, foot-bell, sanding gear, or even his head—which he sometimes loses! It can be folded instantly to enable cars to be coupled together by the drawbars or other device. The extreme projection is only 2ft. 7in. in front of the dashboard, and does not therefore form an element of danger in that respect, nor is it too great for passing round sharp curves. The sections are detachable by removing bolts in the main ribs, so that another section can be fitted if the car has been in collision. It is detachably connected and easily lifted from the holders, so that it can be transferred from one end of the car to the other, or a new one fitted in a moment if necessary. It does not interfere with the working of the sanding gear, drawbar, foot-bell, or any part of any class of car. Every part of the fender is interchangeable, and made to a standard. For use on roads where a steep gradient meets the level, the driver can raise the catches of the lower section, and lift it so as to clear the track at the point of junction. For this purpose a light chain is provided, which also serves to secure the fender in a vertical position when folded up. Its use shows that it answers every requirement, and is suited to British tramway practice. It is in use at Dover, and has been very favourably commented upon by the various deputations which have inspected the electric tramways of that town. The fender is the property of the Dover Safety Car Fender Company, and is manufactured by Messrs. Dick, Kerr, and Co., Limited, of 110, Cannon-street, London, E.C.



The Dover Safety Car Fender—Closed.



The Dover Safety Car Fender—Open.

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QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

261. I have a motor installation working at 100 volts. My engines and generators will only give me 200 e.h.p. The usual power absorbed by the motors is 150 h.p., but at times I shall require 250 h.p. Is it possible to arrange a set of accumulators so as to be charged at light loads, and yet automatically run in parallel with the generators at heavy load? If so, state the arrangements necessary.—F. J. A. M.

262. What are the most important considerations to be observed when designing the ordinary condensing plant for a condensing engine in order that a good vacuum may be obtained in the low-pressure cylinder?—E. W. T.

ANSWERS.

Question No. 275.—Describe a good form of artificial load suitable for a six hours' full-load test of a steam dynamo or alternator.

Best Answer to No. 275 (*awarded* 10*s.*).—The ordinary water resistance is probably the most usual form of artificial load used for full-load tests of large generators. Being non-inductive, it is equally suitable for testing alternators or continuous-current machines. If properly constructed the apparatus is easily adjustable, and, provided it is handled with ordinary care, entirely satisfactory results may be obtained with it. A water resistance as usually constructed consists of two iron plates partly immersed in water, one being connected to the positive lead and the other to the negative, and either or both plates adjustable so as to vary the extent of the immersion. The method of lifting the plates, of course, depends upon conditions, size of plates, etc. As a rule a block and fall is very convenient and cheap, and the ropes themselves form satisfactory insulators. The tank should preferably be of wood, say 4ft. by 4ft. by 6ft., the electrodes being large enough to give about 5in. in the clear when suspended in the tank. The solution may be either of salt or sulphate of soda. The salt solution, however, is not suitable for accurate work, owing to the chlorine gas set free in the decomposition of the solution rapidly corroding the electrodes and forming a heavy scum of a comparatively low specific resistance, which, gradually accumulating on the surface, rapidly diminishes the ohmic resistance between the electrodes. It also has the further disadvantage that its increase of conductivity with rise of temperature is considerable. It is, therefore, much better to use a solution of sodium sulphate, which is free from these disadvantages.

A water resistance of the size above mentioned is easily capable of dealing with a load of 150 kw. for six hours or more without boiling. By providing a suitable circulation of the electrolyte, with the necessary overflow arrangements, the apparatus can be made to handle four times this amount. In making smaller resistances barrels are frequently used, but if a solution of sulphate of soda is employed, the barrels must be free from traces of oil, otherwise foaming will take place, owing probably to the oil saponifying with the soda. A 60-gallon barrel, with cylindrical electrodes arranged concentrically, will easily handle 50 kw. for any length of time. Water resistances can be used for artificial loads at voltages up to 2,500, but it then becomes necessary to provide arrangements for circulating the solution through the tanks, and the tanks must also be mounted on insulators. All circulating pipes must be of rubber, as, of course, the electrolyte would be connected to earth if metal pipes were used.—T. F. T.

Answer to No. 275 (*awarded* 5*s.*).—The most economical load for use when testing a dynamo would be to use the current in motors for driving the various shops, and this method would also be very convenient and desirable, as the load could at will be varied if required to test the compounding and variation in the angle of lead at various loads. Unfortunately, this method can only be adopted under rare conditions. One of two conditions must obtain: either the builders must have in stock motors of the voltage of the machine to be tested, and also in the aggregate equal to the output of the dynamo, or else there must be means of altering the voltage to the voltage requisite for the motors.

If it is not practicable to test with the above "economical" load, several methods are open for adoption, two of which, running on lamps and running on an electric furnace, may be dismissed without notice as being either expensive or impossible; the problem then narrows itself to the use of wire or water as the resistance for the absorption of the electrical power. The writer would strongly advise the water resistance as more easy of manipulation, especially when a variable load is required. Suppose the dynamo has been specified to give y amperes at x volts with a definite speed, it is an easy thing to arrange a wire resistance, which will be all that is required when the machine is started; but as soon as the wire warms up the resistance will increase, and new lengths must be put in in parallel, or else a length or two in series cut out, and whatever form of switch is used it is difficult to get the exact result required and keep a constant load. This difficulty is increased if the machine has to give x volts on open circuit and $x+a$ volts on full load.

With a water resistance the load is altered by moving the plates closer or further apart, or by altering the level of the electrolyte, and accurate results can always be obtained. The writer made a rough but useful testing bank as follows: He first got a watertight wooden box, 6ft. long, 3ft. wide, and 2ft. deep. To one of the long sides an iron sheet was securely screwed, to which one of the main leads was attached. The other lead was fixed to a movable iron plate. This second plate was carried by a long wooden spear in cross-section 3in. by 2in., which rested on the short sides of the tank and overhung them by 18in. on each side to enable it to be readily shifted. In order to prevent any chance of a short-circuit, the inner edges of the plates had a wood moulding 1in. deep run round. A wooden tap was inserted at the bottom of the tank to allow of the electrolyte being run off, while water could be added through a rubber pipe affixed to the nearest water-tap. The electrolyte consisted of water and soda. The writer found that while salt and water made a more conducting fluid, the iron plates rapidly furred, when the resistance would increase; while with common washing soda in place of salt the plates kept remarkably clean and the conductivity constant. With such a contrivance the load could be kept absolutely constant or varied at will. The water gets hot and finally boils during long tests, but this can be remedied by allowing a constant flow through the tank, regulating the inlet and outlet to the same amount, and keeping the solution always saturated by occasionally adding more soda.—M.

Question No. 276.—I have frequently noticed that with three or four alternators running in parallel, all on the governors, an inclination to pull out of step can often be cured by considerably overexciting the field of one of them. What is the full explanation of this?

Best Answer to No. 276 (*awarded* 10*s.*).—The inclination of alternators to pull out of step, indicated by a large amount of synchronising current, shows, on the one hand, that the driving forces of the engines are varying relatively to one another from moment to moment, and, on the other, that no one machine is electrically strong enough to keep the "lead" over the other machines, and thereby break down the surge of the current. By strengthening the field

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of any one machine, one increases the tendency of that machine to maintain a higher voltage at its terminals. Whatever, then, the momentary variation of driving power (within ordinary limits) may be, this machine's terminal voltage will never tend to fall below the 'bus-bar volts, and consequently this alternator will never be motored by the other machines. Not only so, but there will be a constant tendency for current to flow back to the other machines, motoring them quickly, and so preventing any great changes of speed such as cause machines to go out of step.

The practical effect of over-exciting an alternator field is that this machine takes over a large proportion of the load. Any variation in the speeds of the other machines merely involves an equally rapid shifting of load on to or off the over-excited machine, which looks on the ammeters like the passing of a synchronising current. It will be found, however, on adding up the currents of the machines at any moment, that the sum is practically identical with the sum of the currents shown on the feeder ammeters, whereas with a synchronising action the sum of currents indicated on the machines is greater than that on the feeders. An additional advantage may sometimes be accidentally obtained by loading up a machine in this way. The best load for the governors may be obtained, ensuring steady running of the engine doing the most work. It must not be forgotten that if the alternator field core is designed to be worked near its point of magnetic saturation, this method of overcoming surging currents caused by tendency to go out of step will not be so successful, as in order to strengthen the field much, the current would be such as to dangerously overheat the field windings.—J. A. S.

Answer to No. 276 (*awarded* 5*s.*).—If a governor satisfactorily performs its work when controlling an engine which is coupled to an alternator in parallel with others, it is good enough for anything. Not only does it need to be particularly regular in its action, but the wearing surfaces must be made of the very best material, for there is apparently a continual striving on the part of each to get ahead of the other, and this keeps the moving parts in a state of perpetual quiver. Particularly is this the case when the periodicity of the plant is high. When a governor has been in use in an alternating plant for some time it naturally wears somewhat, and it will be found that in some cases there is one certain position in which it runs particularly unsteadily, causing the whole plant to surge in consequence. Now, if, when the machines are surging from this cause, the field of one of them is raised considerably out of proportion to the others, what happens? One result will be that a certain wattless current will flow, making the apparent load, as shown by the "machine ammeters," greater than is really the case. Another result will be that the additional resistance to the motion of the armature of the machine, caused by the extra field, will cause that machine to drop some of its true load (which, owing to the wattless current passing, may not be shown on the ammeter), and this load, dropped, will be picked up by the other alternators. To do this, the governors of all the machines will open out slightly; and it may be that this will be sufficient to cause the faulty one to get out of its unsteady position. This may cause the machines to settle down. Generally speaking, however, a disproportion in the fields, instead of doing away with, will cause surging.

W. G. M.

LONDON COUNTY TRAMWAYS BILL.

The Select Committee of the House of Commons presided over by Mr. W. H. Holland on Tuesday considered the London County Tramways (No. 1) Bill, promoted by the London County Council for the purpose of authorising 11 extensions of the existing tramways in the hands of the Council on the northern side of the Thames; and on the southern side of the river the doubling of the existing line of tramway along Nine Elms-lane, and the erection of a generating station at Camberwell for the purpose of working by electrical traction the tramways running from Westminster and Blackfriars Bridge to Tooting. The Bill was opposed by several authorities, the omnibus companies, the North Metropolitan Tramways Company, the North London Railway Company, and some private house owners.

Mr. Du Cane, in opening for the Bill, said the proposed new tramways or junction lines were confined to the northern side of the Thames, the widenings were both on the south and north, and the electrical equipment sought to be authorised by the Bill was on the south. In the county of London there were 115 miles of tramways, of which the Council owned 48 miles on the north of river and 24½ miles on the south. The northern tramways were worked under lease by the North Metropolitan Tramways Company, which paid a rent to the Council, with an additional payment if the profits increased beyond a certain amount. In the south the 24½ miles were worked by the Council themselves. It had now been determined to apply electric traction to the Council's tramways, and they sought by this Bill and another that had already passed the House to equip a system of tramways for electrical traction. Most of the extensions now proposed had been suggested to the Council by the district authorities, and, with two exceptions, they were unopposed.

The Bill was also opposed by the London General Omnibus Company, who claimed to represent the omnibus interest of the county of London.

Mr. J. W. Benn, chairman of the Highways Committee of the London County Council, examined by Mr. Freeman, Q.C., said the Council, which was the purchasing authority, had found the tramways of London in a state of great confusion, and were endeavouring to bring the whole system into order. The Council had exercised its powers of purchase as opportunity had occurred, and the Council would in three years' time own the tramways of the Metropolis. At present breaks existed between different lines, and the object of the Bill was to fill up those breaks so that a passenger might travel right through from point to point. If the tramways were to be worked economically these junction lines were absolutely necessary.

The committee then adjourned.

PORTSMOUTH ELECTRICITY WORKS.

From the accounts of the Portsmouth Corporation electricity works for the year ended March 31, 1900, it appears that the total expenditure on capital account to date amounts to £161,053. The revenue account, general balance-sheet, and statement of electricity generated, sold, etc., are given herewith:

Revenue Account.

Dr.			£	s.	d.
Generation of Electricity.					
Coal or other fuel	£5,615	12 8			
Oil, waste, water, and stores	855	19 5			
Wages at generating station	1,102	15 9			
Repairs and maintenance—Buildings	57	10 5			
Engines, dynamos, and other machinery	1,144	19 9			
	8,776	18 0			
Less received for old material	34	13 4			
			8,742	4	8
Distribution of Electricity.					
Repairs, maintenance, and renewals of mains	162	0 5			
Repairs, etc., of transformers, meters, etc.	694	10 7			
Cost of materials and lamps sold	119	16 7			
			976	7	7
Public Lamps.					
Attending and repairs	1,150	19 2			
Renewal of lamps	252	9 5			
			1,403	8	7
Rents, Rates, and Taxes.					
Rents payable	19	5 1			
Rates and taxes	468	15 1			
			488	0	2
Management Expenses.					
Salaries—Engineer's department	916	16 10			
Accountant and clerical staff	291	12 10			
Salary of collector	125	11 8			
Stationery and printing	70	17 10			
General establishment charges	128	15 2			
			1,533	14	4
Law and parliamentary charges			125	14	9
Special Charges.					
Insurances	29	10 9			
Interest on overdraft	159	18 0			
Auditors' fees	21	0 0			
			210	8	9
Total expenditure			13,479	18	10
Amount carried to net revenue account			10,463	10	7
Balance to next account to provide for bad debts			47	11	5
			£23,991	0	10

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Cr.	£	s.	d.
Balance from last account, £64. 16s. 10d.; less bad debts written off, £25. 7s. 9d.	39	9	1
Sale of current at 4½d. per B.T.U., £18,110. 7s. 6d.; less allowances, £17. 13s. 1d.	18,092	14	5
Sale under contract	84	0	0
Public lighting	4,798	9	1
Rental of meters and other apparatus	776	16	6
Sale and repair of lamps, arc or incandescent	50	1	1
Sale and repairs of other apparatus	88	13	1
Rents receivable	8	10	0
Part fees from pupils	34	1	4
Charging accumulators	8	16	3
Sale of ashes	9	10	0
	£23,991	0	10

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	159,975	0	0
Sundry creditors	1,912	6	3
Reserve fund account, balance at credit thereof	2,725	0	0
Revenue account, balance at credit thereof	47	11	5
Amount due to treasurer on revenue account	5,060	2	2
Amount due to treasurer on capital account	1,078	12	1
Amounts deposited	204	0	0
	£171,002	11	11

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	161,053	12	1
Stores on hand: Coal	396	8	0
Oils, waste, etc.	203	18	9
General	307	9	3
Lamps	95	6	4
Motors	884	19	6
Sundry debtors for current supplied	8,026	10	11
Other debtors	34	7	1
	£171,002	11	11

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		1,699,540
Quantity sold: Public lamps	419,256	
Quantity sold: By contract	1,784	
Quantity sold: Private consumers by meter	972,051	1,393,091
Quantity used on works		38 426
Quantity used for magnetising current		168,906
Quantity used for motor-generators		36 291
Total quantity accounted for		1,636 714
Quantity not accounted for		62,826
Total maximum supply demanded—kilowatts		1,319

Number of public lamps: 264 arcs, 16 incandescents.

HAMMERSMITH VESTRY.

The following is the report of Mr. A. Ebbs (chairman of the Electricity and Lighting Committee) to the Vestry on the working of the electricity department for year 1899-1900:

In presenting the accounts of your electricity department for the year 1899-1900, I desire, as on a former occasion, to draw your attention to the more important features thereof, and to some which, while they duly appear in the accounts, are not so prominent as their importance perhaps demands, owing to these accounts being of necessity kept in the form prescribed by the Board of Trade. The capital expenditure has increased during the year from £72,425. 11s. 6d. to £104,498. 8s. 11d. The whole of this sum, with the exception of a temporary advance by the Vestry, has been raised by loan, and of it £3,686 has been repaid out of revenue. In other words, debentures have been redeemed to that extent. Much of the capital outlay above referred to has of course only lately been made. I have consulted the chairman of the Finance Committee and your accountant, and we are of opinion that £80,000 is a fair sum to regard as the average capital during the year. On this capital our profits, which have amounted to £5,894. 11s. 6d., would, if we were a joint-stock company, enable us to pay a dividend of 7 per cent. and carry forward a balance of £294. We have, however, to repay capital to the extent of £1,754 and interest £2,525. 6s. 10d., leaving £1,615. 4s. 8d., or almost exactly 2 per cent. net profit for the year after meeting all liabilities. This profit has been made notwithstanding the reduction of price which took effect last June, and may be said to have arisen entirely from increased business and economy in the working of the generating plant. As, however, a large proportion of the increased business is directly due to the decrease in price, I think it quite safe to say that the ratepayers as shareholders in the undertaking have suffered no real loss by reason of its having been made. The committee has been subjected during the year to somewhat severe criticism for having made a few bad debts, I desire, therefore, to call special attention to the following figures: our total sales have been invoiced at £13,835. 11s. 4d., which has been reduced by £96. 15s. 7d., or 13s. 10½d. per cent. in the adjustment of disputed accounts, and by £79. 9s. 4d., or 11s. 5d. per cent., as irrecoverable debts. We have, therefore, failed to collect only 1¼ per cent. of our invoiced sales, bad debts, strictly so called, amounting to only about ¼ per cent. The proportion to capital is: total sales, 17 per cent., 17·294; generation and distribution, 9·005; rates and taxes, 0·7; allowances, etc., 0·121; irrecoverable debts, 0·099; profit, 7·369 per cent. Personally I had hoped that we might this year have discontinued the use of the demand indicators and made a uniform charge for electricity. There is, however, some doubt whether this might not increase the demand upon the station plant without corresponding increase of revenue, and also some difficulty in suggesting a fair compensation to long-hour consumers, inasmuch as we cannot, of course, yet afford to reduce the price to 3d. per unit all round. We have also to consider the formation of a renewal fund, for the replacement of machinery, a purpose for which we cannot borrow again. Your committee is therefore of opinion that the most businesslike course will be to carry forward the balance of £2,325. 19s. 9d., without earmarking it in any way.

Revenue Account.

Dr. Generation of Electricity.	£	s.	d.	£	s.	d.
Coal, including carriage	£2,917	14	7			
Oil, waste, water, and engine-room stores	475	11	8			
Wages at generating station, £1,105. 12s. 7d.; repairs and maintenance of boilers and engines, £477. 8s. 5d.	1,583	1	0			
Repairs and maintenance: buildings, £25. 9s. 7d.; engines, boilers, £194. 6s. 9d.; machinery, etc., £9. 4s. 4d.	229	0	8			
				5,205	7	11
Distribution of Electricity.						
Wages to linesmen, fitters, etc.	92	17	0			
Repairs, renewals, etc., of mains	15	7	4			
Repairs of meters, switches, etc.	5	0	1			
Ditto, apparatus at distributing stations	8	5	11			
				121	10	4
Public Lamps.						
Wages of trimmers, etc.	341	7	10			
Carbons, arc lamps, etc.	342	8	0			
Renewal of lamps	48	1	4			
				731	17	2
Rates and taxes				560	2	8
Management Expenses.						
Engineers' salaries, proportion thereof	400	0	0			
Clerical staff	264	6	2			
Stationery and printing	71	14	6			
Advertisements	8	6	8			
General establishment charges	158	3	8			
				902	11	0
Law charges				68	14	4
Fire, boiler, and employers' liability insurance				174	11	6
				7,764	14	11
Balance to net revenue account				5,974	0	10
				£13,738	15	9

Cr. Sale of Current.—Private Lighting.	£	s.	d.
June quarter, 1899	1,864	19	4
September quarter, 1899	1,697	18	4
December quarter, 1899	3,442	7	9
March quarter, 1900	3,362	0	9
	10,367	6	2
Sales by contract	3	15	0
	10,371	1	2
Public Lighting.			
150 lamps at £22. 10s. per annum	3,375	0	0
Charges for attending private lamps	61	17	3
Work done, and sales of apparatus	10	15	5
Interest on outlay re machinery on hire	16	17	6
	13,835	11	4
Less allowances and adjustments in reading of meters, etc.	96	15	7
	£13,738	15	9

Balance Sheet.

Liabilities.		£	s.	d.
Capital account—London County Council mortgages		97,825	0	0
Temporary advance from loan account		3,017	8	11
Revenue account—interest and repayment of principal on mortgage debt, balance	£1,978 12 9			
Creditors on open accounts	1,439 0 4			
Deposits in hand re installations	98 4 0			
		3,515	17	1
Net revenue—balance as per preceding account	2,335 19 9			
Add surplus on capital account, being the amount of loans paid off out of revenue to March 25, 1899, and during year ending March 25, 1900	3,656 0 0			
		5,991	19	9
		£110,350	5	9

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Assets.	£	s.	d.
Capital account—amount expended for works	104,498	8	11
Revenue account—sundry debtors for current—viz., private consumers... £2,886 10 4			
Public lighting..... 843 15 0			
	3,730	5	4
Ditto on open accounts	274	16	11
Stores in hand	391	11	9
Cash at bankers—on revenue account.....	1,455	2	10
	£110,350	5	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in Board of Trade units		1,247,730
Quantity sold { Public lamps	271,223	
Quantity sold { By contract	150	891,301
Quantity sold { Private consumers by meter	619,928	
Quantity used on works		252 389
Total quantity accounted for.....		1,143 690
Quantity not accounted for.....		104,040
Number of public lamps		150
Total maximum supply demanded—kilowatts		700

The report of the engineer and manager (Mr. G. G. Boll), appended to the preceding report, is as follows:

The number of consumers has increased from 275, with 19,390 8-c.p. lamps, on March 25, 1899, to 464, taking a supply for 26,365 8-c.p. lamps. The average number of lamps per consumer, it will be noticed, have decreased from 70 to 56. This is mostly due to the number of small flats in the parish which are wired for electric lighting. The department has received £3,375 for lighting and maintaining the 150 arc lamps in the public streets. This is a reduction from 3¼d. per unit last year to 2·9d. per unit this year, and is accounted for by the increase in the candle-power of the incandescent lamps, which are used after 12.30 a.m., from 32 c.p. to 50 c.p. Sixty-three additional arc lamps have been added since my last report. With regard to the private lighting, the Vestry has sold 620,078 units, producing a revenue of £10,274. 5s. 7d., which works out at an average price of barely 4d. per unit. The average lighting hours of the lamps have been increased about 60 per annum, but owing to the reduction in our charges of practically ½d. per unit on the price obtained last year, our annual revenue per lamp has gone down from 10s. 10d. to 9s., a most satisfactory state of affairs for our consumers; the price paid by them for electricity being the lowest but one in the London district The total cost for the year of generation, distribution, etc., is £7,764. 14s. 11d., or 2·05 per unit, a decrease of nearly ½d. per unit on last year, being 56·5 per cent. of our revenue, which leaves a gross profit of £5,974. 0s. 10d., or 43·5 per cent. towards paying interest and sinking fund charges. The whole of the buildings, generating machinery, and distributing mains have been maintained in efficient working condition out of revenue. The result of the year's working shows a net profit of £1,615. 4s. 8d. after the deduction of interest and repayment of capital. Although the cost of production has decreased, I am afraid that these results may not be improved upon in the present year, owing to the greatly increased prices of fuel and other materials. With regard to the capacity of the generating station, the machinery now installed and in working condition will be able to supply a further 10,000 8-c.p. lamps after allowing an ample margin for reserve.

LEEDS CITY TRAMWAYS.

From a return just issued by the Tramways Department of the Leeds Corporation we extract the following information relating to the working of the electrical portion of the city tramways for the year ended March 25, 1900:

Total electric car receipts.....	£63,436	10	5	
Total mileage	1,205,812			miles
Receipts per mile.....				12 62d.
Working expenses				5·97d.

Analysis of Working Expenses.

					A
Drivers' wages	£5 657	8	7	1·12d.	
Conductors' wages	4,124	6	11	·82d.	
Generating station expenses	3,547	16	3	·75d.	
Battery station expenses	89	2	9	01d.	
Materials for repairs and car maintenance...	2,427	17	9	·48d.	
Wages of car washers and depôt men.....	3 284	13	2	·65d.	
Depreciation on motor and trailer cars	2,349	10	6	·46d.	
Electrical engineers' salaries	614	7	7	·12d.	
Road maintenance (proportion)	3 000	0	0	·60d.	
Compensation, damage, and personal injuries	630	15	3	·12d.	
Management and general expenses (as per detailed statement appended)	4,145	17	8	·82d.	
Office rents (proportion).....	73	14	11	·01d.	
Payments to army reservists' wives	51	2	2	·01d.	
Repairs to Kirkstall depôt (half)	44	9	10	·00d.	
Total expenses	£30,041	3	4	5·97d.*	
Cost of generating current, per Board of Trade unit				·82d.	

A. Expenses per mile. * This does not include interest on capital and sinking fund, or depreciation on electrical plant other than cars.

Total Miles Run by Electric and Trailer Cars.

Motors	1,052,444
Trailers.....	153,368
Total miles	1,205,812
The consumption of current per motorcar mile is	·917 units.
The consumption of current for each trailer car mile is	·458 units.

Details of Mileage.

Motorcars.....	1,052,444
Trailer cars (mileage taken as half)*.....	76,684
Total miles at ·917 units per mile	1,129,128

* Halve the trailer mileage and add to the motor mileage, and reckon the total at ·917 units per mile.

Total generating station expenses, £3,547. 16s. 3d. = ·75d. per mile.

Number of Units Generated.

Total units	1,095 231
Less supplied to arc lamps, shed lighting, etc.....	59,682
Total cost, £3,547. 16s. 3d.	1,035,549

LIGHT RAILWAYS.

An enquiry was held on June 14 by the Earl of Jersey and Colonel Boughey into the Warrington and Northwich light railway scheme. The eastern branch only was proceeded with, but though the scheme was strongly supported by councils, companies, traders, and residents all along the route it was dismissed on a legal point—viz, that no compulsory powers had been obtained to acquire land. It is the intention of the engineer to amend this point, and again present the scheme. The western branch still stands over, as the days of grace for objections had not elapsed before the date fixed for the enquiry.

Under the Mid-Anglian light railway scheme it is proposed to connect two lines promoted by this company last year by means of short junctions near South Lopham. At a meeting on Thursday of the General Committee, a number of alterations of route were also agreed to.

The Norfolk County Council have adopted a report of the county surveyor with regard to the Norwich and East Dereham light railway, in which he states that it is desirable to require the promoters to provide proper gates and wicket gates at level crossings, with a lodge for a gate opener, and that the surface of the road between the gates be properly paved.

At a meeting of the Aberdeen Town Council the matter of the proposed Echt and Skene light railway was referred to, and the matter was remitted to the special committee, with powers to take such steps as were necessary to find out what financial support they were likely to get and to obtain a proper survey. A conference afterwards took place between a deputation from the Aberdeen District Committee and the Tramways Committee of the Aberdeen Town Council on the subject of the proposed light railway. As to the question of whether the Town Council would be prepared to give facilities for the carriage of goods over the city tramway system, the Tramways Committee assured the deputation that every facility would be given for such carriage, subject to arrangement.

The question of a light railway from Garstang to Blackpool to bring the Fylde villages into more direct communication with the large towns, and which should effect the better disposal of farm produce, came before the Earl of Jersey, Colonel Boughey, and Mr. Henry Alan Steward (secretary), as the Light Railway Commissioners, at Preston on Friday last. There was a large attendance of persons from the rural portions of the Fylde district, while Blackpool was well represented. Mr. Balfour Browne, Q.C., and Mr. Sutton appeared for the promoters, and representatives appeared for the trustees of Messrs. Hodgson, the Lancashire and Yorkshire Railway Company, the London and North-Western Railway Company, the Blackpool Corporation, the Fylde Water Board, the Fylde and Garstang Rural District Councils, and various private persons. The commissioners had a consultation, and the Earl of Jersey said they considered a case had been made out. They were not prepared, however, to pass line No. 2, to Caunce-street, which would go through the streets over which the Blackpool Corporation had control, but were prepared to pass line No. 1 to the Gynn. It would be a great advantage if reasonable arrangements could be made for the transference of produce, etc., from the Hoo Hill crossing to the abattoir.

The United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, are proposing to take steps for a provisional order to be obtained for laying tramways in the Cheshire salt district. The trains will be run on the overhead principle. The engineer to the syndicate is Major Tulloch. A conference has been arranged between the representatives of the syndicate and of the Northwich Rural District Council, Northwich Urban District Council, Middlewich Urban District Council, and Winsford Urban District Council.

At a recent special meeting of the Burnley Town Council a resolution was agreed to that the Light Railway Commissioners be requested to confer upon the Council with respect to the Nelson light railways order, the Colne and Trawden light railways order, and the Barrowford light railways order respectively, authority to enter into agreements with the promoters to work or to contract for the working of these light railways.

The enquiry into the Oldham, Ashton, and Hyde light railways will be held to-day.

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LEGAL INTELLIGENCE.

TELEPHONE RENT.

At the Woolwich County Court on Wednesday the National Telephone Company sued Mr. Barnett, glass merchant, Beresford-square, Woolwich, to recover £3. 12s., a year's rent of telephone wire and instruments between defendant's two shops.

The plaintiff's case was that defendant signed a five years' agreement. He paid the first year's rent in advance, the second year's under an order of the County Court, and the third year's was now sued for. It should have been paid on Dec. 23, but as Mr. Barnett did not pay the company stopped the service.

The **Defendant** said he would have been glad to pay, but the instruments were useless.

The **Judge** said he could scarcely believe that the company would refuse to make the service effective, as it was their interest to please and satisfy their customers. As the company had had recourse to the extreme step of disconnecting the service, he did not think they could recover. He was not assured of the soundness of his decision, and would give the company leave to appeal. The plaintiffs, he held, had broken their contract, and he found for the defendant.—*Woolwich Gazette.*

NATIONAL TELEPHONE COMPANY v. CORPORATION OF TUNBRIDGE WELLS.

An application was made by the defendants on Monday in the Queen's Bench Division, before Justices Grantham and Channell, to prohibit the County Court judge at Tunbridge Wells from further proceeding with a plaint in the County Court, in which the Telephone Company were the plaintiffs and the Corporation were the defendants.

Mr. Justice Grantham said that when it was a Crown monopoly it was right there should be a judicial authority to arbitrate in any difference between the Crown and a local authority, but the moment the powers of the Crown were delegated to a private company the power of appeal to the judicial authority ceased. In these circumstances he thought the prohibition should go.

Mr. Justice Channell concurred, and the prohibition was thereupon granted, with costs.

ISLE OF MAN TRAMWAYS.

In the Manx Chancery Court, Robert Okell, a creditor, petitioned for the compulsory winding up of the Isle of Man Tramways and Electric Power Company, Limited, and the appointment of Mr. W. H. Walker, of Liverpool, as liquidator. As all directors have retired the company did not appear. A number of shareholders were represented by counsel and opposed the application. It was pointed out that a meeting of shareholders had been called, and an adjournment was asked for till the result of the meeting was known. The petition was adjourned.—*Financial Times.*

HUDDERSFIELD TELEPHONES.

On Wednesday before Mr. Justice Grantham and Mr. Justice Channell, sitting as a Divisional Court, the case of the Huddersfield Corporation *v.* the National Telephone Company came on for argument, for a report of which we are indebted to the *Bradford Observer.*

Mr. Macmorran, Q.C., appeared for the Corporation in support of an application for a writ of prohibition to the County Court judge of Huddersfield, to prohibit him from hearing an application which had been made to him by the National Telephone Company, under the Telegraph Act, 1878. The agreement between the parties seemed to be the same as that between the Telephone Company and the Tunbridge Wells Corporation, on which their Lordships had decided against the company on Monday last.

Mr. Cripps, Q.C., for the National Telephone Company, submitted that the agreement differed.

Mr. Justice Grantham said the agreement was just as strong against the company as the one which they had already determined.

Mr. Justice Channell thought it was even stronger, and the writ was granted.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

London, N.E. — The Electric Lighting Committee of the Hackney Vestry invite tenders for the supply of 220 arc lamp pillars. Tenders by July 11.

Edinburgh.—The Corporation invite tenders for the supply of copper strip for electric conductors. Tenders by July 9. Details in our advertisement columns.

Paris.—The Under-Secretary of Postal Telegraphs will receive tenders at Rue de Grenelle, No. 103, for 12 lots of paper-insulated cables on the 26th inst., at 11 a.m.

Manchester.—The Tramways Committee invite tenders for the overhead equipment of three routes of tramways. Tenders by June 30. Details in our advertisement columns.

St. Helens.—The Electric Supply and Tramways Committee invite tenders for the purchase of various plant at their Warrington-road works. Details in our advertisement columns.

Madrid.—The Secretary for Public Works invites tenders for the construction and working of an electric tramway from Puerto de Hierro to Aravaca and Pozuelo. Tenders by July 7.

Newcastle-upon-Tyne.—The New Tramways Committee invite tenders for (Contract No. 16) trolley wires and attachments. Tenders by 25th inst. Details in our advertisement columns.

Calzatada Calatrava (Spain).—The Municipal Authorities will receive tenders for the installation and working of the electric lighting by July 10. Specifications may be inspected at this office.

Tunbridge Wells.—The Corporation invite tenders for the supplying, laying, and jointing of armoured telephone cables; also instruments, etc. Tenders by July 5. Details in our advertisement columns.

Glasgow.—The Corporation invite tenders for the work in connection with alterations and foundations for the machinery at sub-stations at Coplawhill, Dalhousie, Partick, and Kelvinhaugh. Tenders by 29th inst.

Swansea.—The Corporation invite tenders for the supply and erection of main switchboard and instruments, and battery of accumulators and accessories. Tenders by July 5. Details in our advertisement columns.

Alford (Lincs.).—The Urban District Council invite tenders for lighting the town with gas or other light from Aug. 14, 1900, to May 14, 1901. Tenders to be sent to Mr. J. E. H. Sergeant, clerk, Alford, by 26th inst.

Heckmondwike.—The Urban District Council invite tenders for the various works required in the erection of electric light and power station, public baths, and fire brigade station at Heckmondwike. Tenders by June 28.

Limerick.—The Council invite tenders for the supply, delivery, and erection of cables, arc lamps, engines, dynamos, boosters, balancer, switchboard, instruments, and gas plant. Tenders by July 4. Details in our advertisement columns.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of the overhead equipment for the tramways in the borough, exclusive of the steel poles, but inclusive of their erection. Tenders by July 16. Details in our advertisement columns.

Newcastle-on-Tyne.—Tenders are invited for the wiring of 6 and 7, Park-terrace, including the supply of 55 electric lamps. Specification, etc., can be obtained on written application to Mr. J. R. Sisling, 7, Park-terrace, by whom tenders will be received up to 23rd inst.

Wolverhampton.—The Tramways Committee invite tenders for the construction of tramway track and contingent work in Dudley-road, Cleveland-road, Bilston-street, Piper's-row, and Fiveways, amounting to a route length of about one mile seven furlongs, mainly double track. Tenders by June 26.

South Shields.—The Guardians invite tenders for the complete installation of the electric light at the union workhouse, Harton, South Shields. The proposed works consist of (Section A) engines, dynamos, battery, and main switchboard; (B) wiring, cables, and fittings. Tenders by July 14. Details in our advertisement columns.

London, S.W.—Tenders are invited for the supply, within three months of the order being given, of about 70 arc-lamp standards, required in connection with the electric light installation for the Victoria-embankment, for the London County Council. The standards are to carry the lamps suspended, at about 23ft. from the ground level, at the end of a curved arm extending over the carriageway. Each person tendering is to submit his own design for the standard, or, if he so desire, he may submit alternative designs. A short description of the standard, showing generally what is required, may be obtained at once on application to the Clerk to the Council. Specification may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on July 10.

Alexandria.—Tenders will be received at the Central Office of the Administration of Ports and Lighthouses, up to 12 noon on July 1, for supply of the whole or part of an electric generating machine for the Port Said lighthouse, and the tools for the lighthouses workshop at Alexandria. Persons wishing to tender can consult the conditions of tender and the specification, on all days on which public offices are open, from 9 a.m. to 1 p.m., at the office of the Administration of Ports and Lighthouses, Alexandria. Copies of conditions and specification can also be had on application to the Controller-General of Ports and Lighthouses, Alexandria. Tenders must be submitted on stamped paper and addressed to the Controller-General of Ports and Lighthouses, Alexandria, in sealed envelopes, bearing the inscription 'Tender for the Supply of Electric Generating Machinery for Port Said Lighthouse," or "Tender for the Supply of Tools for the Lighthouses' Workshop, Alexandria."

Durban.—The Corporation invite tenders for supply, delivery, and erection of materials under the three following sections: (Part A) comprising the supply, delivery, and erection of the entire overhead equipment for about 16 miles of equivalent single track, including poles, overhead trolley wire, distribution boxes, etc.; (B) comprising the supply, delivery, and erection of 22 double-deck motorcars, complete; (C) comprising the supply and putting into working order of a complete steam and electric generating plant in a power station to be built by the Corporation, including three 250-kw. direct-coupled generators, boilers, condensers, cooling tower, switchboard, etc. Parts A and B will not be separated, but will be let to one contractor. Part C may be let separately. Preference will, however, be given to a contractor

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who will undertake all three sections, and a separate form of tender for all three sections will be supplied. Specifications, bills of quantities, forms of tender, and lithographic drawings may be obtained on application to Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation, on and after 29th inst. A deposit of £10. 10s. must accompany application for specifications and forms of tender. The deposit will be returned on the receipt of a bona fide tender. Sealed tenders, in duplicate, under separate cover, in specially-provided envelopes, to be delivered to Messrs. Webster, Steel, and Co., by June 29, or to the Town Clerk of Durban by mail delivery on or about July 23. The successful tender will be accepted by cable from Durban.

RESULTS OF TENDERS.

Llandilo.—The Town Council have accepted the tender of Mr. Bertram Thomas, of Llandrindod, at £2,415, for the electric lighting of the town.

Farnworth (Lancs.).—The Urban District Council have accepted the tender of S. J. Hodgkiss, Longcauseway, Farnworth, for electricity works buildings.

Bury (Lancs.).—We learn that Messrs. Crowther and Co., of Liverpool and Manchester, have obtained the contract for the electric lighting of the new post office from the General Post Office, London.

Southampton.—The Corporation have accepted the tender of Babcock and Wilcox, London, at £2,766, for the supply and erection of one water-tube boiler, with steam and other pipes, and sundry ironwork.

Southwold.—The Coast Development Company have given the contract for a complete electrical installation for the lighting of their new hotel and pier at Southwold to Edmundson's Electricity Corporation. The contract is to be carried out according to a specification prepared by Mr. A. A. Campbell Swinton, M.I.C.E.

Keighley.—The Town Council have accepted the following tenders: Carter Bros. and Co., Limited, Temple-street Ironworks, Manchester, constructional steelwork in connection with the buildings for electricity works, £1,059. 6s.; Tudor Accumulator Company, Limited, London, storage battery, £1,623; W. Lucy and Co., Oxford, condensing plant, £1,542. 10s. 6d.

King's Lynn.—The following tenders have been accepted: Laurence, Scott, and Co., Norwich, two steam dynamos and one small motor-generator, £3,498. 10s.; Yates and Thom, Blackburn, boiler economiser, condenser, pump, &c., £2,375; Lewis, Bayliss, and Co., Wednesbury, extensions to switchboard, £206; Callender's Cable and Construction Company, Limited, London, feeder mains, joint-boxes, and dynamo cables, £523. 5s.

BUSINESS NOTES.

TRACTION.

Cardiff.—Mr. Arthur Ellis (general manager, Corporation tramways, Bolton) has been appointed tramways electrical engineer.

Acton.—The District Council are urging the Middlesex County Council not to waste any more public money in its opposition to the London United Tramways scheme.

Halifax.—A profit of £500 has been made on the tramways in the fortnight ending June 10, during which the cars travelled 25,270 miles. The receipts were £1,700.

City of Buenos Ayres Tramways Co.—The debenture stock transfer books will be closed from June 23 to 30, both inclusive, for the payment of the half-yearly interest.

Twickenham.—The District Council have come to a supplemental agreement with the tramways company respecting additional widenings, etc., in Richmond-road.

International Tramways and Light Railways Exhibition.—This exhibition will be inaugurated to-day by a luncheon at the Royal Agricultural Hall. The exhibition will be opened to the public to-morrow, and remain open until July 4.

Middlesex.—A meeting of the Parliamentary Committee of the County Council was held on Tuesday evening to decide upon future action in connection with the Tramway Bill. Representatives of the various district councils affected attended.

Reading.—The borough engineer and surveyor, in conjunction with Messrs. Pritchard and Co., have been instructed to complete the valuation of the tramway company's undertaking, so that an offer can be made to the company as soon as possible.

Thames Ditton.—The District Council intend to oppose the application of the British Electric Traction Company (vice Greenwood and Batley) for an extension of the latter's scheme—viz., from Surbiton boundary to the Orleans Arms, *vid* Portsmouth-road.

Batheaston.—At a recent special meeting of the Parish Council a resolution was adopted expressing the opinion that the proposed electric tramway would be very beneficial to the parish, and pledging the Council to support the company in their application for an order.

Swinton and Pendlebury.—The Urban District Council have petitioned the House of Lords in regard to the South Lancashire Tramways Bill, which has passed the House of Commons, asking for the retention of the clause protecting the interests of the Council's district.

Seaforth and Waterloo.—The Liverpool Overhead Railway intend to commence the electric car service between Seaforth and Waterloo to-day. Several trial trips have been made from Seaforth Sands Station to the International Hotel, the experiments giving every satisfaction.

Swansea.—It is intended to open the whole of the system of electric cars at noon on Saturday, June 30. The Mayor will switch on the current, and a number of invited guests will be taken over the service to Morriston, after which a luncheon will take place at the Hotel Metropole.

Southport.—Mr. Wilton, of Sheffield, has been appointed tramways manager. The traction switchboard has been delivered and fixed. The engineer has inspected the traction plant at Birmingham; the boilers have been delivered, and will be fixed in time for winter's work.

Hastings and East Sussex Motorcar Syndicate.—This syndicate has been registered with a capital of £5,000, the object being to adopt an agreement with A. H. Collins, D. Russell, H. Broadhurst, and H. A. Pearch, and to carry on the business of motorcar builders, electricians, engineers, etc.

Northwich.—The Rural District Council have received a notice from the United Kingdom Tramway, Light Railway, and Electrical Syndicate, Limited, London, who propose to take steps for a provisional order to be obtained for laying tramways in the Cheshire salt district, and appear to be favourably impressed with the same.

Light Railways.—The Board of Trade have confirmed an order made by the Light Railway Commissioners authorising the construction of a light railway at Cheltenham. They have also confirmed after modification an order made authorising the construction of a light railway from Bexhill to St. Leonards, in the county of Sussex.

Hampton Wick.—The surveyor (Mr. Horsfield) having inspected the Hampton Court-road with a plan of the proposed tramline, has agreed with the engineer to the London United Tramways Company that a space of not less than 9ft. 6in. should be allowed between the line and the kerb on the north side of the road. This has been confirmed by the Council.

Wednesbury.—At the last monthly meeting of the Town Council the Mayor referred to the West Bromwich Corporation and South Staffordshire Tramway Bills, the opposition to which had been withdrawn owing to everything prejudicial to the interests of the town having been eliminated, and he congratulated the town clerk upon the admirable work he had done.

Chester.—The Chester city surveyor (Mr. J. Matthews Jones) and the electrical engineer (Mr. F. Thursfield) have prepared a report with reference to the tramway extensions. They consider that the extension and improvement of the present track could be effected by doubling the line where practicable, and the extension of the line to near the railway level crossing at Saltney.

Birmingham.—On Saturday an assortment of the poles and wires for the electrical traction of the cars on the Bristol-road was inspected by the Public Works Committee of the Corporation. The collection consisted of samples of different methods of suspending the overhead conductor, being placed in position to enable the committee to judge of the effect of each upon the appearance of the road. No decision was recorded.

Greenwich.—At the last meeting of the Board of Works the Greenwich Committee reported that they had considered the letter of the London County Council with respect to the widening of South-street, Greenwich, Lewisham-road, Lewisham High-street, and Rushey-green, to 50ft. in connection with the proposed doubling of the line of tramway from Greenwich to Catford, and recommended that the London County Council be informed that when they had perfected their plans the Board would be happy to give them consideration. This was agreed to.

Warrington.—At the last meeting of the Town Council it was reported that Mr. Preece had attended a meeting of the Electric Lighting Committee, and a discussion took place with regard to the opposition of the Corporation to the Lancashire Electric Power Bill. The town clerk (Mr. J. Lyon Whittle) reported that the company had agreed not to oppose any future extension of the borough, but could not undertake to cease to supply within an area not yet defined. The company would, however, supply through the Corporation in bulk in the event of the borough being extended.

Huddersfield.—The new electric section from the Huddersfield boundary at Pinfold to the Star Inn, on the Slaithwaite side of Linthwaite—the first extension of the Huddersfield tramways system outside the borough—was inspected by Colonel Yorke, R.E., on the 18th inst. The line, which, with double lines at the passing places, is three miles and a chain in length, has been constructed on behalf of the Linthwaite Urban District Council., and Colonel Yorke intimated that he intended to report favourably on the work, and that the line might be opened to the public on Monday next.

Dudley.—Sir Courtenay Boyle has made the following award with regard to supply of current by the Corporation to the tramway company: for the first 150,000 units per annum, 2d.; for any further amount up to 200,000, 1·9d.; up to 250,000, 1·8d.; up to 300,000, 1·7d.; up to 350,000, 1·6d.; up to 400,000, 1·5d.; for any quantity in excess of 400,000, 1d. The agreement with the British Electric Traction Company is considered most satisfactory. It includes the purchase of the Netherton line by the Corporation at a price to be fixed by the Board of Trade. In two years the Corporation will lease the whole of the tramlines within the borough to the British Electric Traction Company for a period of 21 years.

Hyde.—The Council have confirmed the proceedings of the Electricity Committee, which contained a resolution that the

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chairman (Mr. Tinker), the Mayor, Aldermen Oldham and Shaw, and Messrs. Pollard and D. H. Shaw be appointed representatives of and members for the Corporation on the Joint Committee of the Councils of the boroughs of Hyde, Stalybridge, Dukinfield, and Mossley for the purpose of promoting a joint scheme of electric traction and lighting, and particularly for the purpose of preparing a draft scheme for the proposed joint electric traction and lighting undertaking and works. The following resolution has been passed: "That application be made by the Hyde Town Council, in conjunction with the Dukinfield Town Council, to the Light Railway Commissioners, for an order authorising the said councils to undertake to construct and work, or to contract for the construction and working, of light railways under the Light Railways Act, 1896, in Hyde and Dukinfield."

Paisley.—The reports of Professor Barr and Mr. Cormack upon the specifications and drawings of the two new engines proposed to be substituted by Messrs. Ferranti, Limited, for the three defective engines at the electricity works, which are to be removed, have been adopted by the Town Council. We learn from the *Paisley and Renfrewshire Gazette* that the reporters state that they were glad to have an opportunity of seeing the admirable general arrangements and engineering features of the buildings and plant, which were marred only by the unsatisfactory working of the engines. From examinations they had no doubt of the unsuitability and insufficient strength of the valve gear originally fitted, and they considered that the defects of the design were sufficient to account for the troubles that had arisen. At the same time, they believe that the troubles would have been diminished had these engines been run condensing from the first, as was originally intended. The engines were specified to work condensing, and were designed accordingly. Working non-condensing, the cushioning provided for them as condensing engines was excessive as regards the pressure attained at the end of the stroke, causing the large slide-valves to beat upon the valve faces, thus producing a more rapid deterioration of the surfaces than would otherwise have occurred. That might account also partly for the great trouble that had been experienced with the packings of the valve spindles. From visits and examinations they had been able to familiarise themselves with the design of engine under consideration. They believed that the troubles which had been experienced in the electric lighting station with the present Ferranti engines had arisen mainly, if not entirely, from the construction of the valves and valve gears. The valves, being of the grid type with a large number of ports, had a very small travel, and, moreover, their motion is slow, since they only make 125 strokes per minute when the engine was running at 250—in both of which respects the valve system had marked advantages over the type at present installed at Paisley. The reports of the experts on the proposed new engines are such that the Council have agreed to intimate to Messrs. Ferranti that the committee were favourably impressed by the report on the larger engine proposed to be furnished by them, and that they would be glad to receive their specification for the smaller engine. It was agreed that when this was received it be also submitted to Prof. Barr.

Portsmouth.—The following are the full terms of the agreement come to between the Portsmouth Corporation and the tramway company, over which there has been so much difficulty lately: (1) All omnibuses, hearses, and carriages belonging to the tramway companies, with depôt in Marylebone-street, and the land in Albert-road, and the plant used for the purpose of those vehicles to be retained by the tramway companies, and no claim whatever to be made by them on the Corporation for unexpired profits in respect of the same; and the omnibus depôt on the east side of Broad-street shall be taken by the Corporation. (2) Should the Corporation require to proceed with their work, the company to hand over to the Corporation at any time after Oct. 1 either or all of sections as follows—*i. e.*, from town hall to dockyard, from dockyard to King's-road, from Victoria Hall to floating bridge, and from Pier Hotel to East Southsea, and the remainder of the lines and all the depôts, cars, horses, plant, and stock of every description pertaining to the tramways on Dec. 31, 1900. (3) The tramway company to undertake to arrange for the Portsdown and Horndean Light Railway Company to grant running powers for Corporation tramcars over the light railway company's lines to a point as far north as the enclosed land on Portsdown Hill extends, as shown on the plan marked "A," and the Corporation to run all their cars on the Cosham section to the point "A" instead of to the present terminus near the Cosham railway station. (4) The light railways company to agree that no compulsory running powers will be asked for over the tramways belonging to the Corporation. (5) The running powers are to be granted to and exercised by the Corporation for so long as the piece of line from the borough boundary to Cosham shall be held by the Corporation, and the light railway company to agree not to compete with the Corporation for the possession of the section between Hilsea and Cosham. (6) Payment for running powers to be made by the Corporation at ½d. per passenger carried north of the railway at Cosham, to include electric power, which will be supplied by the light railway company, from the junction with the Corporation lines to point "A" on plan; and a farthing per passenger for all passengers who do not travel north of the Cosham railway station. A daily return of the traffic to be furnished, and tolls to be accounted for and paid monthly. (7) The Corporation to grant permission to the light railway company's inspectors to check the conductors' returns of passengers travelling in the Corporation cars over the light railway. (8) A deduction to be made from any amount which may be awarded for the unexpired profits claimed by the tramway company equal to the time the tramway company retains possession after Dec. 31, 1899. (9) Payment for lines and plant not to be made till the date of Corporation taking same over, and should payment not be made on that day, interest at the rate awarded by the arbitrator to commence from that day only. (10) Any orders received by the Corporation for omnibuses, carriages, or hearses within the first 12 months to be at once handed over to the Provincial Tramways Company or their successors. (11) The arbitration between the tramways company and the Corporation as to the tramway undertakings, lines, and depôts, including the Broad-street East depôt, to be proceeded with as soon as can be arranged, but the tramcars, horses, plant, and stock shall be taken at a valuation on the basis of and as part of the tramway undertakings, to be made at the time when possession of the whole is given by the tramway companies to the Corporation, by two valuers, one to be named by the tramway companies and the other by the Corporation or their umpire, to be appointed by such valuers before entering upon their valuation. As the engineers and experts engaged respectively by the Corporation and the tramways company made their examination of the tramway lines for the purpose of transfer on Dec. 31, 1899, the arbitrator shall make such deduction from his award as he may decide for depreciation of the lines from Dec. 31, 1899, till the date of actual transfer to the Corporation. (12) No claim shall be made by the company in consequence of delay, and when the tramways are taken over no legal differences shall be raised, but the same shall be handed over according to the terms agreed on. (13) In consideration of the foregoing concessions being made by the company to the Corporation, the Corporation to agree for the arbitrator to include in his award the sum of £2,500.

LIGHTING AND GENERAL.

Bolton.—The Electricity Committee have decided to lay a cable along Marsden-road to St. George's-road.

Whitehaven.—It is reported that the buildings at the electric light station are making satisfactory progress.

Trowbridge.—A meeting of the Urban District Council will shortly be held as to lighting the town with electricity.

Bedford.—The Electric Light and Traction Committee have decided to make no increase in the charge for electricity.

Huelva Gas and Electricity Co.—The share transfer register of this Company will be closed till June 27, 1900, inclusive.

Halifax.—A committee of the Guardians have under consideration the question of providing their own electricity supply.

Hampton Wick.—Messrs. Colpoys, Hope, and Bullen have been appointed to further report on the electric lighting of the district.

Heywood.—The Town Council have decided to apply for sanction to the borrowing of £15,000 for the purposes of the electric lighting scheme.

Clerkenwell.—A former resolution directing the installation of the electric light in the City-road Workhouse, at a total cost of £7,623, has been rescinded.

Yarmouth.—The borough surveyor is preparing designs and a report for illuminating on special occasions the north front of the town hall with the electric light.

Tredegar Iron and Coal Co.—An ordinary general meeting of shareholders will be held in the arbitration room of the London Shipping Exchange on July 3 at 11.30 a.m.

Kilmarnock.—The Town Council intend to apply for a provisional order for borrowing powers to the extent of £50,000, the estimated cost of the electric scheme being £26,000.

Stretford.—We understand that the Urban District Council have passed the plans of the proposed works of the British Westinghouse Electric Manufacturing Company, Limited.

Aberystwyth.—The Town Council have decided to memorialise the Postmaster-General with the view to the establishment of trunk-line communication with the local telephone exchange lines.

Ashton.—The Electricity Committee have resolved to increase their generating plant to the extent of two 1,200-h.p. sets on account of the large demand for power and lighting in the borough.

Alnwick.—The Rural District Council have given the local manager of the telephone exchange permission for the erection of a number of telephone poles along the roadsides on the usual conditions.

Chester-le-Street.—The union offices are to be connected with the National Telephone Company's system. The question of connecting the workhouse with the system has been referred to a committee.

Aberdeen.—An application from the National Telephone Company for underground wayleave in connection with their telephonic system in the city has been remitted to the Finance Committee.

Maidenhead.—The Town Council are considering a draft agreement with the National Telephone Company regarding the placing of underground cables and wires for telephonic purposes in various parts of the borough.

Carlisle.—Enquiries as to whether there was sufficient demand for electric light to justify the Electric Lighting Committee in extending the cable to Charlotte-street Congregational Chapel, have not satisfied the engineer.

Perth.—It was originally intended to erect 37 arc lamps at a cost of £1,600, or an average cost of £49 each. It has now been decided, however, to increase the number to 64, the total cost of which will be £2,141, or an average cost of £33. 10s. each.

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Worcester.—The Council have agreed that three members of the Electricity Committee, with the electrical engineer, should inspect stations supplying electricity for lighting and traction purposes before deciding upon the exact form of the supplemental generating station here.

Brianne Electric Lamp Co.—This Company has been registered with a capital of £30,000, the objects being to adopt an agreement with M. Hill, and to carry on the business of manufacturers of patent electric and other lamps and their appliances, accessories, and apparatus.

London Gazette.—A third dividend of 5d. in the £ has been declared *re* G. Chetwynd, telegraph clerk, 27, Newgate-street, E.C. A meeting will be held on the 26th inst. at the Royal Courts of Justice in connection with the winding up of the Westminster Automatic Telephone Syndicate, Limited.

Gateshead Electric and Mechanical Supply Co.—This Company has been registered with a capital of £1,000, the objects being to acquire the business carried on by J. A. M. Collier at 25A and 27, West-street, Gateshead, and to carry on the business of electricians, engineers, suppliers of electricity, etc.

Rochdale.—The six months' extra time allowed to the electric lighting contractor will expire on June 23. The Electric Light Committee have requested Messrs. Crews and Handford to report to the committee the date by which, in their opinion, Mr. Barton should in present circumstances complete his contract.

Merthyr Tydfil.—The Urban District Council have approved of notices and plans from the British Electric Traction Company, showing the mode of laying cables for the electric lighting of a portion of the district under the powers conferred upon the company by the Merthyr Tydfil Electric Lighting Order, 1899.

Stock Exchange. — The Stock Exchange Committee have appointed June 27 as a special settling day for Callender's Cable and Construction Company, Limited, further issue of 10,000 ordinary shares of £5 each, fully paid, Nos. 20,001 to 30,000, and ordered these securities to be quoted in the official list.

Appointments Vacant. — The Ayr Corporation require an engineering assistant for electric tramways.—The Corporation of Sunderland require the services of a chief engineering assistant for the electric tramways, a junior assistant for the same, and motormen. Full particulars in our advertisement columns.

Banbury.—The Board of Trade have issued to the Electrical Power Distribution Company, Limited, the provisional order for the supply of electricity within the borough. At the last Council meeting it was whispered that the order was not precisely in the terms agreed upon between the company and the Corporation.

Quick Telegraphy.—With regard to Messrs. Pollak and Virag's system of quick telegraphy, already mentioned *ad nauseam*, the Vienna correspondent of the *Express* states that an arrangement has been made whereby the messages can now be printed in ordinary Roman lettering instead of Morse characters as hereto.

Greenock.—The Electrical Committee have agreed to recommend that the electrical works be extended at a cost of £8,000, in view of the power that will be required by the tramways company. The applications from candidates for the post of assistant engineer have been remitted to Mr. Nelson to select three names for consideration of the committee.

Salford.—A number of the Electric Light Committee have resigned in connection with the Turner affair, and the committee was at Wednesday's meeting reconstituted as follows: Aldermen Holland, W. Robinson, and Shaw; Councillors Barrett, Bates, Broxap, Higson, Hodgson, Huddart, Leach, Mather, Muir, Stephens, Wilkinson, Worsley, and Yearnshaw.

British Electric Works Co.—We notice that this company have opened a branch at 37, Piccadilly, Manchester, for the supply of electrical fittings. Mr. John Walton, who was for several years with the Manchester electricity supply, has been appointed their inspector of installations for the immediate Manchester districts lying between Warrington, Todmorden, and Blackpool.

Dudley.—The Corporation will supply to the public current for lighting purposes at 6d. per unit for the first two hours per day, and 1½d. per unit for subsequent hours, or at 5d. per unit for the entire 24 hours, with free wiring. They have now engines of 1,000 h.p. at the generating station, and are in a position to accommodate another large engine there if the demand requires it.

Postal and Telegraph Conference at Halifax.—The annual conference of the Amalgamated Postal and Telegraph Benefit Society of the United Kingdom and Ireland took place on the 16th inst. Mr. T. K. Butler presided. The annual report showed that during the past year over £11,000 was paid out in benefits, making a total of £50,000 since the society was established six years ago.

Hammersmith.—At the last meeting of the Vestry it was proposed that, in face of the report of the Electricity and Lighting Committee, it was evident that the public might now reap the benefit of a prosperous undertaking, and have the light at an uniform charge of 3d. per unit all round, and that the scale of charges be reduced accordingly. The motion was referred to the Electricity Committee.

Morecambe.—The financial statement of the Electric Lighting Committee shows a gross profit on the revenue account of £1,764 for the year as against £775 last year. The total cost of works and plant is £39,700, and the amount of principal repaid £2,500, leaving a net value of the works and plant to be £37,200. The current sold during the year amounted to £3,900, as compared with £1,800 last year, being an increase of over £2,000.

Peterborough.—The Town Council have received an application from the Great Northern Railway Company to be supplied with electricity, as they proposed to adopt electrical motors at their sheet stores. The electrical engineer estimates the cost to lay a main to the stores at £200, but considers it would pay the Corporation to lay it. The matter has been adjourned for the engineer to ascertain if the company would take a supply for five years.

Walsall.—The total number of consumers supplied on May 31 last was 163. The total units from the transformers was 20,511, and the total units registered on the meters 15,943. The tender of the National Telephone Company, Limited, for connecting the Stafford-street sub-station by telephone to the generating station for the sum of £7. 0s. 6d. has been accepted. Enquiries are being made with reference to the extension of the electric lighting main up Lichfield-street and Mellish-road.

Telegraph Messengers' Institute.—The annual meeting of the Central Telegraph Messengers' Institute was held on the 19th inst. in the City Temple Schoolroom, Holborn-viaduct. Mr. R. Bruce, Vice-Controller of the London Postal Service, presided, and Mrs. Bruce distributed the prizes. The revenue last year amounted to £241, while the expenses were £252. The members number 428. The institute has a library and reading-room. There are also educational classes which are recognised by the Educational Department.

Paisley.—At the last meeting of the Town Council a letter was read from the Postmaster-General, which was accompanied by a copy of a deed granting authority to the National Telephone Company powers for telegraphic work in certain towns under Section 5 of the Telephone Act, 1892. In Sub-Section 2 of that section powers were conferred upon the Telephone Company, but they could not be exercised without the consent of the local authority concerned in each case. One of the towns scheduled was Paisley.

Huddersfield. — At the meeting of the Town Council on Wednesday the Chairman of the Electric Lighting Committee (Alderman Calvert) said that the National Telephone Company had issued a county court summons against the Corporation in consequence of the refusal of the latter to give permission to the company to lay the wires underground. The Council might have been willing to accede to the request if certain conditions had been accepted. The conditions were intended to protect the town's electric cables and gas and water mains.

Parliament.—In the House of Lords the following Bills have been read a second time: South Lancashire Tramways, City of London Electric Lighting, Charing Cross and Strand Electricity Supply, Latimer-road and Acton Railway, South-Eastern Metropolitan Tramways. The following have been read a third time: Liverpool Overhead Railway, Southport Extension and Tramways, Glasgow District Tramways, and Central London Railway. In the House of Commons the Aston Manor Tramways Bill has been read a second time. The Christchurch and Bournemouth Tramway Bill has been considered, amended, and ordered for third reading. The following have been read a third time: Huddersfield Corporation Tramway, Jarrow and Hebburn Electricity Supply, Tynan Light Railway. The St. Annes and Lytham Tramways was considered and ordered for third reading.

The Coming Week.—We would remind our readers that the annual conversazione of the Institution of Electrical Engineers will take place on Tuesday next, June 26, when the members will be received by the president, Prof. Perry, and Mrs. Perry at the Natural History Museum. On June 27 and 28 the annual summer meeting of the Institution of Mechanical Engineers is to be held. The annual dinner will be held on June 27. The papers to be read at the meeting will include an adjourned discussion on "Road Locomotion," when a short supplementary paper dealing with recent trials will be presented by Prof. H. S. Hele-Shaw; a paper on "Recent Locomotive Practice in France," by Mr. Edouard Sauvage; "Polyphase Electric Traction," by Prof. Carus Wilson; and "Observations on an Improved Glass Revealer for Studying Condensation in Steam-Engine Cylinders," by Mr. Bryan Donkin.

Ipswich.—At a special meeting of the Town Council on Wednesday, the Electric Lighting Committee submitted two reports from Prof. Kennedy, with accompanying drawings. The latter showed the proposed arrangement of the generating station, with contemplated extensions, the site for a destructor, the course of the proposed feeders and mains, and the positions of the arc lamps for public street lighting. The committee had instructed Prof. Kennedy to make provision for 85 arc lights. The committee recommended that Prof. Kennedy's drawings should be approved as submitted to the necessary public departments. They recommended, further, that it should be referred to them to have the detailed drawings and sections and specifications prepared, and to obtain tenders for carrying out the same. The committee proposed that, as far as possible, the erection of the generating station and the laying of the feeders and mains should proceed simultaneously, in such order that it might be possible to use the distributing plant as soon as the generating station was ready. A long discussion took place, but as no amendment was proposed, the report, with a resolution authorising Prof. Kennedy to prepare the plans, was carried.

Portsmouth.—The proposed new arrangement with the National Telephone Company and the Corporation provides for the minimum payment by the company of £227. 16s. per annum, calculated on 800 instruments and 55 junction boxes, but omitting a limit of population. The Corporation undertakes, at the request of the company, to place underground tubes or conduits at the expense of the company. An unlimited service at an annual charge of £10

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per instrument, or a fixed charge of £3. 10s. per annum for each instrument, with a fee of 1d. per call without any charge for messages received at the instrument, is intended.

Harrogate. — The borough electrical engineer in his last report advises that 50-kw. transformers of a new type be built as follows: one for Albert-street chamber, in place of 2-kw. Brush; one 50 kw. in market chamber, in place of two Brush of 18 kw.; one 50-kw. in Prospect chamber, in place of one 18-kw. and one 25-kw. Brush; 1-kw. extra in hand. Resolved that the transformers be purchased as recommended. The Municipal Electrical Association will visit Harrogate electrical works on Saturday afternoon, June 23, and Messrs. McLaren, of Leeds, have offered to provide refreshments, and also to furnish the members visiting Harrogate with a first-class railway ticket.

Gillingham.—After Oct. 1 next the price of energy supplied from the works will be changed from 5d. to 7d. per unit for the first hour's nightly consumption (based on the maximum demand throughout the quarter), and 2d. per unit for all consumed in excess—being a considerable reduction to large consumers. It is also proposed to introduce a system of free wiring, by which consumers who require it can have the first six lamps fixed without any initial charge being made. The charge for current to consumers on this system will be 7d. and 2½d. per unit, the extra ½d. per unit being charged on the lower price until the fittings are paid off, when they become the consumer's property.

Wellingborough.—A local paper comments upon the fact that although there is no intention on the part of the Urban Council, who propose to establish electric lighting works, to cater for private consumers, the Local Government Board insist upon the necessity of the Council going to the apparently useless expense of procuring a provisional order. This appears, says our contemporary, to be a piece of red-tapism purely and simply, for as proof that the Council do not intend using the electricity generated for other purposes than street-lighting, it may be pointed out that that body have already consented to a provisional order being given to a company who will cater for the private consumers.

Lowestoft.—At the last meeting of the Town Council the General Purposes Committee reported that Mr. Hawtayne had discussed with the committee the subsidence at the electric light station, and explained the steps he had taken in reference thereto with a view of obtaining an independent report as to the cause of the subsidence, and the committee expressed itself as satisfied therewith Mr. Hawtayne was directed to lay an electric lighting main in the Victoria Arcade in London-road North, and also in Waveney-road, Suffolk road, and the Marina. It was stated that applications were coming in so quickly for electric light that it had been found necessary to put in a fresh concrete raft to take a new boiler in the near future. The cost would be about £150. This was agreed to.

Colne.—The Town Council have decided to apply for sanction to borrow nearly £40,000 for the purposes of an electric lighting scheme. The borough surveyor's plans and estimates of the cost of erecting proposed buildings, etc., for electrical station include the following: buildings and chimney, £8,591; land, £1,150; paving streets adjoining, £270; footbridge, £300; making a total of £10 311 The electrical engineer's estimates of electrical plant amount to £28,708. Provision is made for supplying the full amount of current required by the proposed light railway, and also for supplying 12,000 8 c p. lamps for inside lighting (private consumers and public buildings) and a small amount of street-lighting. The plant is to be put down from time to time to meet the demands of the district.

St. George (Hanover square).—A special meeting of the Vestry was held yesterday to consider a notice of motion, "That the resolution of the Vestry at their last meeting, that the consideration of the question of the extension of electric lighting throughout the parish for public lighting purposes, and the recommendation of the special committee thereon, be deferred for six months," be rescinded, and if carried, "That the Vestry sanction the extension of electric lighting throughout the parish for public lighting purposes, and also to authorise the special committee of Vestry *re* electric lighting to obtain expert opinion upon the respective offers made by the Westminster Electric Supply Corporation, Limited, as set out in the report on electric lighting presented to the committee by the vestry clerk and surveyor."

Stanley.—At the last meeting of the Urban District Council the following resolutions were agreed to: "That a main be laid to premises belonging to the Industrial Society at an estimated cost of £40 provided the society guaranteed a revenue of 11 per cent. on the outlay; that an offer made to the electrical engineer by the Reason Manufacturing Company, Limited, to purchase the discarded demand indicators at 70 per cent. of the price originally paid for the same; and that the electrical engineer obtain tenders for two transformers for the Westgate sub station, also a few fittings for the boilers." An estimate of the proposed works in connection with the electric lighting undertaking, and a statement of the amount already expended in excess of borrowing powers, making together the sum of £25,000, application for which has been made, was laid before the meeting and approved.

British Iron Trade Association.—The annual conference of members of this association was held on Wednesday at the Westminster Palace Hotel, Sir John J Jenkins, M.P., the president, in the chair. The debate on "British Traders and British Railways with reference to the Control and Cost of Mineral Transport," was introduced by the president. Mr. H. J. Shelton read a paper on "What is the Competitive Outlook in the World's Iron and Steel Trades, or, more particularly, What is the Outlook for the British Iron Trade?" A short discussion took place; also the following resolution was passed: "That this meeting of the members of the British Iron Trade Association approves the proposal made by Mr. H. J. Skelton that an effort should be made to secure greater uniformity of sections, standard or otherwise, in structural shapes, etc., and authorises the secretary to take steps to ascertain the views of the technical institutions and local iron trade associations concerned, looking to possible action on the subject."

Twickenham.—At the meeting of the District Council last week the Clerk reported that the Middlesex County Council had presented a petition against the preamble of the electric lighting provisional orders No. 9 (Twickenham order). The County Council alleged in such petition that provision should be made in the Bill that the final control in respect of the main roads should be vested in them, and that they object to the Council having such power, and that clauses should be inserted in the Bill to that effect. The allegations were somewhat similar to those contained in the County Council's petition against the United Tramways Bill, when the Board of Examiners and Select Committee of the House of Commons limited the County Council's *locus standi*. The Lighting Committee recommended that the clerk inform the solicitors promoting the Bill that the Council deny the allegations contained in the petition, and that they must oppose the same, and did not consent to clause giving the County Council the powers they seek. This was agreed to.

Personal.—Mr. J. J. England, who has just secured an improved position with the British Electric Traction Company, was entertained on the 15th inst. by the Cork Tramway Company's staff at a farewell concert. An excellent programme was provided, and at the close of the meeting a presentation was made.—The Electricity Committee have recommended Mr. G. S. Maben, assistant electrical engineer, Belfast, for the post of chief assistant to the superintendent engineer at the Bradford municipal electric supply works. — The Brush Electrical Engineering Company have appointed Mr. Edward A. Leeson to be works manager at their Falcon Works, Loughborough, in succession to Mr. C. E. Hodgkin.—Mr. H. Davidson, of the Leith Corporation electricity works, was the successful candidate for the post of shift engineer recently vacant at the Blackburn Corporation electric light and tramway generating station.—Mr. E. W. Dunton, assistant to Mr. Cottam, of Hampstead Vestry station, has been appointed electrical engineer to the Corporation of Whitehaven, as successor to Mr. Scott. Mr. Dunton was previously assistant to Mr. Mountain, at Huddersfield, and was one of the selected candidates when Mr. Scott was appointed.

West Ham.—The interim account of the electricity fund for the last half-year shows a gross profit of £2,002. 8s. 10d., a net profit of £470. 4s. 11d., which is to be transferred to the general district rate in part payment of the sum of £1,380, the total loss charged to that account. After the whole of that deficiency has been repaid steps will be taken to create a reserve fund sufficient to meet the cost of renewing any portion of the plant that might become inoperative before the period of 25 years allowed for the repayment of the loan. The cost of the wiring of the artisans' dwellings (£172) will be charged against the housing scheme. Mr. John J. Steinitz, in his report, states that, in comparison with the average of five London municipal concerns, West Ham has sold about half the number of units, and the total cost was only ·09d. higher. There was no doubt that as the sale of units increased, the price per unit would be considerably reduced. The average price obtained for private lighting in West Ham was 4·32d., as compared with 4·77d., the average of the other stations, and they were selling current about ½d. a unit less than the average of the other local authorities who had electricity works in London. The return for public lighting showed a still greater difference, as they obtain 1·9d., as against an average of 3·6d., or rather more than 1½d. less than the average. In conclusion, Mr. Steinitz congratulated Mr. Bock on the very satisfactory results he had obtained.

King's Lynn.—Mr. Boulnois has held an enquiry into the Corporation's application for sanction to borrow £10,000 to extend the electric lighting plant. The town clerk (Mr. J. W. Woolstencroft) represented the Corporation. Mr. Humphreys Davies opposed the application on behalf of the Lynn Docks and Railway Company, the West Norfolk Farmers' Manure Company, Messrs. W. and T. Bagge, and Messrs. Eyre and Co., Limited. The Town Clerk said the existing plant consisted of five gas-engines and dynamos, capable of producing the current to supply 5,544 lamps of 8 c.p., and allowing one engine and dynamo as a stand-by. The chief reason which led the Corporation to lay down the plant and to establish the works was to provide for street-lighting, and displace gas, which cost about £1,300 a year. The demand for current for private consumers had far exceeded anything they had anticipated. At the present current was required to supply 2,001 lamps for street-lighting. They had applications from 201 consumers, requiring 6,332 lamps. During the seven months ending March 31 last they had paid off £940 of the principal borrowed, and £490. 14s. 10d. interest, and the balance on the wrong side was then only £110. 13s. 11d. The had some 10 miles of mains already laid down, and the load could easily be increased without any very great increase of establishment charges. Under their order the Corporation were bound to supply people within a certain distance of the mains under a penalty of 40s. per day for each default, and if the mains were not put in the Board of Trade had power to revoke the order. The extensions proposed consisted of two Lancashire boilers, two steam dynamos, boiler economiser, condenser, pump, etc., the cost of which was £8,400, and the new buildings £1,600.

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COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION.

The fourth ordinary general meeting was held on the 18th inst. at Donington House, Norfolk-street, Strand, W.C., Sir Charles Rivers Wilson, G.C.M.G., C.B. (chairman of the Company), presiding.

The **Chairman**, in moving the adoption of the report and accounts, published in our last issue, went into all the details of the same, and said the operations of the Company during the 15 months covered by the report had been of a very extensive character, and they had been conducted entirely on the general lines of the policy previously indicated to the shareholders. Electric traction had now become well established, and he thought he was justified in saying that the Company held the leading position among undertakings doing their class of work. The appendix in the report enumerated 57 companies and undertakings. Fifty-three were tramway and light railway undertakings, and of that number 31 were actually in operation and all working at a profit. Six undertakings were in course of construction, and 15 had only quite lately been sanctioned.

The **Right Hon. Lord Rathmore** seconded the motion, which was adopted, and the directors were authorised to initiate a superannuation fund as set out in the report.

The retiring directors, Sir Charles Rivers Wilson and the Hon. Sir Charles W. Fremantle, were re-elected, and the auditor, Mr. F. W. Smith, F.C.A., was also reappointed.

An extraordinary general meeting followed, at which a resolution increasing the capital of the Company from £1,200,000, divided into 120,000 shares of £10 each, to £2,000,000, divided into 200,000 shares of £10 each, by the creation of 80,000 new shares of £10 each, was passed.

ELECTRIC LIGHTING AND FITTINGS.

At the meeting of the shareholders of this Company held on Tuesday, the following report was submitted and adopted. The result of the working during the past year is a profit of £564. 1s. 8d., and the amount now standing at the credit of the profit and loss account is £59. 16s. 4d. As anticipated in the last report, the business has materially increased, and better results accrued owing to the facilities at the Duke-street works, and the convenience of the premises, 38, North John-street. In accordance with the articles of association, Mr. Lot. Hughes retires by rotation, but, being eligible, offers himself for re-election. The auditors, Messrs. Simon Jude and West, also retire, in accordance with the articles of association, and, being eligible, offer themselves for re-election.

SUNDERLAND TRAMWAYS.

An extraordinary general meeting was held on Tuesday at Winchester House to consider a resolution for winding-up the Company voluntarily, and for appointing Sir E. T. Gourley, M.P., and Mr. George Haswell (directors), and Mr. J. W. Allison (the secretary) liquidators.

Sir E. T. Gourley, who presided, said in winding up the company the Board had no intention of delaying the distribution of the assets more than could be helped, and on receiving the £35,000 they would distribute £5 a share, and afterwards do their utmost to collect the remainder of the assets and distribute them.

The resolution was carried.

ELECTRIC AND GENERAL INVESTMENT.

The report of the directors for the year ended 31st ult., to be submitted to the meeting on 26th inst., states that the profit and loss account shows a gross profit of £19,796, and after deducting all general charges and the interim dividend on the ordinary shares, there remains £14,711. Of this the directors propose to carry £711 to the contingencies fund. This will leave £14,000 available for distribution for dividend and bonus, as announced in our last issue.

SUSSMANN ELECTRIC MINERS' LAMP.

An extraordinary general meeting of the Sussmann Electric Miners' Lamp Company was held on Monday last at Winchester House, but the Press were not admitted.

BASTIAN METER.

In their report for the year ended Feb. 28 the directors state that the profit and loss account shows a profit of £388. 13s. 3d., whereas the loss on the previous year amounted to £2,227. 16s. 11d., which they consider shows satisfactory progress. During the first six months of the year the Company was worked at a somewhat heavy loss, but nearly the whole of this loss was recouped out of the profits made on the second half-year's tradings, when the orders received increased more than fourfold. The electrical installation at Holbein House has been let on lease at a satisfactory rental, and the Company is thereby relieved of any further trouble or expense in connection with that department of the business. The expenditure upon experiments has been very small as compared with the amount previously expended, and the directors anticipate that this item will continue to decrease. The prospects for the coming year appear to be most satisfactory. Markets are being opened up abroad, particularly on the Continent and in Australia. A license to work the Company's patents in Germany has been arranged on satisfactory terms, and agencies have been established for Belgium, Holland, Italy, and Western Australia. Although the Board of Trade certificate for the Bastian meter is not yet in the Company's possession, the directors have obtained authority to state that the meter has been officially approved by the Board of Trade, and the certificate will be prepared in due course.

NEWPORT GASLIGHT.

The directors' report in reference to the proposed introduction of electric light into the burgh, which was adopted at the meeting on Saturday, states that the Company at its last annual meeting remitted to the directors to have the company formed into a limited liability company, with power to supply electric light or other illuminant as well as gas, and to take the necessary steps for procuring a provisional order for electric light next season. The directors reported that, while they were proceeding to carry out the remit, the secretary had received intimation that the Burgh Commissioners intend themselves to apply for a provisional order, and also to endeavour to have the Burgh Gas Supply Act, 1876, adopted, and to buy up the gaworks. The directors recommended the Company to postpone applying for a provisional order for a year, and to approve of a conditional arrangement come to with the Tayside Electric Company to this effect.

HARROW ELECTRIC LIGHT AND POWER.

Directors: Charles Colbeck (chairman); Edmund Robert Bartley Dennis; Robert Cary Gilson; Edward William Flemying Stiven, M.D., J.P.; Frederick Stuart Winkley. Consulting engineer: W. C. C. Hawtayne. Resident engineer: A. H. Shaw. Secretary and solicitor: R. E. H. Fisher.

Report of the directors (with abstract of accounts) presented to the shareholders at the fourth annual general meeting on June 14:

The steady progress made by the Company from its start has been continued during the past year, the number of lamps (8 c.p.) connected during that period being 2,985, and the number of consumers 92. The increased demand has made it necessary to order a new steam dynamo of 150 kw. (those now in use having a capacity of 60 kw. each only) and an electric pump. The dynamo is to be ready in September, and the pump has been already fixed. The boiler ordered in 1898 was fixed in the course of the year at the cost of £1,030. 15s. Besides the reduction in price from 8d. to 7d. per unit for current supplied for lighting purposes since Lady Day, 1899, the Company have supplied current for arc lamps and heating and cooking purposes at 4d. per unit. The works cost for the year has been reduced to 2·4d. per unit sold. Had the station remained in Messrs. Crompton's hands on the old terms, the working cost in 1899 would have amounted to an additional £321. The business of the Company has been pushed by the directors, and extensions made in Butler, Byron, College, Greenhill, Headstone, Kenton, Kimberley, Lowlands, Lyon, Middle, Lower, Mount Park, Oakley, St. Kilda's, and Vaughan roads, and Roxborough and Kenton avenues, Roxeth-hill, and along Northolt-road to the Roxeth new Sunday schools and the Harrow School laundry. A considerable part of the extensions has been carried out by the Company's engineer and men in a satisfactory and economical manner. The total cost of the extensions was £3,152. 13s. 10d. During the year 73 houses have been wired for consumers on the rental system, against 34 in 1898. Arrangements have also been made by which a large number of houses have been wired by the Company during building. This is especially advantageous, as building operations are now taking place on a large scale. The wiring business increased so rapidly that it appeared to the directors that it would be convenient and profitable for the Company to have their own wiring department, in addition to employing Mr. Tate, who had been carrying out all the work previously. They therefore made arrangements for starting the new department at the beginning of 1900, taking the office portion of Flambards, in High-street, as a showroom and wiring and general offices. There has been a considerable demand for current in that part of the Harrow urban district which was transferred to the Harrow district from Wealdstone in 1895, and as this area was not included in the Company's provisional order which was obtained in 1894, the directors came to the conclusion in the autumn that it would be advisable to apply for a provisional order for the district in question. As it was then too late for the Company itself to apply to the Board of Trade (notice having to be given under the Electric Lighting Acts to the local authority in June), the directors asked the District Council to make the application themselves on the terms of the Company paying all the expenses, and the Council transferring the order to them if and when obtained on the same terms as the original order was transferred, except that the repurchase clauses were to run concurrently with those in the first transfer. The Council assented, and application was made in November to the Board of Trade. The Board of Trade have now granted the order, and the Bill to confirm it has already been passed by the House of Lords. Prepayment meters have been supplied to consumers who desire them. They have been satisfactory, but have not been largely taken up. Of the £35,000 to which the capital of the Company was increased at the last annual meeting, £25,000 has been issued in ordinary and £7,500 in 4½ per cent. preference shares. Of the £25,000 in ordinary shares,

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£22,485 were taken up and paid for by the end of the year, and the remaining £2,515 applied for and allotted. Of the £7,500 in preference shares, £5,375 were taken up at the end of the year, leaving £2,125 available. It will be seen from the accounts that further capital is needed, and the directors propose that the authorised capital be increased by £15,000, and that of the whole capital so increased an amount not exceeding one-third may, in the discretion of the Board, be constituted preference shares, bearing a preferential dividend of 4½ per cent. The sum available for dividend after paying interest on debentures, mortgages, etc., is £1,296 14s. 3d. Out of this it is proposed to write a further £25 off leasehold property, to place £425 to depreciation of plant, to pay £92. 14s. 5d., being 4½ per cent., on the preference shares issued to the end of the year, and to pay a dividend of 3½ per cent. on the ordinary shares, which will absorb £745 5s. 5d., leaving a balance of £8. 14s. 5d. to carry forward. The directors received £150 as their remuneration, in accordance with the vote of the shareholders at the last annual meeting, and the shareholders are asked to settle their remuneration for 1900. Messrs. C. Colbeck and F. S. Winkley retire from the Board by rotation, and being eligible offer themselves for re-election. Messrs. Jackson, Pixley, and Co., the Company's auditors, also offer themselves for re-election.

REVENUE ACCOUNT.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel	£518	4	7			
Oil, waste, water, and engine-room stores	44	0	5			
Proportion of salary of engineer	96	5	2			
Wages and gratuities at generating station	322	1	1			
Repairs and maintenance	189	14	11			
				1,170	6	2
Distribution of Electricity.						
Proportion of salary of engineer	10	0	0			
Wages and gratuities and repairs, etc., of mains	47	2	3			
Repairs of meters, etc.	22	9	3			
				79	11	6
Rents, Rates, and Taxes.						
Rents payable	40	0	0			
Rates and taxes	167	1	10			
				207	1	10
Management Expenses.						
Directors' remuneration	150	0	0			
Salary of secretary	100	0	0			
Salary of consulting engineer	37	10	0			
Salary of collector	65	14	8			
Stationery, printing, and postages	101	16	2			
General establishment charges	31	4	10			
Auditors of Company	10	10	0			
Auditor under the order	12	0	0			
				508	15	8
Depreciation.						
Depreciation in respect of leasehold property	25	0	0			
Depreciation on assets	425	0	0			
				450	0	0
Special Charges.						
Insurances	40	13	8			
Repairs to house property	11	12	11			
Discounts, allowances, etc.	99	8	8			
				151	15	3
Balance carried to net revenue account				1,353	7	6
				£3,920	17	11

Cr.	£	s.	d.
Sale of current as under:			
At 8d. per B.T.U.	1,518	15	4
,, 7d. ,,	1,691	13	8
,, 6d. ,,	291	15	0
,, 4d. ,,	29	2	0
	3,431	6	0
Rental of meters, etc.	99	1	1
Installation rents	132	18	6
Sale and repairs of lamps	46	14	1
Rents receivable	175	3	9
Transfer fees	0	7	6
Commission received on sale of lamps and sundries	35	7	0
	£3,920	17	11

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount received	39,185	0	0
Amount due to bankers	3,423	12	11
Sundry tradesmen and others	1,501	17	10
Sundry creditors on open accounts	425	5	2
Depreciation fund account	535	0	0
Net revenue account	846	14	3
	£45,917	10	2

Cr.	£	s.	d.
Capital account—amount expended	43,017	10	1
Sundry debtors for current supplied, etc.	1,751	15	7
Other debtors	380	2	11
Stores on hand	768	1	7
	£45,917	10	2

PROVISIONAL PATENTS, 1900.

JUNE 11.

10606. Improvements in electrical fuse-boxes. Arthur Denby Smith, Sunbridge-chambers, Bradford.

10612. Improvements in arc lamps. Frederick William Martin, Frank Stewart, John Mootery Brown, and Nathan Glass Boggs, Corner James and Rebecca streets, Hamilton, Ontario, Canada.

10616. Electric bell-striking apparatus. Lorenzo Daw Tillyer and Edgar Derry Tillyer, 11, Queen Victoria-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Nov. 17, 1899, being date of application in United States.)

10637. Improvements in and connected with variable resistance boxes. Alfred Herbert Mayes, Norfolk House, Norfolk-street, Strand, London. (Complete specification.)

10638. Improvements in or appertaining to motor starters. William Phillips Thompson, 322, High Holborn, London. (The Fraser Electric Elevator Company, United States.)

10639. Improvements in or appertaining to controllers. William Phillips Thompson, 322, High Holborn, London. (The Fraser Electric Elevator Company, United States.)

JUNE 12.

10677. Improvements in telegraphy. Frederick William Zimer, 107, Finsbury-pavement, London.

10679. Improvements in or connected with fuse-boards for the distribution of electricity. Albert Reame and Charles Wokes, 8, Quality-court, Chancery-lane, London.

10688. Improvements in electric telephones and apparatus relating thereto. Lionel de Latour Wells and Alfred Charles Brown, Headquarters, Fire Brigade, Southwark Bridge-road, London. (Complete specification.)

10703. Improvements in the manufacture of filaments for electric incandescence lamps. Victor Thomas, 53, Chancery-lane, London.

10711. Improvements in and relating to electric signalling apparatus for railways and the like. Aristide de Filippi, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10713. Improvements in means to be employed in the electrolytic manufacture of bleaching liquors and chlorates. Paul Imhoff and the United Alkali Company, Limited 47, Lincoln's-inn-fields, London.

10717. Improvements in or relating to electrical switches. Sidney Alfred Hunter, 111, Hatton-garden, London.

10724. Improvements in electric current interrupters. William Phillips Thompson, 6, Lord-street, Liverpool. (The Voltohm Elektrizitäts-Gesellschaft, A. G., Germany.)

JUNE 13.

10743. Improvements in dynamos and motors. Claude William Hill, Broad-street House, New Broad-street, London.

10751. Improvement in electrical generators and electrical motors. William Henry Willatt, 4, Westcott-street, Holderness-road, Hull.

10755. Improvement in the governing by electricity of steam-engines and other prime movers. William Henry Willatt, 4, Westcott-street, Holderness-road, Hull.

10772. An improvement in or connected with laminated electric switches. Albert Reame and Charles Wokes, 8, Quality-court, Chancery-lane, London.

JUNE 14.

10808. Improvements relating to electric arc lamps. Herbert Arthur Couchman, 18, Southampton-buildings, Chancery-lane, London.

10811. An improved self-acting time switch or cut-out for electric arc lamps. Charles Alexander Henderson, 57, Queen-street, Edinburgh.

10833. Improvements in and relating to electric accumulators. René Fabry, 72, Cannon-street, London.

JUNE 15.

10890. A life-saving guard or fender for electric tramcars or other motor vehicle, which works automatically or can be worked with the driver with a foot press or hand lever. Arthur Hudson, 13, Fortune-street, off Manchester-road, Bolton.

10892. Improvements in metal conduits or covers for enclosing the wires or cables used for the transmission of an electrical current. Samuel Jevons, 77, Colmore-row, Birmingham.

JUNE 16.

10940. Improvements connected with electrolytic incandescent electric lamps. James Swinburne, 82, Victoria-street, Westminster, London.

10970. Improvements in electric telegraphs. Philip Middleton Justice, 55, Chancery-lane, London. (The Rowland Telegraphic Company, United States.)

10974. Improvements in electric accumulator electrodes or plates. Albert Ricks, 6, Lord-street, Liverpool. (Complete specification.)

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10985. Improvements in the production of soda and hydrochloric acid by electrolysis. John Wilkinson and John Henry Noad, 37, Cursitor-street, Chancery-lane, London.

11003. Improvements in electric railways. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (McElroy-Gruno Electric Railway System, United States.) (Complete specification.)

11006. Improvements in secondary electric batteries. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Arvid Reuterdahl, United States.) (Complete specification.)

COMPLETE SPECIFICATIONS ACCEPTED.

To be published on July 7.

1899.

12279. Electric telegraphs for ships and other purposes. Evershed and Vignoles, Limited, and Evershed.

12506. Automatic magnetic circuit-breakers. Lake. (Scott.)

12565. Windings of dynamo machines and induction motors. Abel. (Karmin.)

13018 Electric arc lamps. Barton and Gorham.

13994. Key switch for electrical circuits, particularly adapted for incandescent lamp sockets. Veritys, Limited, and Ridings.

13995. Carbon feeding mechanism of electric arc lamps. Veritys, Limited, and Ridings.

14224. Apparatus for electrically transmitting orders, signals, or indications from one place to another. Alcock.

14668. Movable electric lights. Farrell.

15614. Coin-controlled telephone registers. Hock and Happersberger.

16820. Electrically-controlled design-reading apparatus for punching Jacquard and like cards. Mills. (David and David.)

20227. Collectors and conduits for electric tramways. Taylor.

24536. Thermo-electric piles. Gottscho.

1900.

6185. Apparatus for winding wire and other material into coils and the like for electrical and other purposes. Heys. (Scott, Varley, and Anderson.)

6478. Electromagnetic mechanisms for producing reciprocating motion. Jones.

7100. Device for fixing incandescence electric lamps. Hollub and Mignal.

7410. Regulators for electric arc lamps. Käsbauer, Haberfellner, and Lenck.

7606. Electrical controlling switches. Lindstrom, Hewitt, and Hewitt.

7851. Electric incandescent lamps. Riebensahm.

8160. Electric switches. Ely.

8584. System of electric traction by surface contact. Tosi, De Felice, and Parboni.

8682. Apparatus for measuring electrical resistances, and chiefly intended for testing the electrical resistance of rail joints in the tracks of electric railways. Conant. (Date applied for under International Convention, Nov. 13, 1899.)

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	June 16	730	648	+ 82	1,454	1,274
Birmingham Tramways Co.	,, 16	4,449	4,350	+ 99	101,178	95,212
Blackburn Corp'rat'n	,, 16	468	461	+ 7	8,772	10,108
Blackpool Corporatn.	,, 14	1,238	551	+ 687	5,826	4,754
Blackpool-Fleetwood	,, 16	989	698	+ 291	8,718	8,709
Bolton Corporation..	—	—	—	—	—	—
Bradford City Trams	,, 17	577	572	+ 5	5 498*a*	4 296
Bristol Tramways Co.	,, 15	3,179	3 165	+ 14	—	—
City & South London	,, 17	1,480	899	+ 581	30,734	24 981
Dover Tramways ...	,, 16	214	189	+ 25	4,072	3,819
Dublin U.T., elec. cars	,, 15	3 665	2,233	+ 1,432	—	—
Dublin S.D. Electric	,, 15	1,005	1,189	- 184	—	—
Halifax Corporation	,, 14	813	609	+ 204	7 935	5,527
Hull Corporat'n E.S.	,, 16	1,304	—	—	12,759*a*	—
Liverpool Corporat'n	,, 9*b*	9,421	7,783	+ 1,638	164.707	144 323
Liverpool Overhead	,, 17	1,424	1,496	- 72	34,214	33,291
Sheffield Corporation	,, 17	2,280	—	—	—	—
South Staffordshire	,, 15	640	640	—	16,201	15,169

a Since April 1. *b* Partly electrical.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	⅜ ⅜
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 6½
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	¾-1
—— 6 per cent. Cum. Pref., 1-50,000	1	—	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	108	—	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4⅝-5½
Brush Electrical Engineering, Ordinary	2	—	1⅝ 1⅞
—— Non. Cum., 6 per cent. Pref.	2	—	2-2⅛
—— 4½ per cent. Debenture Stock	100	..	109-114
—— 4½ per cent. 2nd Debenture Stock	100	—	103-105
Callender's Cable, Debentures	100	—	112-116
—— Ordinary	5	—	13¼-14½
—— 5 per cent. Pref.	5	—	5⅛-6
Crompton and Co.	3	—	3½ 4
—— 5 per cent. Debentures	—	..	100 103
Edison and Swan United, Ordinary	2	—	2-2⅛
—— 5 per cent. Debentures	5	..	3¼-4⅛
—— 4 per cent. Deb. Stock, Red.	100	..	93-95
Electric Construction	2	..	2-2⅛
—— 7 per cent. Cumulative Pref.	2	..	3-3⅛
—— 4 per cent. Perp. 1st Mort. Deb.	100	..	103-106
W. T. Henley's Telegraph Works, Ordinary	5	—	13-14
—— 4½ per cent. Preference	5	—	5⅛-5⅝
—— 4½ per cent. Debentures	100	..	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	..	21-22
—— 4 per cent. Debentures	100	—	100-103
Telegraph Construction and Maintenance	19	..	35 39
—— 5 per cent. Bonds	100	..	102 105
Telegraph Manufacturing, Ordinary	5	..	10½-11½
—— 5 per cent. Cum. Pref.	5	..	5⅛-6
Wilkins and Robinson, Ordinary, 1-30,000	5	..	11-12
—— 6 per cent. Cum. Pref., 30,001-60,000	5	..	6⅞-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	⅝-¾
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	—	..	8½ 9½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	..	6¾-7¼
Charing Cross and Strand	5	..	9-10
—— 4½ per cent. Cum. Pref.	5	..	5½ 6
Chelsea Electricity Supply	5	..	6¾-7⅛ xd
—— 4½ per cent. Debentures	100	..	107-110 xd
City of London, Ordinary	10	..	8-9
—— 6 per cent. Cumulative Pref.	10	..	12½ 13½
—— 5 per cent. Debenture Stock	100	..	124 129
County of London and Brush Provincial, Ordinary	10	..	9-10
—— 6 per cent. Cum. Pref.	10	..	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	..	110-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	..	4½-5
—— 4½ per cent. First Mort. Deb.	100	..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	..	9½-10
London Electric, Ordinary	3	..	1-1½
—— 6 per cent. Pref.	5	..	4-4½
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-100 xd
Metropolitan, Ordinary	10	..	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	113-116
—— 3½ per cent. Mortgage Debenture, Red	100	..	97-99
Notting Hill Electric Lighting	10	..	16-17
Oriental, 1879	1	..	1½-1⅝
—— £5 Shares	5	..	7-7½
—— £4½ Shares, New	4½	..	6½-6⅝
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6-6⅝
River Plate Electric Light and Traction, Deb.	100	..	78-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2½
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	3	..	3¾ 4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-15½
—— 7 per cent. Pref.	5	..	8½-9½
Westminster, Ordinary	5	..	11 12
Electric Railways.—			
Central London, Ordinary	10	..	10-10⅛
—— Pref. Half-Shares	5	..	4¾ 5⅛
—— ,, ,, deferred	5	..	5-5⅛
City and South London, Consolidated Ordinary	100	..	65 68
—— Ordinary	10	..	6-7
—— 4 per cent. Debenture Stock	100	..	123 128
—— 5 per cent. Pref. Stock '91	0	..	140-145
—— ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	..	13½-13¾
Waterloo and City, Ordinary	100	..	100 103
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17½-18½
Brisbane Tramway	100	..	102-104
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10½-10⅝
British Electric Traction, Ordinary, 1-30,000	10	..	16-17
—— 30,001-75,000	10	..	16-17
—— 6 per cent. Cm. Pf. 30,001-60,000	10	..	12½-13½
—— 5 per cent. Perpetual Debenture Stock	100	..	124-127
—— ,, ,, 1900	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	..	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4½
—— 5 per cent. Deb. Stock, Red.	100	..	101-104 xd
Isle of Man Electric Power, 1-95,000	1	..	⅛-3/16
—— 6 per cent. Preference, 100,00.-170,000	1	..	3/16-¼
Kidderminster and District Lighting and Traction, Pref.	10	..	9½-10
New General Traction, Ordinary	5	..	3½ 3¾
—— 6 per cent. Cum. Pref.	5	..	4⅞-5⅛
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— Preference	10	..	10⅝-10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	..	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	..	9½-10½
Telephones.—			
Consolidated Telephone Construction and Maintenance	½	..	½-¾
National Telephone, Ordinary	5	..	4⅞-5⅛
—— 6 per cent. Cum. First Pref.	10	..	12-14
—— 6 per cent. Cum. Second Pref.	10	..	12-14
—— 5 per cent. Non. Cum. Third Pref.	5	..	5-5⅛
—— 3½ per cent. Deb. Stock, Red.	100	..	98-101
Oriental Telephone and Electric Company	1	—	15/16-1 1/16

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NOTES.

The Rontgen Society.—The annual general meeting of this society will be held on July 5, when the presidential address will be given by Mr. Wilson Noble.

Personal.—We are glad to note that Dr. Oliver J. Lodge, professor of experimental physics of the University College, Liverpool, has been appointed principal of the University of Birmingham. We congratulate the University.

Royal Meteorological Society.—The second afternoon meeting of this society for the present session was held last week, when Mr. H. Marriott read a paper on "Rainfall in the West and East of England in Relation to Altitude above Sea-Level." A paper by Mr. J. Baxendell was also read giving a description of a new self-recording rain gauge designed by Mr. F. L. Halliwell, of the Fernley Observatory, Southport.

Bombay Technical Institute.—We notice in *Indian Engineering* that Mr. S. Rebsch, M.I.C.E., has been appointed chairman of the Board of Management of the Victoria Jubilee Technical Institute, Bombay, in the place of the Hon. Mr. W. C. Hughes, M.I.C.E. Mr. N. A. F. Moos, B Sc., F.R.S.E., is the hon. secretary, whose long connection with the College of Science in Poona should necessarily conduce to the advantage of the institute.

Suez Canal Navigation.—The Suez Canal Company has, we learn, recently made various regulations for ships using the canal. Thus no vessel will in future be allowed to pass through the canal unless it has on board at least one electric searchlight capable of lighting the channel 1,400 yards ahead, and so constructed as to enable the beam to be split up into two segments very rapidly. It must also be provided with electric lights capable of lighting up an area of 240 yards around the vessel.

British Association.—The annual meeting of the British Association will this year commence on Sept. 5, and will be held at Bradford. The president is Sir W. Turner, of Edinburgh, and he will deliver his presidential address on the day named. Amongst those who are to lecture are Prof. Gotch, who will speak on "Animal Electricity"; Prof. Thompson, who will lecture to artisans; and Prof. Stroud, who will give a lecture dealing with "Range Finders." As usual, excursions are to be paid to places of interest in the surrounding district.

Society of Model Engineers.—The members of the Society of Model Engineers paid a visit last Thursday to the Swindon works of the Great Western Railway. The various departments of these extensive works were visited in turn, including the boiler shop, foundry, turning, fitting, and erecting shops, the forges and rolling mills, the carriage and wagon shops, the pattern stores and painting shops, etc., thus forming a highly interesting and instructive tour. Later in the day the members visited the rooms of the New Swindon Junior Engineering Society, where an excellent collection of engineering models had been arranged for their inspection.

American Institute of Electrical Engineers.—We have received a copy of the February number of the *Transactions* of the American Institute of Electrical Engineers. This number contains a paper on "The Evolution of Safe and Accurate Fuse Protective Devices," which was read on March 28 by Mr. J. Sachs. This paper, which contains some suggestions as to fuse construction and placing, might be read by the electrical engineers of the Paris Exhibition with advantage, the way the fuses are put in the Exhibition being very dangerous. In the volume in question there is also a discussion on a paper by Lieutenant Squier on "An American Pacific Cable." A short notice of the Paris Exhibition as seen on Aug. 16 last and an obituary notice of Mr. Samuel Dana Greene complete this number.

Institution of Electrical Engineers.—We have received the number of the *Journal* of the Institution for May. This volume contains the paper on "Storage Battery Problems" by Mr. E J. Wade and the discussion on the same; Mr. Grove's paper on "The Electrical Equipment of Ships of War," the paper "On Distant Power Transmission" by Prof. G. Forbes, and also a paper on a "Method of Charging for Public Supply of Electricity" by Mr. W. W. Lackie. This latter paper, our readers will remember, was read at the Glasgow section of the Institution on March 23. We would remind our readers that the library of the Institution is open daily from 10 a.m. to 6.30 p.m. except on Saturdays, when it closes at 2 p.m. It will not be open, however, from Aug. 17 to Sept. 16. The price of this portion of the *Journal* is 4s. 6d.

Jewel Robberies.—The old trick of a man representing himself to be a workman come to examine the electric light fittings, etc., and then robbing the house does not yet appear to be quite extinct. Thus an enterprising individual is just now going about on the same errand, and by a great display of electric fittings and tools usually gains admittance to a house, especially if the occupants have but recently moved into it. When anyone is in the room he is very busy with the switches, wiring, etc., but he usually manages to make a considerable haul of jewellery before leaving. Over a score of robberies of a similar nature have been recorded in the books of the police in various West-end districts quite recently, and it is estimated that the thief has taken something like £10,000 worth of jewellery, not one item of which has been traced or recovered.

Platinum in Electric Lamps. — It has been generally believed that platinum was used for the leading-in wires of incandescent lamps, on account of the fact that its coefficient of expansion is the same as that of glass. Owing to this belief, several misinformed inventors have experimented with various alloys, and found a means of varying the coefficient of expansion by varying the proportion of the different metals used, and thereby obtaining the desired similarity with that of glass. The objection to the use of other metals than platinum is, on the contrary, not discrepancy in thermal expansion, but the fact that all but platinum oxidise. No matter what care is taken to keep oxygen from the metal, a thin film forms around the wire between it and the glass, allowing a slow leakage of air, which gradually breaks down the high vacuum necessary for good incandescent lamps.

Automobile Accumulators.—In Mr. Carl Hering's digest in the *Electrical World* we notice the following abstract of a paper by Mr. Weber, which states that, if there is only one motor, he favours series parallel control by dividing the battery into two halves; the danger that one-half is discharged sooner than the other, and that, therefore, local discharges occur from one half into the other, is small, as the parallel connection is used only for short periods; a rheostatic control while all cells are in series means waste of energy. He thinks that the scheme of some designers to divide the battery into four parts goes too far. In the choice of a battery for an automobile, it should be considered that the cells, while being shaken on the road, give a smaller capacity than while at rest, which is somewhat surprising, as shaking causes a better circulation of the acid; the main causes of the decrease of capacity are, however, momentary overloads. He thinks that for reasons of safety a capacity of 40 per cent. higher should

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be chosen for automobile work than for work requiring the same energy, while the battery is discharged at uniform normal rate while at rest.

Paris Congresses.—The next congress of interest to our readers will be the Chemical Congress, which is to be held in Paris from July 17 to 22. The congress will take place under the auspices of the Société Chimique de Paris, and will include meetings for discussion and visits to the Exhibition and to laboratories devoted to the study of chemistry. The price of admission to the congress is fixed at 10fr., which gives the right of attending all the conferences and visits, to receive a copy of the *Proceedings* of the congress, and free entry into the Exhibition while the congress lasts. A banquet is to be held in connection with the congress on July 19, in the rooms of the Hotel Continental, the price for tickets being 25fr. The president of the organisation committee of the congress will be Mr. M. Berthelot, hon. president of French Chemical Society. The vice-president is to be Mr. M. Hauriot, who is on the council of the French Chemical Society, and the members of the committee (Messrs. A. Gautier, H. Moissan, R. Engel, J. Meunier, and A. Béhal) are all connected with this French society. The secretary of the congress is Mr. G. Bertrand, 188, Boulevard Voltaire, Paris.

Telegraphic Writing.—The Vienna correspondent of the *Daily News* has once more contributed an article concerning the wonderful results obtained by Messrs. Pollak and Virag in the above-mentioned town. It will be remembered that the experiments which he chronicled at the end of last year were said to have resulted in 80,000 words being sent per hour by a single wire. The inventors then went to the United States to try their apparatus, and also, we believe, to increase their powers of exaggeration. In this latter they seem to have been quite successful. On their return we learn they further improved their machines, and the messages are sent and written out telegraphically in a clear, round hand with the very low minimum rate of 50,000 words per hour. The explanation of the manner in which this object is obtained is given by the authors as follows: "We influence the mirror at the sending-off station in such a manner by suitable vibrations of the current that it uses the ray of light which falls upon it as if it were a pen, and draws signs with it just as if it were a human hand writing on the sensitive paper at the other end of the wire." It is interesting to note that in the messages received by the *Daily News* correspondent the letter "i" was not dotted.

Automobile Competitions.—There has just been concluded in Berlin a competition instituted by the Mitteleuropaischen Motorwagen Verein between various types of electromobile cars. On the first day the weights, dimensions, and other particulars of the competing cars were ascertained, and subsequently the batteries of the cars were discharged to the minimum potential permitted, this being about 1·83 volts per cell, and then recharged in order to determine their respective capacities. They were then left in a charged condition until the following day, in order to ascertain if any deterioration had occurred. On the second day, after an inspection of the cars, a trial run at an average speed of 9½ miles per hour was entered upon in order to ascertain the consumption of energy. After about three-quarters of the predetermined capacity of each car battery had been discharged, the return journey was made to the starting point, where the remaining charge in the batteries was discharged through resistances, the potential of the cells being observed during the operation. The batteries were then recharged again. The tests were conducted with considerable care, and although the trials were of too short a duration to indicate the ultimate endurance of the competing accumulators, some interesting results were obtained as to the carrying capacity and range of the electromobiles.

Electric Shocks.—An inquest was held last week on the body of a night watchman employed at the Deptford electricity works. From the report of this inquest it can be clearly seen that whenever the smallest opportunity is given them, an intelligent jury will blame electricity for sins which it did not commit. Thus the deceased man had failed to obtain a certain situation on account of his heart being very weak. At the time of death he was passing a switchboard, and the voltage of the conductors nearest to him was 2,500. He was carrying a bucket with a fire in it when he suddenly fell and died. At the post-mortem examination the cause of death was given as asphyxia, the cause of this being unknown. There were no burns to be seen, as would be expected if he had received a shock. Dr. Jones, of St. Bartholomew's Hospital, stated that he had studied the question of death from electric shock for some years, and had never known a case with such a high voltage where burning did not take place. There were no signs on the conductors of anyone having come near them, and he thought the cause of death was heart disease. Other witnesses practically proved that the deceased did not receive a shock, but yet the jury found a verdict of "Death from asphyxia caused by an electric shock." One juryman only dissented from this verdict, he not considering the evidence such as to warrant it.

North Metropolitan Power Bill.—We are pleased to be able to congratulate the promoters of the North Metropolitan Power Supply Bill on having been the first to secure the consent of the committee of the House of Commons to their Bill. This consent, which was given on the 20th inst., was in the following terms: "The preamble of the Bill is proved, but in view of the importance of the principle involved, the committee will postpone the consideration of clauses until Thursday, 28th inst., with a view to securing as much uniformity of decision as possible with the other Bills now before the Electric Power Supply Committee." It is difficult to foresee what will be the ultimate development of these Power Bills, but we trust that lax parliamentary proceedings will not be allowed to frustrate the hard work done by the Parliamentary Committees and the promoters of the Bills. It will be seen that the final clauses of the Bill are not to be fixed until those of the group of five Bills now before a committee have been decided upon. We trust that this decision will be given promptly, in order that there may be no excuse for the House of Lords to allow the Bills to fall through on the score of want of time. From an electrical engineer's point of view it would be well perhaps to postpone the date when grouse shooting commences, in order that these Bills, so important to the electrical industry, may be decided definitely, and we trust in a way which is favourable to the progress of that industry.

Municipal Telephones. — The example set by Glasgow with respect to municipal telephones was not long in being followed by other municipalities. The latest town that we hear of to take up this branch of work is Brighton, who have just asked the Postmaster-General for a license to work telephones in their district. The Town Council propose to make a maximum charge of £7 per annum for a full service to each subscriber, as against £10 charged by the National Telephone Company. The toll, however, which it is intended to charge is not to be this maximum, but £5. 10s. for a full service, or an alternative minimum charge of £3. 10s. on the "penny-a-call" system. These rates, if the license is granted, should prove a great convenience to the smaller traders and private householders in Brighton, as while £10 may

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be considerably more than the worth of a telephone to any person, he would not mind just over half that amount, or if he did not use the telephone a great deal, £3. 10s. would suit him very well. Mr. A. R. Bennett has prepared an estimate of the cost of the establishment of a system such as is proposed. In this estimate he states that to establish a system with 2,000 subscribers would involve a capital expenditure of about £43,280. The annual working expenses are given at £10,269, and the profit, £1,200. The district included in the license contains not only Brighton and Hove, but also the area between Rottingdean on the east and Shoreham on the west, and also a considerable distance north.

A New Conductor.—We notice an article in *Electricity* of New York describing a new electrical conductor. This is called "phono-electric," and is said to be an exceedingly high-grade wire, admirably adapted for telephone, telegraph, and trolley use. It is said to be perfectly homogeneous both in mechanical and molecular structure, and does not depend on a hardened skin for its strength, as in other drawn wires. Tests made with this wire by removing successive strata on the surface of the wire, showed its tensile strength to be uniform throughout the whole diameter. Hard-drawn copper wire subjected to the same treatment was found to have only the strength of soft copper once the skin was removed. As to the equally important power of enduring severe strains without taking a permanent stretch, a set of comparative tests showed that "phono-electric" had an elastic limit 40 per cent. greater than that of hard-drawn copper wire. It was also a remarkably tough wire, which enabled it to resist bending, kinking, etc. In electrical work the trolley wire comes in for hard service. At turnouts it often comes in for hard knocks from the trolley, and it constantly happens that the passage of the trolley wheel is accompanied by small arcs set up between wheel and wire. These burn and roughen the wire and anneal parts of its surface. If the wire is ordinary hard-drawn copper, the hardened skin is destroyed, and the wire rapidly gives way. This is the secret of the breaking of trolley wire at curves where there is heavy service, arcing being established by the flange of the trolley wheel. "Phono-electric" is free from this difficulty, as it does not maintain an arc readily. Its fusing point is high, and it does not furnish enough metallic vapour to keep an arc going. It also does not rust or corrode, and for long and difficult spans and for telephone and telegraph lines in exposed places it should be extremely useful.

Railway Head-Lights.—We notice in the *Scientific American* an illustrated notice of the electric head-lights now in use on certain railways in the United States. It may be remembered that in a previous issue we commented on these head-lights, at that time the proposal being to use them for signalling purposes. For this purpose we think them entirely unsuitable, but for the uses to which they are now put there is much to be said. Thus in many instances the railway tracks are not separated from the fields and grazing lands by fences, and the farmers allow their cattle to roam at large over these lands, possibly because the compensation which they obtain from the railway company if any are killed is greater than the price obtained in open market. However this may be, the companies have annually to pay large sums in compensation. In view of this, with the old oil lights on the engines, the trains at night had to crawl through the grazing lands for fear of running over cattle. With these new electric head-lights, however, it is shown by our contemporary, by photographs taken at distances of 1,000ft. and 2,500ft., that cattle straying on the line could be easily distinguished at over half a mile. In the photographs small posts, level indicators, etc., can be clearly seen at very considerable distances. The lights are, of course, of the arc type, and the electricity is generated by an ordinary dynamo operated by a Pyle compound steam-turbine of 1½ h.p. The light with a good reflector equals about 8,000 c.p. The dynamo and turbine are attached to the top of the boiler between the head-light and the smoke stack, and steam is introduced into the turbine from the main boiler at the will of the engineer, the mechanism, of course, being operated from the cab. One set of carbons can be used continuously for about eight hours, so that it is unnecessary to attend the lamp during that time.

Injuries from Lightning.—The meteorological report of the United States for the year 1899 gives some interesting information with respect to the fatalities and injuries due to lightning in that year. From this report, as condensed in the *Electrical World and Engineer*, we gather that in the United States 562 persons were killed and 820 persons injured during that time, making a total of 1,382 casualties, or nearly four casualties every day on the average. Among fatalities, it would seem that nearly half were indoors and half out-of-doors, and of the latter 11 per cent. were under trees. Among the injured, about 70 per cent. were struck when indoors, and 30 per cent. when out-of-doors, and of the latter 6 per cent. were under trees. Our contemporary adds that the figures are, however, probably quite unreliable in regard to deductions as to the relative safety or danger of localities in which accident may occur, because on the near approach of a thunderstorm it is customary for all persons to take shelter indoors when possible, and consequently the number of people within doors during the prevalence of a storm would probably be many times the number of people out-of-doors at the same time. There is no information to be gathered from the report as to the efficacy of lightning conductors on buildings, and we are still as far as ever from any conclusion as to what precautions are necessary to render a building absolutely safe from lightning discharges. It will be remembered from Prof. Lodge's paper at the Institution that it is exceedingly probable that while a lightning conductor may be quite capable of dealing with all ordinary discharges from the clouds, a single rod such as is usually installed is quite incapable of providing a path to earth for a highly oscillatory discharge, such as sometimes occurs in heavy thunderstorms. Against such discharges an iron network stretched over the building seems to give more immunity than any other conductor.

Rival Illuminants.—The present high price of coal has, of course, seriously affected the cost of electricity from a central-station engineer's point of view, but up to the present we have heard no rumours even of any advance being made in the price of electricity to private consumers. It is a good sign of the progress which has been made in the cheap production of electrical energy that central-station managers are able to stand a very large increase in the cost of coal without making a corresponding increase in the cost of the energy supplied. The gas companies do not seem to be in such a favourable position, and the Gaslight and Coke Company are considered by the public to be the chief offenders, inasmuch as they have notified an increase of 6d. per 1,000 cubic feet, to take place forthwith. We very much fear that if a radical change is not made in the Board and staff of the above gas company a further increase in price will soon be found necessary to make up, not for a further increase in the cost of coal, but for a decreased output. The inhabitants of the districts supplied by the company find it exceedingly hard to undertand the reason why they should, under ordinary conditions, pay about 1s. more per 1,000 cubic feet for gas than those more fortunate

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inhabitants of London living on the south side of the river. The present increase will, of course, drive many more to use electric light instead of gas, and we are quite sure that when the change has once been made, the decreased cost and increased comfort will keep these consumers on the electricity mains in spite of any future decrease in gas. It is no doubt most important that a large company like the Gaslight and Coke Company should preserve its dignity and maintain its dividends, but in the present instance we fear that they are playing much too much into the hands of their rivals for any ultimate benefit to be derived. It is a fortunate thing that the Metropolitan Electric Supply Company have now their Willesden supply station in good order, so that they will be able to do their share in supplying the gas consumers who refuse to pay 3s. 5d. per 1,000 cubic feet.

Institution Conversazione.—On Tuesday last the annual conversazione of the Institution of Electrical Engineers was held in the Natural History Museum, South Kensington. This museum has been chosen for so many years by the members of the Institution as the meeting-place for their conversazione that nothing remains to be said concerning it, except that the stairs and galleries form coigns of vantage from which a good view of the gathering in the main hall can be obtained. The result of the numerous rooms and galleries which were thrown open was that it was exceedingly difficult to find any particular member one might wish to see. Any endeavour in this respect is, of course, hampered by the fact that such a large number of friends one is pleased to see interfere with the search. The President (Prof. J. Perry) and Mrs. Perry received the members and their ladies at the main entrance, and a number of the members of the Council also took up a position near this point so that they could support Prof. Perry in his arduous task of shaking hands with some 1,500 guests. Some excellent music was provided by the string band of the Royal Engineers, by the kind permission of Major-General Sir T. Fraser. As the various exhibits in natural history have been thoroughly inspected by most members at previous conversaziones, the greatest attraction of the evening was, of course, the meeting of old professional friends. The meeting was the more enjoyable from the fact that it has been during the past session almost impossible to enjoy the reunions after each meeting of the Institution, owing to the exceedingly late hour to which the discussions were allowed to continue. While on this topic we might remind the President and Council that the discussion of technical papers is not the sole object in life of electrical engineers, and that for every one member who speaks in the lecture theatre there are half-a-dozen who will discuss the subject in the tearoom after the meeting, provided that they have not to sleep in town in consequence. As a whole, the conversazione of 1900 was undoubtedly a success.

Charging Electrical Vehicles.—The handling of a number of electrical vehicles in a charging station is not the simple problem which one would be led to expect on first consideration. We remember that the London Electric Cab Company had an independent charging circuit for each set of accumulators, and an ammeter in each circuit. It was found, however, by the above company that the means of charging were none too complete. There are numerous other details which have to be attended to in the upkeep of such electrical vehicles, and which have a great influence on the ultimate cost of upkeep of the same. The New England Electric Vehicle Transportation Company, of Boston, have recently equipped their charging station, and a few notes on the same may be of interest. From the description appearing in the *Electrical World* we gather that the company started in May, 1899, with three cabs. It now handles some 150 vehicles, to which 30 more cabs are soon to be added. The equipment now under construction for handling the batteries will provide eight loading stands fitted with vehicle-centering devices, and an arrangement for pulling the batteries out horizontally and replacing them with others. Power for charging the batteries is obtained from the Boston Edison Company's three-wire circuits, boosters being used to ensure that the voltage supplied to the batteries shall always exceed their counter E.M.F. The control of the charging current is effected by means of a rheostat. For shifting the vehicles round the building, an arrangement which is called a trolley is used. This consists of a two conductor cord and attachment plug hung from the centre of the roof and counterweighted. A source of current supply is obtained from the two-conductor cord for moving the vehicle around the station by means of its own motors. The trolley supplies current at low voltage, so as to enforce slow motion. This arrangement does away with the need of men to move the vehicles. There is also another trolley for use over the three pits which are provided to give easy access to the running gear for inspection and repairs. This trolley supplies power to run the motors when under test for electrical faults in the apparatus or connections. The inspection of the vehicles is very complete. Every morning every vehicle that has been out is looked over by three men, one of whom is an inspector, who goes over every bolt of the running gear, screws up every contact of the circuits, files the controller fingers, and examines the commutators, brushes, etc; the second is an oiler, who oils the wheels of all vehicles one day, the running gear the next, and the motors the third; the duty of the third man is simply to inflate the tyres, the inflation being accomplished with compressed air at 140lb. per square inch. These men catch many faults before they become serious enough to do any damage. Once a month each vehicle is practically dismantled and reassembled, all wear being taken up and severely worn parts being renewed. A special room is fitted up for tyre repairs. The batteries are also well looked after, the plates being separated from time to time, each being scraped with blunt tools and scrubbed with brushes before replacing. The specific gravity of the acid is also carefully measured by means of an arrangement consisting of a hand suction pump, which draws the acid from the battery jar up through a flexible rubber tube into a piece of glass tubing, within which an hydrometer is mounted. With a few strokes of the pump the acid is drawn up until the hydrometer floats, when it can be read, after which the acid can be restored to the battery jar by simply admitting air. Records are kept of all tests on the vehicles, and a ring of sub-charging stations is being placed in the city at a radius of four or five miles from the central station.

Measuring Alternate Currents.—The following is an abstract of a paper contributed by Mr. Benischke to the *Elektrotechnische Zeitschrift*. The abstract, which appears in the *Electrical World* of New York, reads as follows: "The paper describes the instruments of the General Electric Company, of Berlin. They are of the dynamometer type, with magnetic damping. Magnetic damping has so far been supposed to be impossible in wattmeters of the dynamometer type, especially if they are to be calibrated with continuous current, because the damping magnet distorts the field in such a manner that no practical scale can be obtained, and because under the influence of the alternating current the permanent magnetism is diminished by-and-by, and therefore also the damping effect. If, however, it is intended to calibrate with

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alternating current, wattmeters can be constructed which contain iron, therefore it was his first endeavour to improve the methods of calibrating so that wattmeters of the dynamometer type can be calibrated with alternating current. The general scheme of the instruments described is as follows: a movable coil mounted on an axle, the direction of which is determined by springs, is deviated under the influence of a fixed coil; for damping, the axle is provided with an aluminium disc, which oscillates between the poles of a permanent magnet; the whole dynamometer is surrounded by a laminated iron mantle of such a form that the magnetic lines of force are running through the iron mantle, and do not touch the damping magnets; the internal part of the instrument, where the movable coil is oscillating, is free of iron; the magnetic circuit is therefore far from being closed. The instruments described and illustrated are a voltmeter, a wattmeter, and two ammeters. He shows that the indications of the wattmeter are practically independent of the angle of phase, as the ratio of the reactance and the resistance in the shunt coil of his wattmeter is very small; the wattmeter gives practically correct readings even with a very great phase difference in the main circuit, as in measurements of the no-load loss of transformers. The readings of the instruments are theoretically dependent upon the frequency, as the deviation of the movable coils depends upon the current in the same, and this current upon the impedance and the reactance upon the frequency; but the reactance is extremely small, compared with the resistance, so that the impedance is practically equal to the resistance, and therefore independent of the frequency; hence, also, the readings of the instrument are practically independent of the frequency. He found that the differences between the readings for alternating current of 50 periods and for continuous current were very small, and concludes that if the influence of the frequency is so small, there can be practically no influence of the wave-form. As the magnetic circuit is far from being closed, the magnetisation of the iron mantle is very small, and there is practically no influence of the hysteresis. In the discussion which was held on a following meeting, Franke questioned the practicability of calibrations with alternating current; in a wattmeter of somewhat similar construction, but with a more closed magnetic circuit, he has found that hysteresis caused extremely wrong results; he also said that it is difficult to get aluminium free of iron, and that, therefore, aluminium should be used very cautiously in magnetic fields. Benischke denied the influence of hysteresis in his instruments; he also said that in the meanwhile he has succeeded in making the difference between calibration of his ammeters with continuous current and with alternating current so small that it is now only about 0·2 per cent., so that the ammeter may be calibrated just as well with continuous current as with alternating current. With the voltmeter he obtained nearly as good results."

Units.—In the June number of the *Journal* of the Franklin Institute, Prof. R. A. Fessenden publishes an article on "Electromagnetic Mechanism." In it he again refers to the unit question, and gives the following dialogue to illustrate the trouble which is now experienced in teaching students. An electrical unit maker is supposed to be showing a one-volt cell to an electrical engineering student, and the dialogue opens with the statement from the unit-maker that "this cell gives exactly one unit of electromotive force." Student: "Why was that name given to the quantity?" E. U. M.: "I perceive that you misunderstand me; that is not its name—it is what it is called. Its real name is the volt." S.: "I beg your pardon. Why is it called by the title electromotive force?" E. U. M.: "Because it is not a force, and has no immediate connection with motion, that being determined by its space differential." S.: "Well, if that is what it is——" E. U. M.: "Permit me to interrupt you. It isn't. It really is the unit difference of electrical potential. It is defined as the unit difference of electrical potential." S.: "Ah! now I understand. You explained potential very fully to me yesterday. It is equivalent to electrical energy, then, isn't it?" E. U. M.: "Not at all; not at all. You misconceive me entirely. It is true that we generally connect the idea of energy with the word potential; but in this case we use it in a special way. It really is only one factor of energy, and to get the electrical energy you must multiply it by another term, quantity of electricity." S.: "You will excuse me for a moment, I am a little dazed. As I understand it, then, this unit——" E. U. M.: "You must be very careful. There are three units. This is not the real fundamental unit. That is only one one-hundredth millionth of the volt. The volt was chosen this size for your especial convenience." S.: O, Lord! (After a pause) Then this other term which I see, magnetomotive force, is that also so called because it is not a force and has nothing to do with motion?" E. U. M.: "Exactly." S.: "But from the definition of unit current it certainly seems as if there must be some tendency for a magnet to move round a wire carrying a current in the direction of the magnetomotive force." E. U. M.: "Not at all. That definition was adopted for the sake of making the idea more simple; but, as I have on several occasions noted that professors of electrical engineering have published articles in the technical journals in which, the magnetic lines being represented by vortex rings, they have stated that these rings rotated round the axis of the wire as well as around the axis of the vortex, it may not be so clear as it was originally thought to be." S.: "And still I am at fault. Surely this unit magnetic pole——" E. U. M.: "There is no unit pole. True simplicity is obtained by defining things in terms of other things which cannot exist, calling them by names which are as misleading as it is possible for them to be, multiplying them by all sorts of constants, and stirring the whole thing up with a stick. By giving eight or ten names to the same quantity, and using the same term with different significations in different connections, still further advantages are obtained. By a judicious extension of these principles, and the adoption of still other practical units, it is hoped in time to have a system which no one can understand." After poking fun in the above way at the state of things as they now are, Prof. Fessenden explains what he would like to have. He says how much better it would be to call a certain quantity the voltage, the integral of it the voltance, the intensity of it the voltivity, and the absolute unit itself the volt. By following this system 110 volts would then be 11 bega-volts, and there would be no practical units, and all units would be connected by equations without constants. Similarly, gilbertage, gilbertance, gilbertivity, and gilbert. As regards symbols, E would stand for voltance, F for voltivity, and E for time rate of change of voltage. We consider offhand that endless confusion would result from Prof. Fessenden's proposal, as if the absolute unit was the volt, numberless volumes would be rendered quite useless for reference, and the confusion between volts and bega-volts would not be simplified by the fact that there were actually no practical units left. In the same way we consider that too much importance is attached to the supposed inconvenience of the use of 4π in electrical formulæ. To the engineer using the slide rule for a table of logarithms there is no inconvenience whatever.

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THE VERBAND DEUTSCHER ELEKTROTECHNIKER.

EIGHTH ANNUAL MEETING AT KIEL.

[BY OUR OWN CORRESPONDENT]

There were many members of the Verband Deutscher Elektrotechniker who, when Kiel was first mentioned as the selected centre for the eighth annual meeting of the Verband, were inclined to doubt the suitability of the place for the purpose in view, but now that the meeting has come and gone nobody will venture to deny the wisdom of the selection. The meeting, which, as usual, extended over four days, commenced on Sunday, June 17, and must be proclaimed a huge success. The delightful surroundings of Kiel no doubt contributed in a large measure to this happy result, while to the natural attractions of the town others had been added in the shape of a large squadron of battleships, etc., which were anchored in the bay in anticipation of the "Kieler Woche," and the arrival of the Kaiser as a guest in connection with that event. It is not our intention to describe the town itself or its many interesting institutions—suffice it to say that it enjoys an equivalent importance in Germany to our Portsmouth at home.

But besides being Germany's most important naval base and marine shipbuilding centre, the town possesses the charms inherent to a magnificent position and great natural beauty. In its industrial aspect Kiel has made rapid strides since its incorporation with Prussia in 1867, and its subsequent selection as a naval base. From a town of 24,000 souls the place has developed since the date in question, until it can now boast some 100,000 inhabitants.

The Marine Academy Kiel.

The pride of Kiel are the delightfully-wooded heights which skirt the town on the Düsternbrook side. From these heights a commanding view of the splendid harbour with all its shipping is obtained. No words could do sufficient justice to the superb and quiet beauty of the woods themselves, nor to the panorama which they command. The trees with their luxuriant foliage in pleasing contrast extend to the water's edge. Walking towards Düsternbrook we approach a large establishment—the Hotel Bellevue. It has a delightful position, with the advantage of an unexcelled view of the bay below. This was the spot which many of the members of the Verband and others taking part in the meeting, including the writer, selected as their headquarters.

The Government Dockyard, Kiel.

Of the industrial establishments of the town, those belonging to the Government—namely, the Imperial dock-

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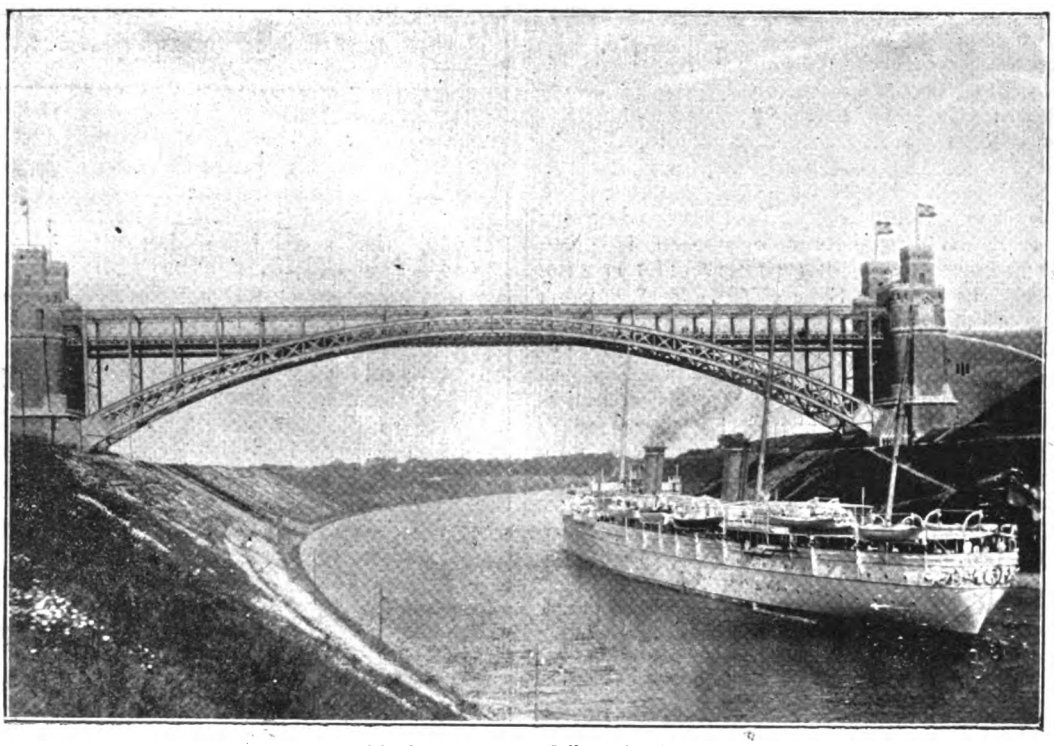
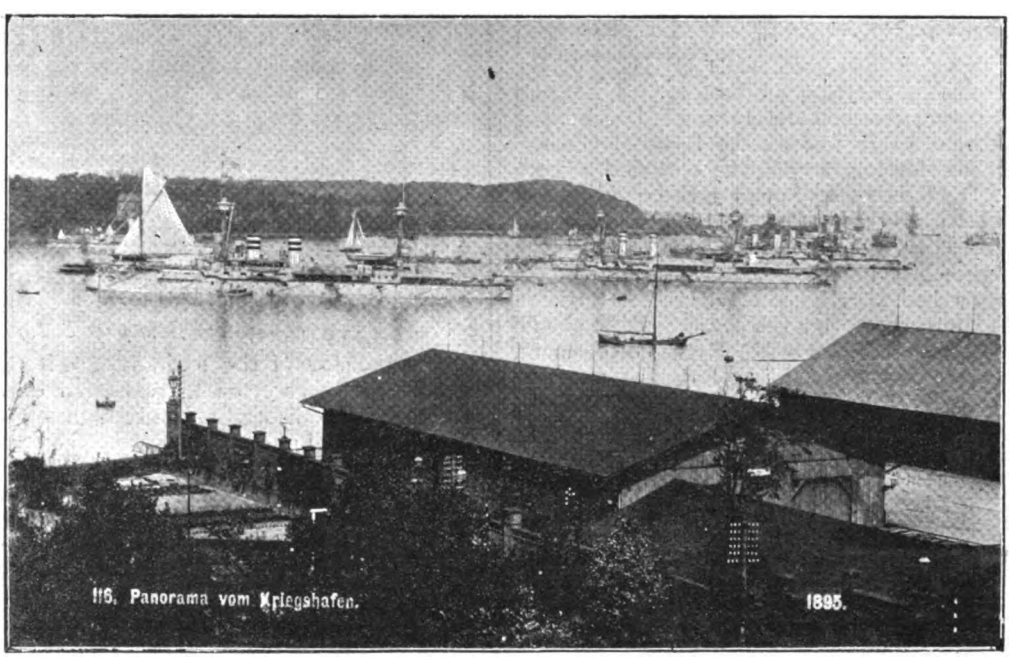
yards—of course, enjoy prime importance, employing as they do upwards of 5,000 workmen, but there are also several private shipbuilding yards and manufactories of note in Kiel, with which I hope to deal in turn later on. The actual proceedings of the Verband commenced, as previously mentioned, on Sunday, June 17, when council and committee meetings were held respectively at 9 and 11 o'clock a.m., a room attached to the Restaurant Hoffnung being reserved for the purpose. In the evening on the same day, at 8 o'clock, a reception took place in the great hall of the Hotel Bellevue. This function, which was held in the usual "go-as-you-please style," was mainly characterised by a very large attendance. The reunion of old friends and acquaintances after a year's separation was celebrated with the enthusiasm and joviality characteristic of the German race. The delicate wines of the Rhine, not to mention the inevitable "Lager," flowed freely, and the guests settled down to the quiet enjoyment of the annual reunion in full appreciation of each other's society. Ideas were exchanged and interchanged while light refreshments were partaken of to a musical accompaniment, and a few pleasant hours thus spent. On this occasion the town of Kiel, of course, acted in the capacity of host. Speechmaking was, however, restricted to very narrow limits, the absolutely essential only being done. In the first of the two speeches of the evening, the Mayor (Herr Fuss) welcomed the guests on behalf of the town in a very able and humorous manner. He (the mayor) had hoped to obtain inspiration for his speech from Meyer's "Conversational Lexicon," but had found opposite the words "electra" and "electrum" more than 150 words constructed from these derivations, besides auxiliaries, which occupied together over 64 pages. He had thereupon resolved to leave the study of the matter to more youthful aspirants.



High-Level Bridge over Kaiser Wilhelm Canal at Levensau.



Panorama of the Harbour, Kiel.

The President of the Verband, Dr. von Siemens, in thanking the Mayor for the hearty welcome accorded them, said that of late years Kiel had exerted a very powerful magnetic influence. There were none more sensitive to this influence than the electrical engineers who had assembled in the town for the purpose of discussing a multitude of questions.

An attempt was subsequently made, at the express wish

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of some of the ladies present, to organise a dance; but owing no doubt partly to the heat of the hall, and partly to the superior attraction offered by a jaunt in the fairy-like neighbourhood, not a great deal of enthusiasm was evoked, and the dancing came to an early termination. But, for all that, a very pleasant evening was spent, although it terminated earlier than is usual on such occasions in the happy Fatherland.

The business of the meeting commenced in real earnest on the following morning (Monday), when, notwithstanding the dissipation of the previous evening, a large number of members and others interested in the proceedings congregated in the Marine-Akademie punctually to time—*i.e.*, 9 o'clock. Incidentally, those present had an opportunity of admiring the splendid proportions and admirable equipment of the building, a view of which is given in one of the accompanying illustrations. The meeting was presided over by Herr von Siemens, who, in his opening speech, expressed pleasure at the general approval which the selection of Kiel as centre for the eighth annual meeting of the Verband had found. He welcomed the representatives from the Marine, whose presence was an indication of the important part played by electricity in modern warfare. The influence of electricity, especially in Germany, was gaining ground; one observed that the voice of the electrical engineer obtained more and more recognition. Technical knowledge and industry were still young, but made rapid strides, and the welfare of the country might, perhaps, in the future depend to a larger extent than now upon the prosperity of the trade. Above all, it was essential that the technical knowledge of those industrially engaged should be attended to. The rapid development of the electrical industry had shown that electrical energy had become a universal demand. Previous to the invention of the dynamo electricity could be usefully employed only to a very limited extent, but the dynamo had enabled the generation and transmission of electric energy in every form and magnitude, affecting thereby all phases of life. The electrical industry had therefore attained to considerable magnitude, and it had become necessary for those engaged in the industry to organise themselves for common action. This organisation was, in fact, the Verband, which had already won considerable recognition, had never adopted any but an impartial policy, and therefore accomplished its work very effectively.

Several speeches welcoming the Verband to Kiel followed. Of these, perhaps that made by Dr. Völkers, as representative of the Secretary of State for the Interior, was the most instructive and interesting. Dr. Völkers remarked with what lively interest the Imperial Government followed the development of the electrical science and industry. The industry had made such rapid progress in Germany that within three years the number of persons engaged by it has advanced from 26,000 to 54,000. Amongst the principal industries of the country, the electrical industry had already attained to the fifth or sixth position of importance on the list. That it should further develop itself was the wish of the Government, which had succeeded in ascertaining how the electrical industry had developed in its production, turnover, and competitive capacity. The returns had been rendered ascertainable only through the close friendship which existed between the Government and the Verband. It was essential to successful competition in the world's markets that economical organisation should exist, which would be more effective from the fact that it worked quietly.

From the annual report subsequently presented to the meeting by our old friend, Mr. Gisbert Kapp, general secretary, it transpired that the number of members belonging to the Verband now amounted to 2,874. Several minor associations, including the electrical institutions of Aix-la-Chapelle, Kiel, Magdeburg, Mannheim, and Würtemburg had amalgamated themselves with the Verband. Further, the financial position of the Verband was extremely satisfactory. To the annual report were appended the reports by the various commissions. During the subsequent proceedings Dresden was decided upon as the centre for the next annual meeting of the Verband.

The morning's business having been satisfactorily disposed of, the first of a long list of papers was then read by Herr Gauert, naval architect, Kiel, which dealt with the "Electrical Installations on Modern Warships." In the course of his remarks, the author said the year 1882 saw the introduction of the first electrical machines into warship equipment, while in 1887 the "Bayern" of the German navy was provided with an installation of 225 lamps of 10 c.p. each, besides two 50-ampere searchlights. The total length of wire employed amounted to only 5,000 yards, while the cost of the installation was £1,150. At the present time the "Fürst Bismark" was lighted by means of 900 lamps, the wire employed having a length of 20 miles. The ship was further provided with five searchlights, taking 90 amperes each. Exclusive of the searchlights, the cost of the latter installation amounted to £11,000, the searchlights accounting for a further £3,000. The electric lighting of warships was preferred to-day, amongst other reasons, because the wires were easy to fix, and if shot away might be quickly repaired. For a long time electricity was employed on warships exclusively for lighting purposes, and, indeed, in an inferior manner to that of to-day, when the most important parts of the ship were illuminated by means of 16-c.p. lamps. The first ships to be electrically equipped were provided with two searchlights having a capacity of 4,000 c.p. each, while modern warships possessed five searchlights with a capacity of 40,000 c.p. each. The author also described the lamp signalling apparatus employed on modern warships of the German marine. The first experiment made with an electric motor in the German navy took place on the "Aegir." To-day all ventilators were electrically worked, likewise ammunition hoists for guns up to 15cm. calibre. For steering purposes electricity had not yet been employed. In speaking of the different systems of ship telegraphy in vogue, the author remarked upon the desirability of having one system only to each ship, as upon the "Fürst Bismark." He also described the telephone system introduced by Messrs. Siemens and Halske for use on board ship. An experiment with electrical heating had shown that the same was twenty times as dear as the present method of steam heating. With electrical cooking no extensive experiments had yet been conducted. The "Fürst Bismark" was equipped with an electrical installation of 300 kw. capacity. Continuous current only was employed on account of the searchlights. Formerly compound-wound machines were used, but parallel running was now favoured with shunt dynamos. The employment of accumulators on board ships was also considered by the author, whose paper received evident appreciation.

(*To be continued.*)

THE MUNICIPAL ELECTRICAL ASSOCIATION.

HUDDERSFIELD CONVENTION.

(*Continued from page 881.*)

After the close of the business meeting on Wednesday, June 20, the lunch given by Alderman Calvert, the chairman of the Huddersfield Electric Lighting Committee, was duly appreciated. A good many of the members then proceeded to Bradford, where the Corporation electricity works and the electric tramway system were on view. Mr. R A. Chaddock, the electrical engineer of Bradford, met the members at the railway station and arranged them in two parties so as to facilitate the inspection. Before leaving again for Huddersfield light refreshments were provided in the town hall, where an informal reception was given by the Mayor of Bradford. The return train was due in Huddersfield at 6.30, which gave those who went to Bradford an exceedingly short interval before the dinner at the town hall at night. At this dinner the members of the association and other visitors attending the convention were the guests of Messrs. J. Hopkinson and Co. The dinner was served in a way which was exceedingly creditable to the landlord of the George Hotel.

THURSDAY, JUNE 21.

The reading and discussion of technical papers was

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resumed in the Technical College, Queen-street, at 10 a.m., and Mr. MOUNTAIN, the president, called the members to order promptly at that time. The two papers by Mr. T. P. Wilmshurst and Mr. C. A. L. Prussman were read in abstract and discussed together. We give below the full text of these papers:

Power Supply by Single-Phase Motors.

BY T. P. WILMSHURST, BOROUGH ELECTRICAL ENGINEER, DERBY.

Note.—In the following paper, the abbreviations D.C., A.C., S.P., refer to direct current, alternating current, and single-phase respectively.

The principal objections which are usually urged to the distribution of electricity by alternating currents are: (1) that alternating-current is less economical than direct-current working; (2) that alternating arc lamps are inferior to direct-current lamps; (3) that single-phase motor working is impracticable.

While the writer is prepared to admit that in some instances objections (1) and (2) are valid, and (3) also in a modified degree, he holds the conviction that they originate rather from unsuitable arrangements or want of appreciation of the varied requirements of electrical supply on the part of the designers, than from any inherent unsuitability of alternating currents. He is led to this conclusion from a study of the costs' analysis of various towns, from which it appears that the following results have been achieved in A.C. stations: fuel costs of ·25d., ·3d., and ·32d., and works costs of ·78d., 1·02d., and 1·16d., all on outputs of less than a million units per annum. As regards objection (2) the writer would only remark that those members of the association who visited Cheltenham during the last convention would hardly deny that the A.C. arc lighting there left little to be desired. Coming to objection (3) the object of the paper is to show what is the present position of the S.P. motor in the struggle for existence. In nearly every town, certainly in all manufacturing towns, there will in the future be an enormous demand for motors when the cost of supply is sufficiently low and the public appreciate the advantages of electric driving. Since the S.P. system has been adopted in nearly 100 towns in this country, the question arises, how is this demand to be met? (1) Shall we change over our whole system to D.C., as is proposed in one or two cases? (2) Shall we lay down D.C. plant and mains for the motor supply, leaving the A.C. plant to supply current for lighting? (3) Shall we supply S.P. motors from our ordinary A.C. plant and mains? (4) Shall we lay a special A.C. motor network supplied from the A.C. plant? (5) Shall we lay down multiphase plant for power supply?

The writer has come to the conclusion that while cases do exist in which, by reason of abnormal frequency, excessive armature drop in the generators, or other causes, the good working of A.C. motors is rendered difficult, in the majority of cases, under reasonably favourable conditions, the inferiority of the S.P. motor to the D.C. or three-phase motor is not sufficiently marked to justify the laying down of special plant. It is obvious that method (3) has the great merit of simplicity and low cost. It is a matter of common knowledge that at the present time, while the proportion of motor to lighting load on D.C. circuits is small, it is still less on A.C. circuits, and it is a matter of interest to study the causes of this. The two principal reasons appear to be the difficulty of successfully competing in cost with gas and steam engines and the fear that the use of motors will injuriously affect the steadiness of the light. It is a self-evident truth that the more the day load can be increased, the lower can the charges be made. An examination of the power charges in various towns reveals the curious fact that these charges vary from 8d. per unit down to 1d., and inasmuch as the cost of production can hardly vary within such wide limits, it would appear that the size of these charges is a measure of the appreciation by the engineer of the value of a motor load. In the case of a gas-engine a brake horse-power can be obtained for about 1d. per hour; in the case of electric motors, therefore, it is necessary to bring the cost down to 1d. to 1½d. per unit before we can hope to enter into successful competition.

The second point is of vital importance and merits careful consideration. The principal causes which are likely to disturb the supply voltages are: (A) bad regulation in engines, alternators, and transformers; (B) the use of small generating sets and transformers; (C) defective working of the motors themselves; (D) the adoption of a high frequency.

The first (A) is a prolific source of trouble. An armature drop of 20 to 30 per cent., even on non-inductive loads, is by no means uncommonly found in this country. Why these abnormal drops of pressure have been tolerated it is difficult to say. It is obvious that the starting of a large motor on mains supplied by such a machine must cause an instantaneous drop of pressure which no amount of switchboard manipulation can prevent. When one considers that in a D.C. station an armature drop of 6 per cent. is rarely exceeded, is it any wonder that A.C. motor working on such circuits has been discouraged? A similar abnormal drop may also be found in transformers which have been designed for a lighting load only. It is quite possible that a transformer with heavy magnetic leakage may have three or four times the terminal drop on a motor load which it would have on a lamp load. It is therefore obvious that all transformers before being sent out should be tested on an inductive load in addition to the non-inductive load test. The writer has adopted the practice in specifying for transformers that when tested on a non-inductive load the drop shall not exceed 2 per cent., and not more than 3 per cent. when tested on a load with a power factor of ·75.

(B) The question of the size of the day load sets is one which will right itself as the motor load increases, since the possibility of any single motor disturbing the supply will diminish as the number of motors increases, and this may therefore be classed as a temporary difficulty only.

(C) The chief defects are heavy starting current and low power factors. The starting current in a S.P. motor need not necessarily be abnormal, though undoubtedly this often is the case, and it is surprising that A.C. engineers do not more rigorously insist on the starting current of motors being kept down. It is purely a matter of what starting torque is required, and it can be brought as low as two-thirds of full-load current or less by suitable arrangements.

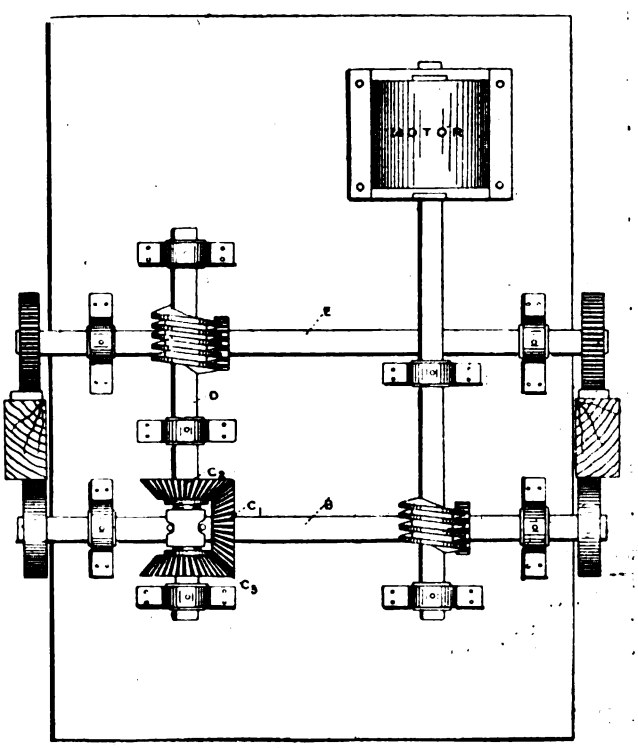

FIG. 1.

(D) A high frequency was adopted in the early days when it was common practice to instal small transformers in houses, with a view of keeping down the iron losses, the designers losing sight of the objection to a high frequency in view of motor working. It is well known that with a low frequency a motor has the advantage of higher efficiency, higher power factor, and smaller starting current.

The writer trusts that he has shown that the prejudice against the single-phase motor has its root, not in any inherent defect in the motor, but in the unsuitable nature of the appliances used. It will be seen that direct-current engineers would have equal cause to complain of their motors if they tolerated the defects in their systems which alternating-current engineers accept as inevitable. Imagine a D.C. engineer, being first hampered with a 25 per cent. drop in his armature, then a drop in his feeders and distributors corresponding to the drop in the feeders, distributors, and transformers (the latter wound for non-inductive loads only), allowing motors to be started from rest by means of a resistance so imperfect as to pass double or treble the full-load current, and we should not be surprised at his complaining of the disturbance caused by his motors. Consider now the A.C. engineer with the added losses caused by a power factor less than unity, and we see his difficulties in the face of unsuitable plant. The writer believes that it would be well worth while to go to the expense of rewinding alternators with these abnormal drops, to use only transformers rated on a power basis, and in extreme cases to bring down the frequency to a reasonable value. Exception has been taken to the S.P. motor owing to its alleged inability to start against a load. This allegation is quite

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unfounded, as this condition can be complied with, but at the expense, of course, of starting current. It appears to the writer that this point has been laboured too much, as there are few cases in which a fast and loose pulley cannot be arranged. Moreover, this defect has not prevented the enormous use of gas-engines, which, so far from being able to start against a load, have actually to be pulled round by hand before they will start at all! Even in the case of lifts there is a wide sphere of utility for S.P. motors. The writer has a lift worked by a S.P. motor on the Derby mains which is perfectly satisfactory. Although the motor starts light, the lift is working at full speed within seven seconds of the motor being switched on. A short description may be of interest.

Fig. 1 is a plan of the cage; the motor and gearing are fixed on the top of the cage and move with it. The motor, a 4-b.h.p. Langdon-Davies, is switched on inside the cage and quickly runs up to speed, simply driving its own spindle and spindle B, and also the bevel wheels, C1, C2, C3; the two latter are at present loose on their spindle. The starting lever inside the cage when pulled over brings a friction cone to bear on the inner surface of the shoulder on bevel wheels C2 and C3. This throws shafts D and E into gear and causes the lift to rise or fall at will. The time necessary to start the lift—*i.e.*, seven seconds—is sufficiently small to justify the contention that the S.P. motor can be used for lift purposes in a great variety of cases.

A few notes as to what is actually being done on supply systems with S.P. motors may not be out of place. For purposes of comparison, it is a matter of interest to note what is being done in a city where the D.C. motor business is vigorously pushed. In Bradford the low charges and easy terms of hire have resulted in a considerable motor load being obtained. Up to the end of June, 1899, there were 307 motors connected to the mains, and the proportion of units sold for power to total units sold was about 17 per cent. It is doubtful if this result has been equalled in any other town in the country. It will perhaps be somewhat of a surprise to some members of the association to find that on the Continent the above results have been far eclipsed by the use of S.P. motors. In the city of Frankfort, on March 31, 1899, there were single-phase motors of an aggregate of no less than 4,532 b.h.p. connected to the mains, while the proportion of power units sold to total units sold was no less than 58 per cent., the figures being: for power, 1,851,268 units; and for light, 1,342,399 units—total, 3,193,667 units sold. The largest motors are of 750 b.h.p., of which there are three. They are of the synchronous type and are coupled to D.C. generators, and are used for driving the trams. With the exception of these all the motors are of the induction type, the largest of which are of 90 b.h.p. The larger motors are run from separate transformers fed from the nearest feeders, while the smaller sizes are taken direct from the low-tension network, while the steadiness of the light leaves nothing to be desired. The generating sets are as follows: two of 1,500 i.h.p., and four of 750 i.h.p.; the frequency is 45 periods, and the armature drop 6 per cent. The charges for power are equivalent to 2d. per unit, with discounts up to 25 per cent. The Corporation of Derby have within the last few months commenced letting out S.P. motors on hire with gratifying results. At the present time motors equivalent to about 200 b.h.p. have been connected, of various sizes up to 30 b.h.p., and the units sold for power during the year have amounted to about 12 per cent. of the total units sold. The charges vary from 3d. to 1d. per unit, according to the length of time the motor is used.

A few words may now be said on the chief characteristics of the modern S.P. motor. The only practical motors on the market are of the synchronous and the induction type. The synchronous motor requires its field to be excited by a direct current. It is not usually self-starting, and this defect precludes its adoption for any but large sizes. It has an extremely high efficiency and power factor, and it runs at a synchronous speed. The induction motor, which is almost exclusively used, has been greatly improved in recent years. A few years ago the maximum efficiency was not expected to be more than 60 per cent. to 65 per cent., with a power factor of about the same value, while the starting current, even when the motor started light, was often twice or three times the full current. Thanks, however, to the good work of Tesla, Brown, Langdon-Davies, and others, very marked improvements have been effected within the last two or three years. The following table (I.) gives a good idea of the efficiencies of modern single-phase motors, as compared with direct-current and three-phase motors. All the tests are made from motors actually at work, the S.P. motors being on the Derby mains. The motors were all made by leading firms, and though the figures do not necessarily represent the highest attainable results, they are a fair sample of good modern practice.

Diagram 2 shows the efficiencies of the above-mentioned four motors of 25 b.h.p. plotted together for ease of comparison. The interesting fact to be noted in both the diagram and the tables is that while the efficiency at full load in the D.C. motors is the higher, the S.P. motors has the advantage

TABLE I.

Type of motor.	B.H.P.	Efficiency. Full load.	Load.	Quarter load.	Eighth load.
Direct-current	4	78 %	68 %	53 %	—
Direct-current	3	84 %	77 %	59 %	35 %
Single-phase	2	78 %	76 %	62 %	—
Single-phase	6	80 %	76 %	62 %	46 %
Three-phase	10	83 5 %	82 %	72 %	55 %
Single-phase	12	75 %	78 %	68 %	54 %
Single-phase	25	80 %	83 %	80 %	68 %
Three-phase	25	87 %	86 %	82 %	72 %
Direct-current	25	91 %	83 %	75 %	54 %
Direct-current	25	86 %	78 %	66 %	—

at low loads, and it is probable that where the work to be done by a motor varies considerably, as, for instance, in a machine shop, the average efficiency of the S.P. motor is quite as high as, if not higher than, in the D.C. motor.

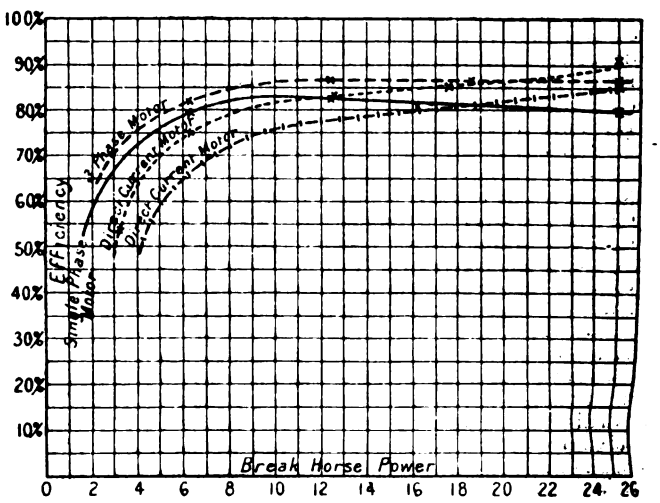

DIAGRAM 2.

Diagram 3 of the power factor and efficiency of the above 6-h.p. motor shows that while there is still room for considerable improvement in the power factors, the modern motor exhibits considerable advancement during recent years.

In conclusion, the writer would urge that while the S.P. motor still leaves much to be desired in the matter of power factor, starting current, starting torque, and facility of running at variable speeds, yet the absence of commutators, with their attendant troubles, giving such simplicity in working, together with the high average efficiency, render it eminently suitable

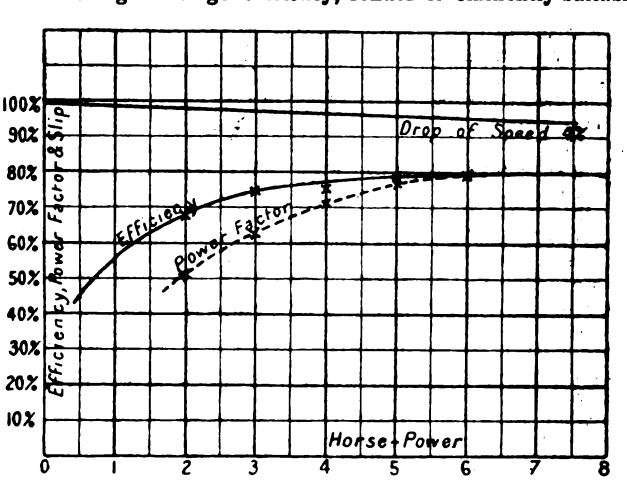

DIAGRAM 3.

for general distribution work. As is shown in Table I., the polyphase motor outstrips both its competitors in point of efficiency. The writer would suggest that, should a transformer or other appliance be placed on the market which without moving parts would convert a single-phase into a polyphase current in the same manner that a two-phase can be converted into a three-phase current, in this direction may lie the solution of the motor problem. With the increase in size of our stations the engineers of direct-current works are more and more realising the advantages of alternating currents for generation and transmission. The improvements in modern A.C. motors have gone a long way to lessen the force of the objection to alternating currents for distribution purposes as well, and

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the writer's experience justifies him in the opinion that the A.C. motor (either single or polyphase) is quite capable of satisfying all ordinary demands for power from the mains of public supply undertakings.

Notes on the Maintenance of Motors on Hire from an Electricity Works.

BY C. A. L. PRUSSMAN, BOROUGH ELECTRICAL ENGINEER, DONCASTER

The principal factor in bringing about the steadily increasing day load of an electricity station is the electric motor, and, as a consequence, the amount of information relating to it has increased considerably during the last few years, so that much useful and interesting data is now available. A large number of papers and articles have been written on it bearing such titles as "The Prevention of Sparking," "The Advantages or Disadvantages of using Smooth or Slotted Core Armatures," "The Use of Bipolar or Multipolar Machines," and "Carbon *versus* Copper Brushes." The result is that electric motors are now much more efficient and mechanical machines than they were only a short time ago. For instance, the life of the motor of to-day is considerably longer than was that of the motor of the early days, and the cost of repairs and maintenance over a given time is of course proportionately less. It has been proved beyond dispute that the electric motor is a thoroughly mechanical, efficient, and reliable piece of machinery, and capable of adaptation to nearly every class of work in which motive power is required. Several of our electricity committees, acting on the advice of their electrical engineers, have commenced to purchase motors, which they are hiring out to consumers at fixed rentals. The amount of the rental naturally varies in different towns, but whatever it may be fixed at it must, of course, cover maintenance, inspection, and depreciation over and above the amounts included for interest, etc.

The present paper is intended to deal with the question of motors when owned in large numbers by a corporation and let out on hire to consumers. The author would not have thought of submitting to the Municipal Electrical Association a paper on this subject had it not been for the fact that he held the position of assistant electrical engineer to the Bradford Corporation, under Mr. A. H. Gibbings, when the hiring-out system of motors was adopted in 1896. The three years during which he was connected with the Bradford undertaking, and responsible for the testing, fixing, and maintaining of a large number of motors, gave him somewhat exceptional opportunities for observing the working of motors ranging from ¼ b.h.p. to 12 b.h.p., and when working under many different conditions. A few notes on the motor-hiring department, therefore, when viewed entirely from practical and working conditions as regards maintenance and upkeep may be of some little interest to members of this association, particularly at a time when many station engineers are seriously considering the question of adopting some system of letting motors out on hire. The anxiety as to the cost of maintenance of the motors on the part of many people would frequently seem to be groundless, the motor often being blamed when the blame might justly be placed elsewhere. As a matter of fact the motor itself seldom gives trouble of any description, provided it is chosen and fixed with due consideration to the nature of the work it is to perform, and that the starting arrangements are satisfactory. The starting switch is an item of vital importance, whose imperfections are often mistaken for the misdeeds of the motor. There are many manufacturers who turn out an excellent motor, but reliable starting switches are by no means so plenteous. Again, the few manufacturers who have a comparatively satisfactory motor-starting switch, standardise it, and make no other pattern or form, forgetting, it would seem, that if a corporation is to let out motors on hire satisfactorily, the motors must be capable of being used for all classes of work, and often it is absolutely imperative that not only the motor, but, what is as important from a maintenance point of view, the starter should be suitably designed for a given purpose. Probably there are many who will disagree with the opinion that standardisation in a department such as that now under discussion can be carried too far, but the author thinks that, of all things, starting switches are least capable of being standardised. A short reference to some of the cases with which the author has had to deal will go far to prove that a very considerable proportion of the maintenance charge is due not so much to the motor as to the apparatus and other causes external to to it.

In the early days of the Bradford Corporation motor department shunt-wound machines were exclusively used, as it was then thought that this type of machine would best suit all requirements, and standardisation was considered desirable. Applications commenced to come in rapidly. At first it was found that the majority of motors were to be used for hoist and crane purposes, and hence it was frequently essential that they should be operated from any floor of the building in which they might be installed. Many of these buildings were six storeys high. The motors in practically all these instances were fixed in the top flat or even in the roof. To ensure the starting of the machines from any floor, a form of starter was employed, consisting essentially of two lead plates falling by gravity into jars containing a dilute solution of sulphuric acid. The plates themselves were operated by means of a rope or chain carried to the entire height of the building. The speed of the plates when descending was regulated by means of a dash-pot containing glycerine, the plunger having an adjustable valve. Primarily then the type of starter for all purposes was the above liquid form, and owing to the ease with which it lent itself to being operated from any floor, it answered for some time admirably. One morning, however, the motor department staff was suddenly called out. A heavy frost the night before had so altered the density of the glycerine that the plates would not descend sufficiently to reach the short-circuiting contacts, the speed of the motors falling considerably below what the consumers were accustomed to obtain, to say nothing of clouds of steam and acid spray, due to the rapid boiling away of the liquid. The dash-pot valves were then readjusted, and after a considerable time the whole of the complaints were remedied, and the motors were working again as merrily as ever. A few days later another similar call was made on the motor department. None of the motors would work! This time a sudden atmospheric change sent the thermometer several degrees above freezing point. The result was obvious—dash-pot valves wide open, lowered density of the glycerine, rapid short-circuiting of the resistance, blowing of contractors' and Corporation main fuses, with the usual violent ringing of the telephone bell and calls from enraged consumers. The rapid changes in temperature for some weeks caused very great trouble and expense, to say nothing of the annoyance to consumers, who promptly argued that electric motors were a failure. Experiments were next carried out with different oils in the dash-pots, and in many cases where there had been trouble with glycerine, the subtitution of oil cured it. Oil, however, had several drawbacks, the most troublesome of which was the unpleasant manner it had of dropping out of the dash-pot and generally causing a dirty sticky mess on the working parts of the starters. The condition of affairs now arrived at was that in some cases the starters had glycerine dash-pots, while in other cases oil was used. The oil for some time gave little trouble. As the winter passed the glycerine began to behave much more systematically, and, curiously enough, for many weeks little or no trouble was experienced from it, whilst the oil began to require greater attention. It may be incidentally mentioned before leaving liquid starters, that in no single instance was trouble experienced with the liquid in the jars freezing, and only a very small percentage of jars were broken, either in carriage, fixing, or under ordinary conditions of use. Generally, however, it was decided that liquid dash-pots were not all that could be desired. The next step was the substitution of "air" dash-pots. These were not worked in conjunction with liquid for the resistance, as in deciding to abolish liquid in the dash-pots it was deemed advisable to endeavour to completely leave liquid of any kind out of the starter. This decision was come to on account of the evaporation of the water, the trouble experienced in keeping the liquid the right height, and maintaining the conductivity constant. The new starters now took the form of a movable contact, falling by gravity along a series of contact studs, which in turn were connected to iron wire resistances. For some time the results obtained were most satisfactory, but a slight sparking on the contacts soon commenced to bring about worse troubles than ever, and in spite of many types of contact being tried, among which were different forms of adjustable carbon contacts, the results were not entirely satisfactory. The author has not seen as yet a really reliable form of starting switch for working under the conditions given above, but when next he has occasion to use a starter for this class of work, he will feel much incline to try the old liquid starter, with an air dash-pot, a combination as yet not attempted by him. With a more even temperature the starter difficulty lessened, and the next trouble to grapple with was the continual blowing of Corporation fuses, and all the attendant expenses. It will readily be seen that a very serious item of expense is introduced into the motor department if the inspectors are to spend half their time in climbing up and down the stairs of six-storey buildings. The fuse trouble with crane motors for a time became very serious. The step first taken was to fix compounding coils on the existing shunt motors, the compound winding being arranged to assist the shunt coils. Four motors were first tried, and the number of visits of the motor inspector in the cases mentioned were greatly reduced. This was a most marked improvement, and the cost of maintenance of crane and hoist motors rapidly fell. In those cases where the load on the crane rarely varied, and the motors were of such a size as to be well above their work, compound coils were not fixed, as no very serious trouble was experienced such as to warrant the extra expense in alterations to the motors. It is interesting to

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know that, in spite of the somewhat severe conditions under which these motors were working in the early days, practically nothing was spent on the maintenance of the machines themselves, either in material or labour. In one or two isolated instances the commutators required attention, but nothing more than what emery cloth could put right, and such instances were distinctly attributable to the defective working of the starters. While the author has often heard the statement made that series motors give the best results for crane and hoist work, a well-compounded machine, in his opinion, gives excellent results as far as a motor department is concerned, and the production of shunt motors so arranged that compounding coils could be readily and easily attached, should they be required, might be worth consideration on the part of manufacturers. The size of motors used for hoist work was found to range generally from 4 b.h.p. to 6 b.h.p.

Leaving the question of hoist motors and starters, the next class of machines demanding attention was that in which the motors had a practically steady load throughout the day. Cases of this kind were numerous, lines of shafting driving light machinery, such as sewing machines, small lathes, etc. Generally shunt-wound motors were used except in one or two cases where compound machines were employed, the compounding opposing the shunt coils, when a particularly steady speed on a constant load was required. Many forms of starters were tried, the chief of which were the following: (1) movement by means of worm and gear wheel, no automatic attachments of any kind being used; (2) contact lever moving over contacts, and finally, when all the resistance cut out, lever held in permanent position by small exciting coil, in series with the shunt coils of the motor; (3) automatic overlaid attachment starters. Much has been said of late about the advantages to be gained by using overload automatic arrangements on motor starters. Taking our present example of a constant steady load, the following notes of experience obtained in Bradford with the three classes of starter named above may not be uninteresting:

Using Starter, Class 1.—It was found that only about 5 per cent. of the visits of the motor inspector were made on account of fuses having blown. Absolutely no trouble was experienced with the starter itself, as there is little doubt that a starter of this description can be made the simplest and most mechanical of all starters. The attention required was found to be less than in any other case.

Using Starter, Class 2.—It was found that 30 per cent. of the visits of the inspector were made on account of fuses having blown owing to too rapid operating of the switch, and another 20 per cent. on account of the exciting coils having either burnt out or being unable for various reasons to hold the contact lever in position. The latter defect often necessitated the complete removal of the starter and repairs to same. The commutator of the motor required considerable attention as compared with that necessary when using starter Class 1, on account of the repeated heavy short-circuits through the armature due to the fuses blowing.

Using Starter, Class 3.—It was found that 6 per cent. of the visits of the motor inspector were made on account of fuses blowing, and another 15 per cent. owing to the automatic starters going wrong. Considerable attention was required to commutators.

It will therefore be seen that where the motor has a steady constant load without repeated stops and starts being required, some form of starter which cannot be short-circuited too suddenly proves itself most efficient, while overload and automatic starters have introduced troubles without effecting any advantage.

The third purpose for which motors have been largely used is the driving of circular saws, planing machines, mortar mills, and comparatively heavy machine tools, etc.—in fact, all those cases where a fluctuating load of short duration is required, but where such load may for short periods amount to an overload of considerable magnitude. Further, in these cases it is only necessary to start the motor from one fixed point. That the question of the starter has an important bearing on the cost of maintaining the motor in a working condition will be seen in the following instance: In a joiners' and builders' works were installed two 6-b.h.p. motors and one 10-b.h.p. motor; the two 6-b.h.p. motors were used to drive a circular saw and a planing machine respectively, and the 10-b.h.p. motor a mortar mill. These motors were started by means of starters coming under Class 1. The result was most expensive. A fuse was blown nearly every other day. Estimating this to involve five hours per week on the part of the inspector, which is well below the actual time, and assuming the wages of the inspector to be at the rate of 8d. per hour, it gives an expenditure per week of 3s. 4d., and to this must be added sundry items, such as fuses. It will be seen from this that if expenses of this character are going to be incurred, in many cases an appreciable sum will soon be run up against the motor department. The starters were now removed, overload starters substituted, and the weekly expenditure fell from the above 3s. 4d. to 3d. In nearly every instance the same result was obtained, and it is surely evident that in the face of actual results it is not the right policy to adopt one class of starter for all purposes, but to judge each case on its merits, and instal the motor and starter of such a type as to best suit the conditions under which they will have to work. By all means let manufacturers standardise so long as they standardise more than one type of starter. Again referring to the starters under Class 2, in which only an underload automatic device is used, in theory this is all very well, and should prove of the utmost use; but the author's experience with them, when used on the mains of a supply station, which does not every now and then shut down, is that they are somewhat of a nuisance, and in some cases where the field circuit is accidently broken when the motor is running, it will often be found that the fuse will blow, and the release on the starter will come back to its "off" position. The automatic overload starter in many cases is of the utmost value, and effects a very considerable saving to the motor department. The minimum automatic starter has proved to be more troublesome than otherwise if not combined with an overload arrangement. Before leaving the question of starters it may be mentioned that a great fault to be found in starters generally, and particularly in many of the later types of the automatic ones, is the very small margin allowed in the resistance wire. In many places it was found that long before the motor was running up to speed, the starter was acting more as an electric heating appliance than a starter, which, while useful in its way, is hardly the function for which the starter was installed. The starter of to-day is too electrical and not sufficiently mechanical.

Turning from the troubles caused by the motor starters we come to some of the principal difficulties that were experienced with the motors themselves, apart from those caused to the motors by defective starting apparatus. Motors from ¼ b.h.p. to 3 b.h.p. were found to give more trouble by some 30 per cent. than those ranging from 4 b.h.p. to 12 b.h.p. By more trouble is meant that for every 100 visits of the inspector to the larger sizes some 130 would have to be made to the smaller. Assuming each visit to take 1½ hours at 8d. per hour, we get £5 for the larger motors as against £6. 10s. 8d. for the smaller, the number of motors, of course, being equal in both cases. Looked at in another way, there is an expenditure in the maintenance of the small motors of much greater magnitude per £100 of capital expenditure than in the larger motors. Motors geared to their work by means of spur gearing were found to cost in maintenance practically the same as when belted, there being only a difference of 3 or 4 per cent. in favour of the belted machine. Very few armatures of motors of 4 b.h.p. and upwards burnt out under ordinary working conditions. Exceptions, however, are taken to several cases where the faults have been due to defects in the design and manufacture, but as the whole of the expenses were in all these instances borne by the manufacturers, it would not be fair to include them in the maintenance of the motors. With small motors up to 3 b.h.p. over 100 per cent. more armatures were burnt out than was the case with the large machines, and in several instances the cost of rewinding had to be borne by the Corporation, as it was quite impossible to assign any reasons for the burn-outs, other than those due to ordinary wear and tear and depreciation. The most exceptional case of armature burn-outs which came under the author's notice was that of the armature belonging to a 10-b.h.p. shunt-wound enclosed motor driving a line of shafting. In this instance eight armatures burnt out, or, rather, broke down, within 14 days. The cause was ultimately found out by the manufacturers, and it is only fair to add that it was largely due to circumstances over which they had practically no control. The whole of the large expense was defrayed by the manufacturers, who did their utmost throughout to investigate and remedy this remarkable instance of armature trouble. A large number of exactly similar machines had been working for weeks in other consumers' premises without giving any trouble whatever. Breaking down of field coils was a very rare event, but here again the small motors account for 150 per cent. more failures than the large ones. When the motor department was first commenced open-type machines were used, and several shunt coils had to be replaced on account of external injury, which in all cases except one were caused by the consumer and replaced at his expense. In two cases armatures of 6-b.h.p. motors were completely wrecked: (1) through a consumer letting a spanner fall on the revolving armature, and (2) owing to a box catching a brass armature guard and so throwing it out of position as to cause the sharp corner of the guard to catch the armature wires, with the result that nearly every connection to the commutator was cut. Needless to say, in both cases the consumer had to defray the expenses of repairs. The above remarks show what an enormous advantage the enclosed motor has over the open type in view of the great risk there is of external injury to the latter. Apart from this point and the objections raised to the open machine by the fire insurance offices, there is much to be said in its favour. This opinion will doubtless be considered antiquated and out of date, but the cost of maintenance of these open-type motors was

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found to be less than that of the enclosed, and for cool running they certainly are superior to the enclosed motors, many of which become merely cooking stoves after a four or five hours' run on full load. While fully believing the enclosed motor is the motor of the future, there are nevertheless features about the open-type machine of a very desirable character, and which are not possessed by the enclosed type.

Commutators and sparking at the brushes were the causes of considerable expense, and in a number of instances armatures had to be removed and the commutators re-turned. Defective and inefficient brush gear was responsible for a large amount of trouble, augmented in some cases by vibration due to poor foundations, screws, nuts, etc., becoming loose and consequently ineffective. The greater part of the expense incurred through attention required to commutators may be avoided if suitable and efficient starters are available, and if the foundations are of a rigid and solid nature. The passing and inspection of motor foundations will be found to play a most important part in the maintenance account. Again and again has it been shown that any sort of foundation will not do for motors, and the importance of the foundations complying with the corporation requirements cannot be overestimated. In those cases where the corporations lay the necessary foundations and charge consumers with the expense, the vibration difficulty disappears to a great extent, together with many of its attendant consequences. There are instances, however, where it is impossible to completely obviate vibration whatever precautions are taken in laying the foundations. There was an instance which once came under the author's notice where a 12-b.h.p. motor was fixed in the top room of an exceptionally high building, the peculiar shape of the structure of which made it impossible to get a really solid foundation. Work, which required very exact setting out, was proceeding in the same room, and the vibration of the motor was likely to prove absolutely fatal to the adoption of this form of driving. The particular motor installed was of a design in which the armature shaft was a considerable height from the floor. A second motor was tried in which the bearings of the armature were much lower than in the first machine. The effect on the vibration was most marked, so much so that no inconvenience was experienced from it, and the adoption of electric driving has proved a wonderful advantage to this consumer.

Bearings running hot gave much less trouble than was to be expected, and, again, the small motors must stand the charge of causing considerably more trouble than the larger ones. As a rule, the trouble could be traced to some definite cause, such as grit getting into the bearing, or the machine not being properly lined up to the driven pulley, or damage to the oiling arrangements. Other troubles at intervals would show themselves, such as terminal screws, etc., working slack. The clamping arrangements for holding the brush rocker in position on several occasions become loose, the result generally being the blowing of the fuse or the release of the overload attachment. Insulating bushes and washers would crack or sometimes soften from the heating of the motor, particularly the bushes, etc., used on the brush rockers in some types of machines. In one case a 10in. pulley bolted on to a flywheel worked loose on the shaft, but fortunately it was discovered in time to avert what might have been a serious accident. Generally it was found that very little trouble and expense was incurred in keeping the motors in thorough working condition, but it should be noted that all motors were thoroughly examined and tested at the station, on delivery from the manufacturers, and before sending out to be fixed on consumers' premises, and these examinations frequently revealed defects of a nature hardly to be expected in machines sent out by manufacturers of repute. Motors without terminal screws, terminal screws that would not fit, sweating sockets missing, washers broken, portions of brush gear missing, etc. A practice was always made of carrying out an inspection, first for mechanical details, then electricity, and finally the motors and starters were tested for efficiency, heating, insulation, etc. It was no doubt largely due to this thorough overhauling at the supply station that much trouble and annoyance was saved when the motors were finally fixed in consumers' premises.

It was the author's intention to include a table in these notes giving particulars as to the sizes, causes of defects when used for driving different classes of machinery, etc., of the motors he has had to deal with, but want of time has prevented him from getting this done. The foregoing remarks may, however, prove of some little use, if only in helping to show that when properly organised and worked a corporation motor hiring department is not a scheme which need cost excessive sums for its maintenance in thorough working order. The very great advantages of a motor load and the great success which met the Bradford Corporation's enterprise in this direction, managed by its late engineer, Mr. A. H. Gibbings, are now too well known to require any comment on the present occasion. The maintenance of the motors, it has been said, would prevent such a system ever becoming successful. If this paper has done ever so little to dispel this idea and to show where some of the cost in maintenance is likely to be encountered, the author will feel amply rewarded.

Mr. S. Z. DE FERRANTI, asked by the president to open the discussion, said there could be no question of greater importance to municipal electrical engineers than that brought forward in the two papers before them. It had been felt that the single-phase alternating-current system was handicapped as compared with the continuous-current system with respect to motors. He thought that after reading Mr. Wilmshurst's paper the conclusion would be come to that the motor difficulty was practically solved. He considered that the arc lighting question was much more difficult to get over. The idea that the alternating-current motor was exceedingly costly to maintain was very incorrect. As regards the arc lighting, an attempt had been made to solve the difficulty by using the enclosed arc lamp, but if comparative trials of candle-power were made, it would be found that there was very little advantage in these arc lamps as compared with incandescents. In fact, the incandescent lamps were almost as efficient, and hence were to be preferred. The same objection did not apply to street-lighting, where a series of lamps could be supplied with rectified current. Reverting to motors, it was his deliberate opinion that the single-phase system was by no means played out, and that there was no commensurate advantage in changing over a single-phase system to a multiphase one. The extra cost more than counterbalanced the slight advantages gained. Single-phase motors had been improved very much of late, both as regards their capacity for starting under load and in efficiency. He had recently seen at Paisley a single-phase motor of the Schuckert type driving a centrifugal pump at the central station. It was equipped with a clutch to engage the pump when a predetermined speed had been attained. It had worked splendidly, and he thought it was much better than a continuous-current motor, as a commutator was not required. Again, in simplicity the single-phase system was to be advocated, and he did not think it would be long until its remaining few disadvantages were got over. The General Electric Company of America stated that they were now able to supply single-phase motors with a power factor of unity. This was obtained by means of condensers in one circuit. He thought some years ago that the great troubles with condensers were due to the occluded layer of air between the tinfoil and the dielectric. He had taken steps to avoid this, and had had a condenser under trial for five years. Two thousand five hundred volts were placed across the condenser for that time, and a recent examination of the plates and dielectric revealed no signs of deterioration. He had also made condensers to stand 15,000 volts. He did not wish the members to receive the impression that these condensers were now on the market, but that considerable progress was made in the development of a commercial condenser which would practically solve the single-phase motor question.

Mr. S. E. FEDDEN, of Sheffield, said that he wondered, when reading Mr. Wilmshurst's paper, if it was a fairy tale. As regards the arc lamps, he could now withdraw the remarks he made some two years ago as to the trouble caused by rectifiers in connection with alternating-current system employing arc lamps for street-lighting. There was a distinct advantage with alternating-current arc lamps in that distribution coils could be used, enabling one arc lamp to be supplied on a 200-volt circuit. Owing to the trouble with single-phase motors, they had had in Sheffield to lay a special continuous-current feeder to one large consumer, which was supplied by means of a 75-kw. motor-generator. The motor of this combination took from 10 minutes to a quarter of an hour to run up the speed and synchronise. Mr. Fedden proceeded to quote figures from tests he had made on both the Langdon-Davies and the Heyland single-phase motors, which were not satisfactory. For instance, the last-named motor for 3 h.p. ran at 3,000 volts per minute. The makers claimed an efficiency of 75 per cent., while he found only 55 per cent.

Mr. W. A. CHAMEN, of Glasgow, commented on the great efforts which were being made to get over the difficulties which were found with alternate-current systems of supply. He was recently approached by a manufacturer

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for permission to hire motors in his district, and he saw no reason why this should not be done by such manufacturers; in fact, he would rather let them do it than undertake it himself. He appreciated very much Mr. Prussman's paper and the ingenious starting gear described in it. He agreed with the author that the days of liquid resistances in starting switches were numbered. The paper contained most valuable information of the various little difficulties of working continuously direct-current motors.

Mr. LANGDON-DAVIES said that he endorsed the difficulties which other speakers had referred to, and which were mentioned in the paper, of providing motors to meet the requirements of the various circuits. He thought that the power factor was the key of most of the troubles. The alternators in use in many circuits were designed for lighting only, and had a drop of 25 per cent. from low load to full load even on a non-inductive load. They were thus wholly unsuitable for supplying motors unless condensers could be used. Without the use of condensers a power factor of about ·9 could be obtained from the motors, but even this was too much for such alternators to supply. A large amount of trouble was also due to defective wave shapes, and the speaker proceeded to explain how with a double-peaked curve it was found quite impossible to run a single-phase motor up to approximately synchronous speed. This was because one of the peaks produced a torque in the wrong direction. Manufacturers were reproached with not giving results promised. He would remind them, however, that there were 17 different frequencies in use at different stations in England, excluding small differences, and that it was quite impracticable to design a small motor to give the best results on everyone of these frequencies. If this were done, it would entail 17 different stampings being kept for every size of motor, which was impossible commercially. He believed that if others would do as Mr. Wilmshurst had done in the case of the lift described in his paper, great strides could be made in the use of single-phase motors. The consumers would believe the electrical engineer and take his suggestions when they would not consider the same from a motor manufacturer.

Mr. R. C. QUIN, of Blackpool, considered that the alternating-current single-phase system was the best for general purposes, apart from the supply of power. Direct-current systems had, however, got a new lease of life from the increase of voltage. It was quite possible to run two or three-phase motors on single-phase mains, and to transform down at the same time, which was a distinct advantage. As regards the wave-form of the supply, Blackpool was very bad. They had three distinct types of alternators, all with different wave-forms, and they all worked in parallel; but the resultant wave-form was, of course, very variable, and alternating-current motors were not a success in Blackpool. Motors were, however, supplied in Blackpool from the tramway system with direct currents at 500 volts.

Mr. W. B. ESSON said that the troubles with alternating-current motors were generally due to the generating plant, which in some stations had a drop of 30 per cent. in voltage in full load, even on non-inductive loads. When it was remembered that a 4 per cent. drop on a non-inductive load often corresponded to a 15 per cent. drop on an inductive load of the same value, it would be seen that it was quite impossible to supply motors from such machines. He considered that in alternating-current motors the power factor was even of more importance than the efficiency from the central-station engineer's point of view. He did not agree with Mr. Ferranti on the question of multiphase working. Take, for instance, the alternate-current single-phase generator: only one-half of the holes in the armature core were wound with wire, and the extra cost of filling the empty holes with conductors was only about 5 per cent. of the total cost. This gave a two-phase machine with very little extra cost. The same way with the mains: single-concentric mains could be used to supply the consumers of light, and two concentric mains only were required in supplying power. The extra cost was almost inappreciable. As regards the use of condensers, he considered that the employment of a single-phase motor with a condenser gave much more chance of a breakdown than the employment of a multiphase motor, for which a condenser was not required.

Mr. H. FARADAY PROCTOR, of Bristol, asked Mr. Ferranti what influence the frequency of the supply had on the condensers used with the alternating-current motor.

Mr. FERRANTI said there was no chance for high frequency, and he advocated it being reduced to low frequency as soon as possible. The cost of the change-over was not so great as was generally supposed. As regards the wave-form, he would point out that it cost no more to obtain a good wave-form than a bad one.

Mr. A. S. BARNARD, of Hull, asked if Mr. Quin gave a motor supply from the trolley wire, and elicited a reply from Mr. Quin that they were not allowed by the Board of Trade to do so, but Mr. Quin did not state whether he did or did not supply motors in the way suggested.

Alderman WOODHEAD, of Halifax, said that alternate-current motors did not give the success they hoped they would, and that prevented the committee from listening to the request of consumers for motors, which they otherwise would have provided.

Mr. R. S. PORTHEIM said that the users of small motors of from 3 h.p. to 4 h.p. expected great things of the same, and they strongly resented the charge which had to be made for the starting switches. Thus, with a motor costing £30, a £10 starting switch was required, and it was difficult to make the non-technical man understand that these starting switches cost no more for a 10-h.p. motor than for a 2 h.p. one. He thought that the electrical engineers of the towns could help in removing these and similar objections.

Councillor SMITH thought manufacturers should themselves take up the question of the starting switches; for instance, a Scotch motor would often be found accompanied with a German or American starting switch. He thought that a good mechanically-designed switch should be got out by the manufacturers and supplied at a reduced price. It was very important to see that good foundations were put in for motors to run at such high speeds as 1,000 to 1,500.

Mr. WILMSHURST, in reply, pointed out that the improvement in question with respect to the single-phase system was, Shall we be able to get satisfactory motors in the future, or shall we scrap at the present time, say, £50,000 worth of machinery? His paper was intended to show that there was every prospect of a successful motor supply on the single-phase system. As regards Mr. Prussman's paper, a large number of faults with direct-current motors had been referred to, and he might say that out of a large number of alternating-current motors in Derby they had never had one go wrong. The alternate-current system also avoided the electrolysis troubles, which he predicted would be found serious in the future with a continuous-current system.

Mr. PRUSSMAN, in replying to a query as to a manufacturer of the eight armatures which went wrong in 14 days, said that he had kept back the name because the manufacturer had acted in a "very sportsmanlike manner" in meeting the troubles. It was not sufficient for a manufacturer to standardise one type of starting switches only, as several types were wanted to meet individual conditions. He would reply to the rest of the points raised in the *Proceedings*

(To be continued.)

THE TRAMWAYS AND LIGHT RAILWAYS EXHIBITION.

The International Exhibition of Tramways and Light Railways was opened on Friday last at the Agricultural Hall. The proceedings were commenced by Mr. W. H. Dickinson, the chairman of the London County Council, declaring the exhibition open. The guests, to the number of about 300, then partook of an inaugural luncheon, at which Mr. Dickinson presided. The company included some very well-known men in electrical, engineering, and municipal circles.

The PRESIDENT, in proposing the toast of the "Tramway and Light Railway Enterprise," said that in recent years nothing had been more remarkable than

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the development of the means of locomotion, but the only branch he would deal with was what might be called domestic locomotion. The development of this branch was quite as important as the railways going over the globe. It was the tendency of man to congregate in towns, the population of London and its suburbs numbering seven millions, New York four millions, and Paris two millions, and their prosperity and freedom from crowding depended on the means of locomotion afforded the citizens. Although this country was said to be backward in providing this means, it had lately been making great progress in the development of tramways. London was very backward in respect to other towns. There were 871 million people in London who travelled every year by tramway or omnibus, and these people lived on the outskirts of the City, and they depended for their existence on a good means of locomotion. With all this need for locomotion, however, tramway enterprise in England was almost dead. This was largely due to two reasons: first, because of the conditions as to purchase imposed by the 1870 Act, and, secondly, because of the change in the system of traction. New methods of traction had had to be considered, but now all doubts as to the powers of electricity as the future means of locomotion had disappeared, as it had passed its elementary stage, and was now used all over the world. Its advantage was shown in comparing the two systems where both horse and electric traction were used. In Glasgow the horse traction cost 8½d. per car mile and 6½d. for electric traction. There was, however, other things considered, a total gain of 4½d. per car mile by the use of electricity. At the same rate, London with an electric traction system would be able to make a profit of £562,000 per year, which could go in reducing the rates or cheapening the fares. They ought to be grateful to the organisers of that exhibition if only because it would show that there were British inventors and manufacturers who could give what was required without causing them to trouble their friends in the United States.

Mr. Alderman CLEGG, of Sheffield, in reply, said he congratulated the London County Council in coming more into line with other large municipal bodies. He was glad to say that the experience of electric traction in Sheffield had been very satisfactory. There they had gained considerably by reducing the fares and also the hours of labour of their employés.

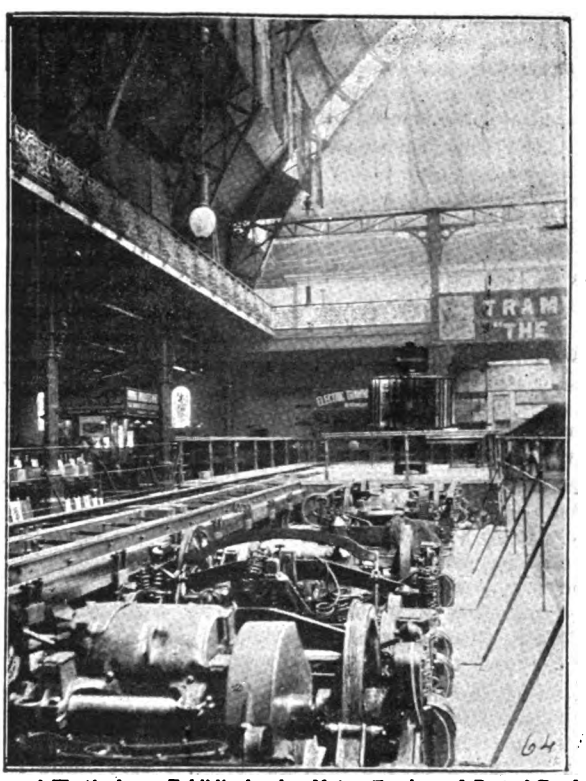
Mr. J. B. CONCANON, also replying, said that in Dublin, though the tramways were owned by a private company, there was the best system of electric tramways in the world and the cheapest fares in the kingdom.

Mr. BRYCE, M.P., next proposed "Municipal Authorities," and after expressing satisfaction at the way in which the Light Railways Act was being taken advantage of, he said the time had come for London, and other great centres of population, to have an enquiry on large lines as to the means of communication for the future. He suggested that the Government, or the London County Council, or the Government at the suggestion of the London County Council, should institute an enquiry in order to grapple with the increasing congestion of the thoroughfares. The municipalities, he thought, were the right bodies to deal with transport and conveyance in large cities. In the first place, the citizens were ratepayers, and when profits were to be made they should go to lessening the rates; while in the second, the authorities who had control of the streets should also be the authorities to control the means of conveyance. There was, however, ample room for private enterprise. In conclusion, he referred to the tradition of purity maintained by the London County Council, as well as to the energy, enlightenment, and bold initiative it had displayed.

Mr. J. W. BENN and Sir S. JOHNSON replied to this toast, the other toasts being "Board of Trade and Light Railway Commission," "The Engineering Profession," and "The Chairman."

As to the exhibition itself, the first exhibit, and the one which at once attracts attention, is that of the British Westinghouse and Manufacturing Company, Limited, comprising, as it does, a perfectly equipped electric railway in actual operation on the conduit system. Practically all the work on this tramway is above board, and may be inspected; the central generating station, the track, the car and its control, are all in evidence. Those parts of the system which are necessarily hidden from view are clearly explained in pamphlets presented by the company, and in many cases specimens of these parts themselves are shown. The system used is a conduit system, in which the steel slot or channel, about three-quarters of an inch wide, running between the rails for the full length of the track, is the only feature which distinguishes it from the ordinary horse tramway track. No part of the electrical circuit, either lead or return, is exposed, and there is no possible chance of danger from shock. It is an entirely original system, designed throughout by British engineers, and the whole of the work in its construction has been carried out in Britain by British workmen. It is an interesting fact that the whole of this large installation, from the time of the delivery of the first batch of materials to the time of the car running on the track, was completed within 10 days.

The generating plant consists of a British Westinghouse three-cylinder gas-engine, which generates the power. It is rated at 112 b.h.p., but has a maximum capacity of 126 b.h.p. when operating with coal gas of average quality. Its normal rate of speed is 260 revolutions per minute. This gas-engine has a very uniform speed and accuracy in



View of Westinghouse Exhibit, showing Motor, Trucks, and Part of Track.

governing, and has been constructed to supplant the steam-engine for electrical driving and all other work where these conditions are essential. These properties, together with the facts that the engine is self-starting, and that it is reliable owing to the careful design, good workmanship, and quality of the materials used in its construction, have, we learn, created a great demand for it. The works now in course of erection in Manchester are to have a large portion set apart solely for the manufacture of this engine. The largest gas-engines ever built are on this principle, several of 2,500 h.p. being at present on order and under construction.

The governing of this engine is one of its great features, as it is not governed by changes in the number of crank revolutions per piston impulse, nor by variations in the proportions of air and gas in the explosive mixture. The number of piston impulses is always the maximum. In the three-cylinder engine, since each cylinder works on the Otto cycle and the cranks are 120deg. with each other, the maximum means that the engine receives one impulse every two-thirds of a revolution of the crankshaft. The proportion of air to gas in the explosive mixture is kept constant, and means are provided on the engine by which the proportions of the mixture can be accurately adjusted to suit the particular quality of the gas in use, so that the maxi-

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mum power may be obtained from the gas consumed. Changes of load are accommodated by varying the quantity of the explosive mixture admitted to the cylinder. This admission is regulated by a valve actuated from a very sensitive five-ball governor. The efficiency of this form of regulation is very apparent on the exhibition engine, as the load varies repeatedly and considerably with the starting and stopping of the tramcar. A variation of load from full to zero causes but an instantaneous variation of 2 per cent. in the engine speed. This gas-engine runs without causing any vibration, and also with very little noise, the sharp explosions in the usual type of gas-engine being absent. The engine is direct-coupled to a 75-kw. 500-volt compound-wound engine-type generator of the standard Westinghouse design. The switchboard is of marble, the five panels being fitted with the usual switches, circuit-breakers, and instruments, all of Westinghouse construction. The back of the switchboard is open to view, so that the usual laminated connection of heavy copper strip and the general construction of the board can be inspected.

The track is equipped on the Westinghouse sectional conduit system, and extends the full length of the building (310ft.). The whole of the track is left open for inspection of the underground work, with the exception of a short length at each end which is made up with a wooden block paving, so that the line appears at these ends as it does when installed in the street. The line consists of a series of cast-iron yokes, spaced 5ft. apart centre to centre. These yokes are cast all in one piece, and are of solid and substantial design. They bear the tramrails at their extremities, with the channel rails and the conduit section in the centre. In actual practice the conduit extending between the yokes is of concrete, built in on a collapsible former. In the conduit are placed the two electrical conductors, which are of iron of L section. Both the lead and the return conductors are insulated from the yokes and earth by means of porcelain insulators fixed to the yokes at suitable points along the track length. The conductors are split up into sections, and only that section of the conductors over which the car is actually passing is "alive." This is accomplished by means of a simple electromagnetic switch, which automatically closes and opens the electrical connections between the highly-insulated underground feeders and the electrical conductors of the conduit as the cars pass on to or leave behind the respective sections. These switches are very simple and reliable, and they are readily accessible, as are also the conduit conductor insulators, through small hand-holes placed in the roadway at the side of the channel or slot of the conduit. By this means repairs and inspections can be attended to without causing any interruption of the traffic.

An important advantage of this sectional system is the great reduction of the leakage losses, a very large item when long lengths of bare conductors are left exposed to the weather. The only length of the bare conductor which is "alive" is made up of those comparatively short sections over which the cars are travelling at any moment. The insulated return is also a good point of the system, the earth leakages, and the resulting destruction of gas and water pipes, being entirely avoided. The current is collected from the conduit conductors by means of a contact plough, which passes through the narrow surface slot of the conduit, and is fixed on suitable insulators beneath the car. The plough is hinged, so that it can without difficulty accommodate itself to curves in the track.

The motors, of which there are two on the cars, are of the British Westinghouse No. 49 type. They are four-pole machines, with small armatures and light revolving parts, enclosed in steel casings, and equipped with single-reduction gears. The gear wheels and pinion wheels are composed of cast steel and forged steel respectively. Easy access is gained to the armature by dropping the lower half of the steel casing. The usual Westinghouse controller is provided for the control of the motors.

Probably the most novel and interesting part of the car electrical equipment is the electromagnetic brake (Newell patents), manufactured by the Westinghouse Brake Company, of London. It consists of a horseshoe electromagnet suspended on spiral springs, so that the legs hang directly above the rail. When this magnet is excited it grips the rail, as does the shoe of an ordinary track brake. There is an important difference, however, between the effects of the Newell brake and those of the ordinary type of track brake when applied. In the case of the latter the braking effect is gained at the expense of the car weight—that is, by reducing the grip of the car wheels on the rails, and therefore destroying to a considerable extent the effect of the wheel-rim hand-brake. In the Newell brake, by a simple arrangement of levers connecting the electromagnet with the shoes of the wheel-rim hand-brake, the pressure of the shoes on the track is taken up by an increased thrust or pressure on the shoes of the wheel-rim hand-brake. Thus an increased braking effect on the wheel rims is caused, and the effective weight of the car on its wheels is not changed by the application of the track brake. Another point is that the power for the brake is produced by the generator current of the car motors; the electromagnet is not excited by current taken from the mains. The momentum of the car after the main current to the motors has been switched off drives the motors as generators, and it is this current from the motors which furnishes the power for the electromagnetic brake. The action of the brake, therefore, is independent of the continuity of the main electrical supply, and any failure of the supply current will not interfere in the slightest degree with the braking of the cars. There is, then, a triple braking action with the Newell brake, the loading of the motors as generators, the grip of the magnet shoes on the track, and the increased pressure on the wheel-rim shoes. The proportion of the braking effects on any car produced in the last two cases is adjusted to the weight of the car and the gradients of the track, so that the maximum pressure which will not cause skidding of the wheels may be applied to the shoes of the rim-brakes. In the case of the exhibition car, which weighs 12 tons, empty, the thrust on the rails is equal to that on the wheels; but on an 8-ton car, 60 per cent. is applied to the rails and 40 per cent. to the wheels. The brake is actuated by a backward motion of the controller handle.

The car body is a handsome example of the most modern British pattern, constructed by Milnes and Co., of Birkenhead. It is mounted on a Brill truck, is double-decked and can seat 28 persons inside and 36 outside. The seats outside are of various designs. There are specimens of four different types, three of them being designed to keep a dry seat in all weathers. The car is fitted, both inside and outside, with an electric bell system, the pushes being placed within easy reach of the seats for the convenience of passengers who wish to signal to the conductor. The interior of the car is heated by electric heaters.

The whole system runs very smoothly, and will certainly prove a beneficial object lesson for visitors to the exhibition, showing, as it does, that there is at least one British company which is able to supply completely, right from the first cutting of the ground to the rapid and luxurious travelling of a well-equipped tramway, a system which more nearly approaches the ideal means of transit for our busy city streets than has heretofore been attained by any of the many systems which have from time to time been put forward.

(To be continued.)

CENTRAL LONDON RAILWAY.

On Wednesday last the Prince of Wales, in a quiet, informal way, opened the Central London Railway, which was promptly closed again after the ceremony. It is hoped, however, that the ordinary traffic will be commenced in the course of a few days. The Prince of Wales is said to have taken a great interest in the line, and to have expressed himself pleased both with the means of approach and with the facilities offered in the rolling stock. The train conveying the Prince took 22 minutes in traversing the full length of the line from the Bank to Shepherd's Bush. Luncheon was served to a distinguished gathering at that end of the line, after which the Prince of Wales, in declaring the line open, said: "I have much satisfaction in having been asked to take part in to-day's ceremony.

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I wish also at the same time to drink success to the undertaking, and to congratulate Sir Benjamin Baker, the eminent engineer who has constructed this railway, and I have little doubt it will be a great boon to our great city. I wish you to join me in drinking success to this undertaking."

MERRIMAN'S RISING CONTACT STUD.

Several months ago a description of this contact stud for electric tramways appeared in the *Electrical Engineer*, when it was pointed out that the probability of grit working in under the treadle and eventually preventing its depression was considerable. This drawback, together with the danger of a passing wagon-wheel depressing the treadle, the inventor claims to have overcome in the improved form shown in the accompanying diagrams.

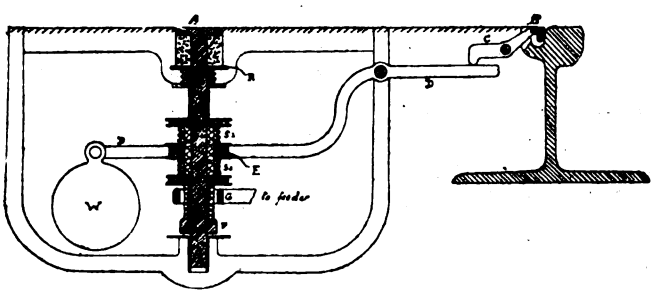

FIG. 1.

Fig. 1 represents a section of the contact stud and treadle in their normal positions, while Fig. 2 shows the action of the flange of the car-wheel. The contact stud, A A, is flexibly connected by means of the ring, E, to the weighted lever, D, which is actuated by the bell-crank lever, C, attached to a continuous flexible strip or treadle, B, which rests in the groove of the rail till it is wedged out and held in the position shown in Fig. 2 by the flange of the car-wheel as it passes. The bell-crank lever then presses down the shorter arm of the lever, D, consequently raising the weighted end and, with it, the contact stud, the enlarged portion of which (F) makes electrical contact with the split ring, G, connected through a fuse to the main feeder. The object of the spiral springs, S_1 S_2, is, in the first place, to ensure a firm

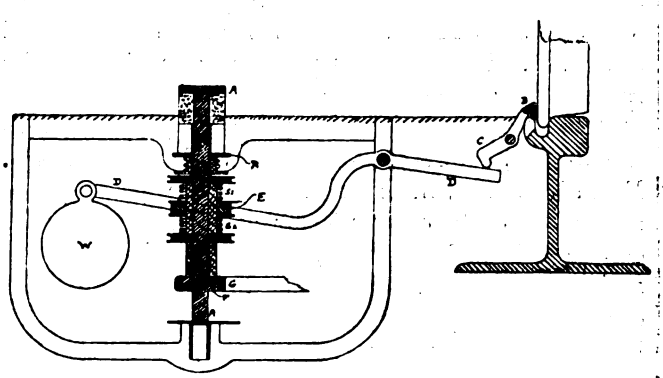

FIG. 2.

rubbing contact between the top of the stud and the collecting skate of the car, and, secondly, to keep the head of the stud while in its normal position tightly pressed against the rubber washer, R, so that the containing box may be kept watertight. After the wheel has passed, the weight, W, causes the stud to fall, thereby breaking the electrical contact, and forcing the treadle back into its groove. The distance between each box depends upon the wheel base of the car, which should be short in proportion to the length of the body, to ensure the stud falling while the car is still over it; also it is necessary for the wheels to be comparatively close together to hold the treadle up until the last wheel has passed. Immediately below the head of the stud is shown a large washer of porcelain or other suitable material, which, while insulating the stud from the top of the containing box, prevents grit blowing into the recess when it is raised. The top of the box may, in its turn, be insulated from the roadway, thereby minimising the leakage from which surface-contact systems suffer in wet weather.

THE POWER BILLS.

The decision of the committee of the House of Commons respecting the Electrical Power Bills was given yesterday by Sir J. Kitson, chairman, as follows: "The committee, subject to the principles contained in their declarations to be embodied in their clauses to be agreed upon, and subject to amendments to clauses as on going through the Bills appear necessary. The preamble of the South Wales Electrical Power Distribution Bill is proved. It may be convenient, although the business is not down for to-day, too announce also that the preamble of the Durham Electrical Power Distribution Bill is proved, and that the preamble of the Tyneside Electrical Power Distribution Bill is not proved to the satisfaction of the committee. The preamble of the Lancashire Electrical Power Distribution Bill is proved to the satisfaction of the committee. The intention of the committee is to insert so far as may be applicable the same conditions in each of the Bills. I should like to ask, gentlemen, if it could be convenient to attend here on Tuesday next at half-past eleven to consider the clauses."

In answer to questions, the Chairman said that the clauses of all three Bills would be considered, the South Wales Bill being taken first.

STAFFORD ELECTRIC LIGHTING ACCOUNTS.

From the accounts of the Stafford Corporation electric lighting department, it appears that the total expenditure on capital account for the year ending March 31 amounted to £19,949. We give herewith abstracts of the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.:

Dr. Revenue Account.	£	s	d.
Generation of electricity	612	4	10
Distribution of electricity	137	4	0
Rents, rates, and taxes	178	7	8
Management expenses	30	14	1
Bad debts	3	0	8
Insurance	21	2	9
Electric fittings	0	6	8
	983	0	8
Amount carried to net revenue account	789	14	11
	£1,772	15	7

Cr.	£	s.	d.
Sale of current per meter	1,574	0	9
Public lighting	90	0	0
Rental of meters and other apparatus	86	1	0
Rents	22	13	10
	£1,772	15	7

Balance-Sheet.

Dr. Liabilities.	£	s	d.
Capital account—amount received	17,537	6	9
Sundry creditors	713	18	8
Balance at credit of loans account	2,462	13	3
Amount due to bankers	1,318	17	3
	£22,032	15	11

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	19,949	17	9
Stock of fittings, cable, etc.	742	15	0
Sundry persons for rental and fittings	883	9	6
Balance to debit of profit and loss account	456	13	8
	£22,032	15	11

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T.U.		118,341
Output of station in B.T.U.		98,748
Quantity sold: Private consumers by meter	83,311	86,780
Quantity sold: Public lamps	3,469	
Quantity used on works		6,477
Total quantity accounted for		93,257
Quantity not accounted for		25,084
Total maximum supply demanded (kilowatts)		116
Equivalent in 8-c.p. lamps connected		8,558
Number of public lamps		4

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THE
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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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THE BATTLE OF THE PHASES.

The discussion which took place at the Huddersfield convention of the Municipal Electrical Association reminded one somewhat of the fights which in past years have raged in the Institution of Electrical Engineers as to the relative advantages of alternating and continuous current. The object of Mr. Wilmshurst's paper was to show how far the disadvantage of a single-phase alternating-current system supply with respect to motors has been overcome up to the present, and is likely to be still further overcome in the near future. As the author put it in his reply, it was not so much a question as to whether, when equipping a town *de novo*, a single-phase or multiphase systen should be used, but rather as to whether the advantages of a multiphase system were sufficiently great to warrant the expense of changing over when a single-phase plant was already at work. While the single-phase system has such an eloquent advocate as Mr. S. Z. de Ferranti it is not likely to be lightly set aside by central-station engineers, but we think Mr. Ferranti referred in somewhat strained terms to the complication of a multiphase system of supply. The advocate on the other side (Mr. W. B. Esson) tried to bring the discussion down to details rather than confining it to abstract opinions *only*. He pointed out, as will be seen from our report of the meeting, that the extra cost of converting a single-phase generator into a two-phase one was exceedingly small, the winding in the idle holes in the armature only costing some 5 per cent. of the total. He, however, neglected the very strong argument, that for this increased 5 per cent. in cost a very considerable increase of output is obtained. In order to see how far this increased output goes, we have consulted the price list of the British Schuckert Company. We find from this, fixing the engine speed at 150 revolutions and the power factor of the load at 0·9, a 324-kw. three-phase alternator is listed at £1,750. The nearest single-phase machine at the same speed and power is a 300-kw. alternator listed at £2,050. Increasing the price in proportion to the output, a 324-kw. machine would cost £2,200. From this it will be seen that the single-phase alternator costs quite 25 per cent. more than the corresponding three-phase, as is only to be expected, seeing that, as Mr. Esson puts it, idle holes in the core of a single-phase machine are wound with wire in the multiphase type. Looking at the matter in another way, one sees elsewhere in the above-mentioned list of single and multiphase alternators that with the same size field magnets and core about 22 per cent. more output can be obtained from large alternators by making them three-phase, and over 25 per cent. more in the case of smaller alternators. Of course, the cost of machines is only one item in the comparison, but when large extensions are being made a saving of 25 per cent. in the first cost of the alternators is by no means to be despised. The question of the cost of mains we do not propose to go into here, but where, as is the case in many towns, the distributing mains are already too small for their work, it is a comparatively easy matter to change

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over to a multiphase system when laying down the additional copper, which would be required in any case. As regards the question of the motors themselves, there can be no two opinions as to the superiority of the multiphase system—in fact, all single-phase motors are really worked on the multiphase system, and the same comparison of cost as we have made in favour of the multiphase generators will apply in an exaggerated form to the motors. We trust that the engineers who will have the opportunity of laying down large new works in this country, if the Power Bills now before Parliament are successful, will not handicap themselves in the first instance by adopting a system which will require modification after a few years.

ELECTRICAL CABS.

Mr. Carl Oppermann, in a letter given in another column, calls attention to the defunct cab company, and incidentally mentions a number of causes which prevented success. Of course, the important question always has been, How about the wheels within wheels? The outsider could never see any chance of commercial success, though electrical engineers hoped that they might witness another case of the unforeseen occurring. Certainly Mr. Oppermann is correct in stating that no license was required by anyone to make electrical vehicles unless for the use of patented details, which might or might not be of value. If, however, the company was promoted in order to grant licenses for these details, and the investors were made fully aware of the fact, and that electrically-driven vehicles could be, and were, made without such license, then they deserve no sympathy. There may have been some originality in the design of cab introduced. We never could see any, and more than once stated that the cabs were cumbrous and unsuited for the work they had to do. It may be that failures lead the way to success, and that in the sweet by-and-bye motor carriages driven by electricity will be introduced into London. If, however, they are to be fashioned upon the frames of the late company's plant, let us hope the time may be very long. Health, longevity, comfort, convenience, sanitation, nerves, are words, mere words, used in phrases which govern the talkers in this country, just in the same way as grandiose phrases govern the politics of a neighbouring country. Motor 'buses and carts are to be seen about London, fit inventions of Diabolus. What are they but modified traction engines—noisy, stinking, ugly—put on to a 'bus or a cart body? Is it beyond the power of mechanical engineers to design something noiseless? Fancy motor 'buses of the present type as thick as horse-driven 'buses in the Strand, and you had better live in the Dowlais Ironworks! There, at any rate, you would be within the area of noise for a comparatively limited time—say, eight hours—but business people, and those who live in houses bordering busy streets, cannot cry "Eight hours' work, eight hours' sleep, and eight hours' play," or even the modern variant which adds "Eight bob a day." Our remarks are limited to vehicles plying for hire or used in business for carrying goods, but they are not altogether incorrect even when applied to the ever-increasing number of vehicles used for social purposes.

ELECTRIC POWER BILLS.

The committee which has been considering this question for some time has closed its enquiry. At the close of the enquiry on Wednesday, the chairman (Sir James Kitson) made a declaration in the following terms, thinking the time had come when it would be convenient to give an idea of the committee's conclusions: "A local authority which undertakes and is prepared to give a full and ample supply of electrical energy for all purposes to consumers within its district ought not, without its consent, to be required to give facilities for the supply within its district of electrical energy by other undertakers. But if a local authority is unable or unwilling to provide on reasonable terms and within a reasonable time a full and adequate supply of electrical energy for any purpose to any company or person applying for the same within its district, such company or person should be at liberty, after notice to the local authority, to obtain their supply from other authorised undertakers, and the local authority should be required to give all necessary facilities for this purpose. Any difficulty arising out of the above questions should be subject to arbitration as provided by the general Acts." It will not be wise, perhaps, just at this moment to enter into any lengthy discussion as to the conclusions of the committee, but at the same time it must be said that they have carefully and somewhat arduously examined the cases laid before them. Yesterday, as given elsewhere in our columns, their final decision was made public, and, with perhaps one exception, will prove fairly satisfactory to those gentlemen who have brought this matter forward. Of course, the promoters of the Bills will not get all they want, but it seems certain that no local authority will longer be allowed to act as a drag on progress. If the matter comes within the scope of municipal action they will be allowed to undertake it if they can carry it out quickly and satisfactory, but except under these conditions they will have to give way to those who can and will conform to them.

CORRESPONDENCE

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRICAL CABS.

SIR,—One would think from reading the circular issued by the directors of the late London Electrical Cab Company, Limited, that the electrical vehicle was an impossibility, and that the vast sum subscribed by the public was used in endeavouring to put a practical vehicle on the streets.

From the manner in which the capital was spent, wicked-minded persons might feel inclined to suggest that the only reason for which the company was started was to obtain the £25,000 for the valuable (*sic*) licenses, without which, we were told, you could not make electrical vehicles at all, although the electrical landau, which was shown to the

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would-be shareholders at Winchester House, was made under quite a different system, and one for which no license was required other than that conveyed to the purchaser of any patented article.

The directors say that, although the designs were approved of by engineers and engineers and experts, several defects developed themselves in the vehicles. To my knowledge the directors were advised to make only two cabs in order to find out what was required to stand the London streets; but no, this would have been too prudent, and the license money could not be paid out soon enough, so without any actual experience to guide them the first 40 cabs were put in hand at once. They say they were too heavy for the rubber tyres; of course, 38cwt. to 40cwt., which was their weight, is too much for the same wheels and rubbers one would find on an ordinary four-wheel horse-drawn cab, which weighs only 8cwt., and which were the sort put on the first cabs! The vibration too, we are told, destroyed the cells. One cannot be surprised at the vibration in a vehicle which was built practically without springs. What further damaged the cells was the enormous amount of current taken from them, owing to the want of attention to the gearing and sending out of the cabs without proper oiling arrangements. Not any of the vehicles had an ampere-meter, so that however anxious a driver might be to run the cab successfully, he had no certain means of telling whether his cab was running properly or not.

Then there was the driver bogey. Can one expect men who have a living to earn not eventually becoming disheartened and reverting to the old horse-drawn vehicle in consequence of the continuous breakdowns?—breakdowns which could in all cases have been prevented by proper supervision and examination of the cabs after each day's run. I know that it is possible to obtain any number of men who could, with slight training, properly drive an electrical vehicle.

Consider again the large sum spent upon that alternating transformer plant, which was put down to supply the electricity for the accumulators, and which turned out to be practically useless, as the current ultimately cost 4d. or so a unit, and was abandoned, a continuous-current plant, with Babcock-Wilcox boilers, being afterwards put down, at a further cost of several thousand pounds, although all the current necessary for the undertaking could have been obtained without a farthing outlay at about 1½d. per unit from one or two supply stations in London.

That electrical vehicles can be made to run, and at a profit when properly managed, you have only to turn to New York, where, starting with a modest 20 cabs, the number is now increased to over 200, and to Berlin, where electrical omnibuses are in use successfully, and also to the few electrical victorias which have been recently hired out here in London, and have proved such an unqualified success. But no company started to hire out electrical carriages can ever prove profitable if run upon the lines of the late London Electrical Cab Company.

That smart, comfortable, and reliable electrical carriages will eventually appear in our streets in large numbers there is not the shadow of a doubt. Their popularity is beyond all question. The entire absence of noise and vibration, heat, or unpleasant odours, not only to the passengers, but to anyone in the immediate neighbourhood, and the ease with which they are controlled, all tend to make them an ideal means of locomotion.—Yours, etc.,

CARL OPPERMANN.

Automobile Club, S.W., June 21, 1900.

INSTITUTION OF MECHANICAL ENGINEERS.

The Institution of Mechanical Engineers held their annual dinner on Wednesday evening in the Grand Hall of the Hotel Cecil, Mr. E. Windsor Richards, past-president of the institution, presiding, there being some 500 guests. The company included, amongst others, the Master of the Rolls, the United States Ambassador, the Earl of Rosse, General Sir Evelyn Wood, Sir Frederick Abel, Sir Courtenay Boyle, Mr. Charles Morgan, Sir Edward Carbutt, and Rear-Admiral A. K. Wilson, controller of the navy. Sir William White, the president of the institution, was unable to be present owing to ill-health.

After the loyal toasts had been honoured, the Earl of ROSSE proposed "Her Majesty's Forces."

Rear-Admiral WILSON, in replying, referred to the work of the Naval Brigade in the South African war, and maintained that they had convinced the British public that they were efficient for any work that might be required.

General Sir EVELYN WOOD responded for the army, and observed that whereas some year and a half ago the Commander-in-Chief stated he could send two army corps abroad at short notice, he had, in fact, sent the equivalent in men of six army corps—211,000 men—in addition to which the War Office had helped to equip the 33,000 men which the patriotic feeling of the Colonies had supplied. They had, moreover, supplied for the sick 1,000 medical officers and as many female nurses in South Africa had been willing to accept. They had been told that Great Britain had only a phantom or a paper army, but this phantom army had made itself felt in a territory which extended in length a greater distance than from the Pyrenees to the Carpathian Mountains.

Mr. CHOATE, replying to the toast of "The Guests,' said the exchange of thought and fellowship between the professions of mechanical engineers and other professions on both sides of the water would do more to promote friendship and common feeling between both nations than anything else. There was one delightful thing about engineers—their minds were always open to learn. His belief was that the mechanical engineers of England had a great deal to learn from the mechanical engineers of America, and they on their part had many valuable lessons to learn from the mechanical engineers of England. There was such a thing as the mutual dependence of nations, especially of two great nations like Great Britain and America, speaking the same language and preaching the same lesson.

Mr. C. H. MORGAN, president of the American Society of Mechanical Engineers, also replied to the toast.

Lord ALVERSTONE gave the toast of "The Institution of Mechanical Engineers," which was responded to by the Chairman.

THE ENGLISH ELECTRIC MANUFACTURING COMPANY'S WORKS.

AN OBJECT LESSON.

(Continued from page 888.)

Worth notice, too, are the grinding machines for grinding the dies with flat cutting surfaces, these moving the piece of work back and forth solely while the large grinding cylinders roll rapidly, and at the same time move along their axes at right angles to the movement of the work, thus ensuring perfectly flat surfaces. Next comes the annealing process, where the armature discs are packed into iron cases and covered with sand to exclude the air. They are then placed in ovens, where they are raised to a dull red heat and then slowly cooled, afterwards being passed through the painting machines, which cover them with the thinnest possible layer of varnish. Issuing from the varnish tools they are dropped on a moving chain belt, which passes them through a drying oven and delivers them in the assembling department to be built up into cores ready for winding. Moving down the shop, we now come to a second railway track, entering the machine shop from the foundry. By means of this track the castings of motor and generator frames are delivered directly to the respective departments equipped for their completion. The first process with the motor castings is to place them on the vertical milling machines, which face the two halves, to form a perfect magnetic joint. Next in line are the radial drilling machines, which drill all the holes in the motor frame. After being bolted together, the frames are placed on the horizontal boring mills which finish the bearings for the armature and axle, and bore out the frames to receive the pole-pieces. The frames are now completed and ready for delivery to the

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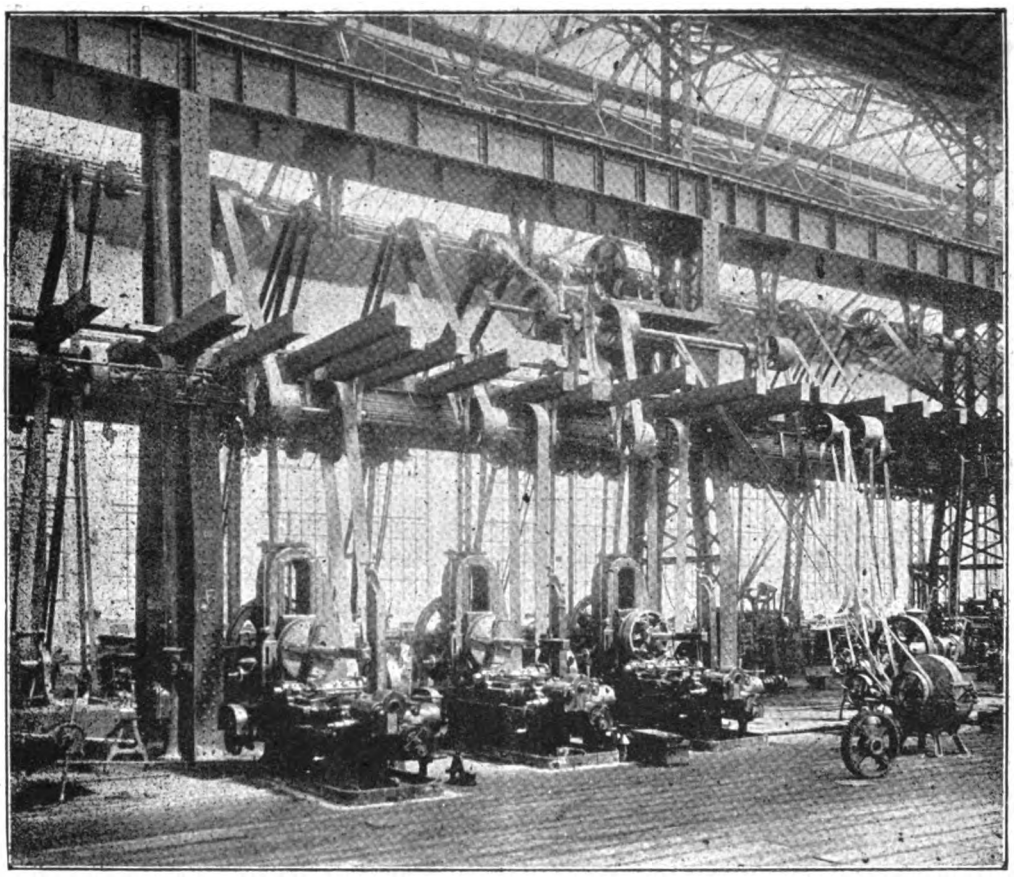
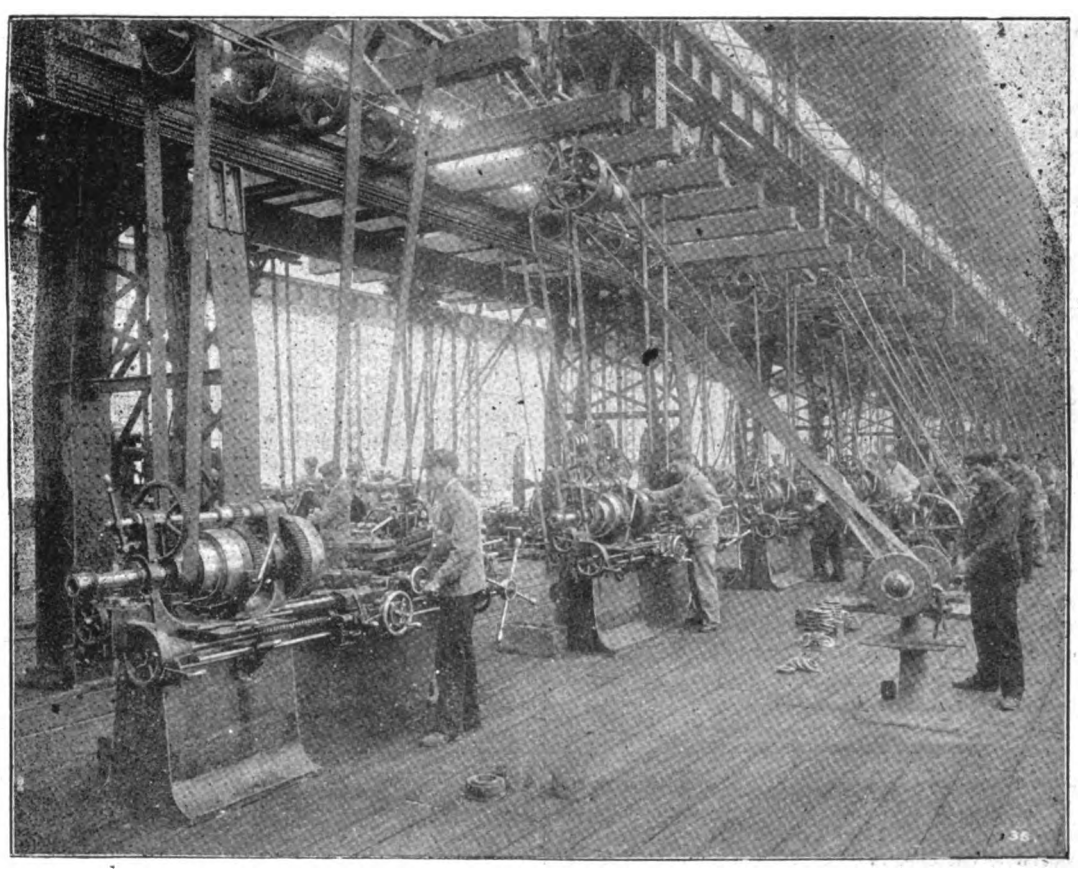
motor assembling section. Coming next to this group of magnificent boring mills are the motor-shaft lathes and



Gear Department, showing Line Shaft and Motor.

special machines for grinding the armature shaft bearings. Then come the massive turret lathes for finishing the



Turret Lathes, Motor Department.

armature and plates, the commutator heads, and the bearing shells. The next group of tools, comprising lathes, planers, shapers, milling machines, and many special tools, constitutes the brassworking department, where the controllers, rheostats, trolleys, commutators, and brush-holders are made. The next department is the field-magnet winding section, where the motor and generator field magnets are wound, insulated, and baked, and the armature coils placed on the motor armature cores. The motors and controllers have now reached the assembling and painting department,

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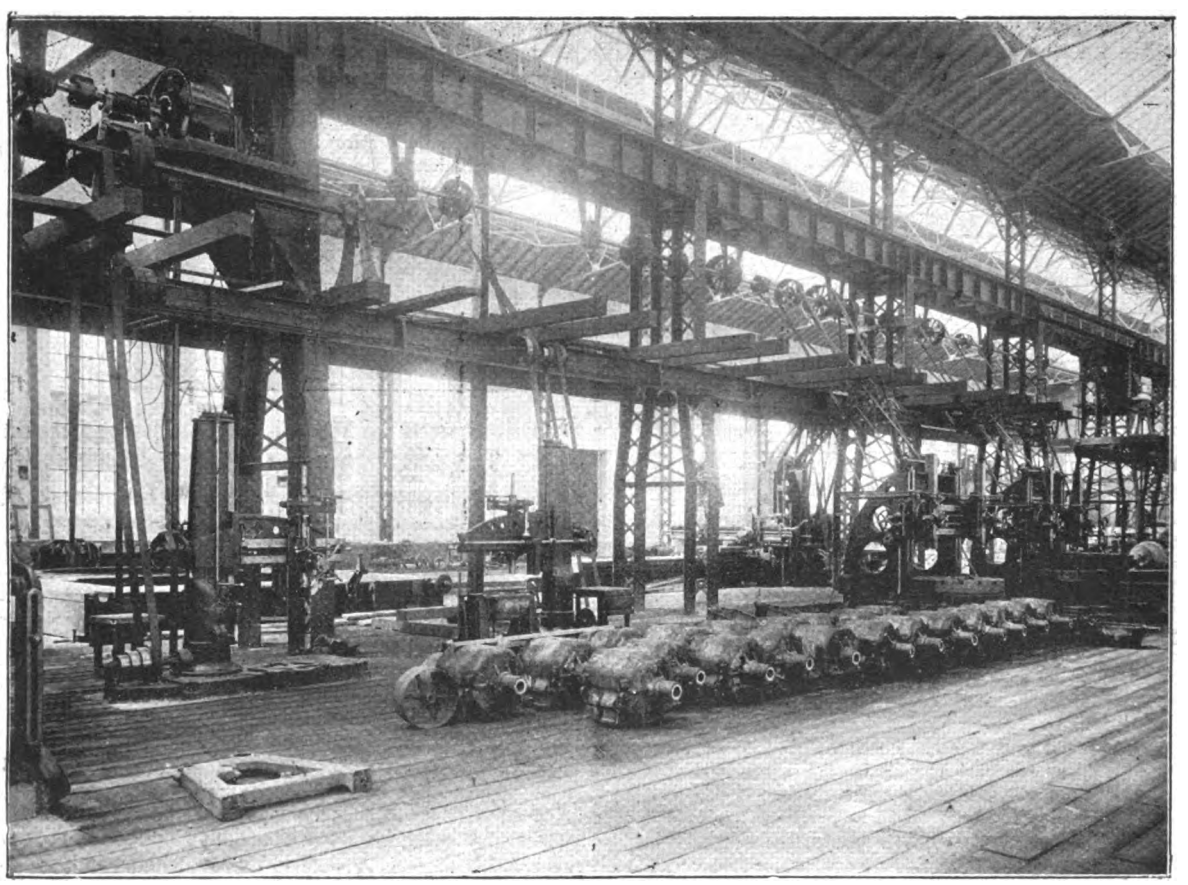
from which they are delivered to the testing department, where they are subjected to severe tests for insulation, etc., and run under full and over load conditions for the specified time. After the tests are completed the temperature of each part is taken, and a thorough examination made as to the quality of workmanship, etc. If perfect in every respect the completed machine is taken charge of by the shipping department, where it is loaded into trucks on the shipping track, which enters the building at the opposite end from the receiving track. The armature winding, insulating and mica department for motors, dynamos, and alternators, is separated from the main portion of the machine shop occupying the extreme south end of the generator bay. A brief description of the interesting operations which take place in this department will be of interest. The armature coils, which are wound or formed entirely by machinery, must be thoroughly insulated with mica, paper, and cotton braiding. They must be properly dried, dipped into special varnish, and then baked in order to exclude all moisture. Afterwards they are pressed into exact shape, and formed to size so



Drill Presses and Vertical Mills.

that all coils and windings may be alike and interchangeable. The mica rings and tubes for commutators are moulded under great pressure while being heated. The presses in which this work is being done have their various parts heated by steam-pipes from the boiler-house to this portion of the machine shop. Nearly all the winding, insulating, and mica moulding in the department is done by girls, and its separation from the main portion of the shop obviates the possibility of metallic chips or filings getting into the insulation. Returning again to the point where the foundry track enters the machine shop and coming down the generator side of the shops, we find the largest and finest tools in the plant for machining and finishing the huge generator frames, armature heads, etc. The generator frames after coming from the foundry are first placed on an enormous planing machine to be faced at the joints. The bed of this planing machine is 24ft. long, and will receive a casting of this length. This tool is driven by its own motor, and weighs over 75 tons. The next tool is the largest in the works, being a boring mill, swinging 24ft., used to bore out armature heads, to receive the engine shafts, to finish the armature end rings for large generators, and to make the large commutators for these machines. This mill weighs over 100 tons. Next comes a universal boring and milling machine, which, while not so heavy as the boring mill last mentioned, occupies more room, its table, flush with the floor, being 24ft. square. Along one side of this table travels an upright pillar about 10ft. high. To this pillar is attached a spindle, which can be moved to any position, vertical or horizontal, within the limits of the tool. Generator-frame castings are placed upon the table of this machine, and all the holes bearing bored, surface milled—in fact, all the remaining machine work is finished without moving the casting. For the armature heads of large dynamos and alternators portable slotting machines are provided, each with its own motor, which cut the keyways for the engine shafts and the dovetailed slots for fastening the armature laminations. The machine work on the generator frames is now finished, and they next proceed to the assembling department, opposite the shipping track, where they are erected for test, each generator being thoroughly tested for insulation, output, temperature, and commutation. In the testing-room there is arranged a complete switchboard about 48ft. long, with a full assortment of approved testing instruments of wide range. Through the switchboard is also arranged a supply of alternating current at various pressures for testing insulation, and from it as well is distributed all the power for the different parts of the works. In the testing department there is provided live steam from the boiler-house, so that complete engine-dynamo sets can be tested with perfect ease and without the necessity for making special arrangements. Midway down the generator bay are located two important departments, the toolroom—sunk 4ft. below the floor-level, so as not to interfere with a clear view of the shops—and the gear-cutting department. In the latter is comprised a group of special tools by which all the operations involved in the complicated and tedious operation of cutting the gears are performed automatically and with absolute precision.

(To be continued.)

Swansea Tramways.—The official opening of these tramways, after being electrically equipped, is to take place on Saturday, June 30, at 12 o'clock. After the official opening a luncheon will take place at the Hotel Metropôle, Swansea.

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INSTITUTION OF ELECTRICAL ENGINEERS.

A Frictionless Motor Meter.

BY S. EVERSHED, ASSOCIATE-MEMBER.

(*Concluded from page 845.*)

APPENDIX.

Calculation of Armature Torque, Brake Torque, and Frictional Resistance.

I.—Armature Torque.

In designing an Ayrton-Perry motor meter the driving torque may be calculated from the formula

$$d = \frac{H a N C}{\pi},$$

which gives the torque, d, in terms of H, the field of the main current coils, a the area of the average turn of wire on the armature, N the total number of turns in the armature winding, and C the whole pressure current from brush to brush.

A sufficiently close approximation to the true mean value of the field throughout the space occupied by the armature is obtained by calculating H at several points of the axis of the main coils, and taking an average. When the coils are rectangular, the field on the axial line may be deduced from the formula

$$H = \frac{8 C \sqrt{p^2+q^2}}{p q},$$

which gives the field at the centre of a wire rectangle whose sides are p and q. If the coil is square, this reduces to

$$H = \frac{8\sqrt{2}\, C}{p},$$

p being now the side of the square. The field at the centre of a circular wire being

$$H = \frac{2\pi C}{r},$$

we find that if $r = \cdot 56\, p$ the circular and square wires will have the same field; hence for purposes of calculation a circular coil of appropriate radius may be substituted for the square coil.

There are, of course, various methods for arriving at an exact value for H, but as they involve applications of spherical harmonics they are far too cumbersome for practical use in design. When the meter is made, its driving torque is easily measured by passing a fine thread round the axle and hanging a known weight on the end. When the axle is vertical, the thread is brought out in a horizontal direction from the axle and passed over a freely pivoted pulley, from which it hangs down, carrying the weight at its end. To avoid side pressure against the axle bearings, it is desirable to use two threads brought away from the axle in opposite directions, and each carrying half the weight so that a proper turning moment is produced. Having adjusted the thread and weights, current is turned on, and varied until the armature torque just balances the weight. When the full-load torque is small, it is desirable to make this measurement with two or three times the full-load current, otherwise the weight required will be too small to enable accurate results to be obtained. The calculated torque is found to agree within 2 or 3 per cent. with that obtained directly by measurement.

II.—Brake Torque.

The difficulty of determining the average path of the eddy current in a given brake conductor prevents us from predetermining the torque unless we have previously ascertained the effective electrical resistance of the current path in a brake of similar shape. There are, however, some general principles applying to the design of Foucault brakes which may be shortly stated here. Consider a cylindrical conductor, of radius r, spinning on its axis between the poles of a magnet. Let the polar gap have a breadth b and axial length l, and let the field within the gap be H. Then if x is the electrical resistance of the current path, and ω the angular velocity of the cylinder, the current generated will be

$$C = \frac{H l r \omega}{x}.$$

Now the force between conductor and magnet is H l C, hence the torque will be

$$M = \frac{H^2 l^2 r^2 \omega}{x} \quad \ldots\ldots \quad (1)$$

When the cylinder extends axially for some distance beyond the poles in both directions, x becomes simply proportional to the resistance of the metal in the gap. Now this resistance is

$$\frac{\rho l}{b t},$$

t being the thickness of the metal. We can therefore write

$$x = k \frac{\rho l}{b t}.$$

The value of k depends on the shape of the polar area, and on the extent of conductor outside that area. The author finds k varies from about 3 for a square or circular area of gap up to 6 or 7 with oblong poles, even as high as 9 or 10 when there is very little metal beyond the poles. Inserting the value just given for x in equation (1) and multiplying both numerator and denominator by b, we get

$$M = \frac{H^2 t^2 b^2 r^2 \omega t}{k \rho b l},$$

$$M = \frac{B^2 r^2 \omega t}{k r b l} \quad \ldots\ldots \quad (2)$$

from which we see that for a given value of total induction, B, passing through the brake cylinder, the torque increases as the area, b l, is diminished. The deduction is well borne out in practice, and by giving the brake magnets conical poles ending in a circular gap of small diameter the torque for a given weight of magnet is considerably increased; or, what is generally more important, for a given torque the weight of metal in the brake may be greatly reduced by using magnets with conical poles. The formula also shows the advantage to be gained by increasing the diameter of a cylindrical brake; since the weight only increases in simple proportion, while the torque increases in proportion to the square of the radius.

III.—Frictional Resistance.

When mechanical friction is a fairly large percentage of the full-load torque, air friction may be safely neglected; the only retarding forces are then mechanical friction, which is practically constant, and the brake, which is proportional to the speed. Hence if s_1 and s_2 are the observed speeds with two torques, d_1 and d_2, we have

$$d_1 = f + b\, s_1 \quad d_2 = f + b\, s_2,$$

where f is the torque required to overcome friction, and b is the brake torque at unit speed. Hence

$$b = \frac{d_2 - d_1}{s_2 - s_1}, \text{ and } f = \frac{d_2 s_1 - d_1 s_2}{s_2 - s_1}.$$

To get accurate results, stray fields must be eliminated by reversing the current in the main coils and taking a second set of readings with the same numerical values for d_1 and d_2. In testing the friction of a "frictionless" meter, the greatest care is required in measuring speeds and torques, and it is necessary to reduce the strength of the brake to a small fraction of its normal value in order to obtain anything like accurate results, for, obviously, errors of observation have a rapidly increasing effect on the determination of f as the two quantities $d_2 s_1$ and $d_1 s_2$ approach each other in magnitude. Each of the results given in Tables III. and IV. is the mean of a number of observations, and to avoid effects due to want of truth in the brush wheels the speeds were deduced from the times taken to make 12 (and multiples of 12) revolutions of the armature, corresponding with whole revolutions of the brush wheels. Even with the utmost care, discrepancies of as much as 10 or 15 per cent. in successive tests are quite usual when the friction is under three dyne-centimetres. When the armature and brake of a "frictionless" meter are both figures of revolution with smooth surfaces, air friction is inappreciable up to speeds of 40 or 50 revolutions per minute, but when there are any parts attached to the axle which can have a fan action, air friction becomes evident, and although it would cause no appreciable error in the registration of the meter when the normal brake is in use, it will, if not taken into account, lead to an underestimate of the mechanical friction. To avoid this, observations are made at three speeds in order to determine a, the coefficient of air friction, as well as f and b. Thus, assuming the air friction of a rotating body to be proportional to the square of the speed, we have—

$$d_1 = f + b\, s_1 + a\, s_1^2\,; \; d_2 = f + b\, s_2 + a\, s_2^2 \; d_3 = f + b\, s_3 + a\, s_3^2,$$

from which we first find a, then b, and finally the mean value of f.

$$a = \frac{(d_3 - d_2)(s_2 - s_1) - (d_2 - d_1)(s_3 - s_2)}{(s_3 - s_2)(s_3 - s_1)(s_2 - s_1)}$$

$$2\, b = \frac{d_3 - d_2}{s_3 - s_2} + \frac{d_2 - d_1}{s_2 - s_1} - a(s_3 + 2 s_2 + s_1)$$

$$3\, f = d_3 + d_2 + d_1 - b(s_3 + s_2 + s_1) - a(s_3^2 + s_2^2) + s_1^2).$$

The air friction of a rotating body is probably not exactly proportional to the square of the speed; but the formula is found to agree very closely with experiment. An example of the effect of air friction is afforded by meter No. 5, in which each of the two parts of the astatic armature is made up of four oblong coils wound on open "formers." Such an arrangement naturally fans the air, and experiment showed that air friction at speeds of from 40 to 50 revolutions per minute was by no means small compared with mechanical friction. The brake having been reduced to about one-sixteenth of its full

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strength, the following readings of torque and speed were taken :

METER No. 5.

Full load, 100 volts × 10 amperes.
Full-load torque, 1,610 dyne-centimetres ; drop ·6 volt.
Effect of air friction exaggerated by use of a weak brake.

Volts.	Amperes.	d Dyne-cms.	s Revs. per min.
100	·10	16·1	6·58
100	·50	80·5	37·40
100	1·00	161·0	72·60

By inserting these values in the above equations we find

$$f = 3{\cdot}16 \; ; \; b = 1{\cdot}95 \; ; \; a = {\cdot}003$$

The curve of the meter with its weakened brake is shown in Fig. 13, where the lower curve line is drawn to the equation

$$d = 3{\cdot}16 + 1{\cdot}95\, s + {\cdot}003\, s^2,$$

while the upper curve (a straight line) shows what the law of this meter would have been if no air friction existed. It will be seen that at 80 revolutions per minute air friction amounts to as much as 19 dyne-centimetres. At full speed (50 revolutions per minute) the driving torque is expended as follows :

In overcoming mechanical friction.....	3·2	dyne-centimetres
,, ,, air friction	7·5	,,
,, ,, brake torque	97·8	,,
Total	108·5	,,

That is to say, with the weak brake air friction amounts to about 7 per cent. of the whole resistance to rotation. With the brake restored to its normal strength the corresponding figures are :

Mechanical friction	3·2	dyne-centimetres
Air friction	7·5	,,
Brake (full strength).....	1,600·0	,,
Total	1,610·7	,,

It will be seen that the air friction is now less than ½ per cent. of the total resistance, although this particular meter has less torque than the standard now adopted. Another method of determining friction which seemed at first sight to offer several advantages is to run the meter at about full load, and having carefully determined the speed, at a given instant cut off the currents and note the time taken by the meter in coming to rest. If at any instant the angular velocity is ω, we have the equation

$$I \frac{d\omega}{dt} = f + b\omega \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where I is the moment of inertia of the meter axle and parts attached to it ; f is the mechanical friction, as before, but b now stands for brake torque at unit angular velocity. (1) gives the value

$$t = \frac{I}{b} \int \frac{d\omega}{\frac{f}{b} + \omega},$$

hence

$$f = \frac{b\,\omega_1}{e^{\frac{t\,b}{I}} - 1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

ω_1 being the initial angular velocity. The moment of inertia is easily determined by attaching a hair-spring, of known strength s, to the axle and observing the period of oscillation, τ ; then

$$I = \frac{s\,\tau^2}{4\,\pi^2}.$$

s must be taken in dyne-centimetres per radian of torsion.

In practice this method has not given good results. A meter—especially a frictionless meter—comes to rest so gradually that it is exceedingly difficult to determine with exactness the instant when it stops. Again, if there is the least want of balance in the axle it will very rarely happen that the meter comes to rest at its position of stable equilibrium without first making one or more very slow oscillations about that point. Hence there are often very large discrepancies in successive observations, and on the whole the average time taken in coming to rest will be greater than it would be if the meter were perfectly balanced. Some early experiments with meter No. 2 may be quoted as an illustration of this uncertainty. Measured by the torque-speed curve the friction was 2·65 dyne-centimetres ; the mean of two fairly good observations of the time of stopping gave the value 2·98 dyne-centimetres. This result being considered encouraging, a large number of similar tests was made, with the result that the average of the whole series gave 1·27 dyne-centimetres as the friction. This figure is undoubtedly a good deal lower than the true value, and, except as a rough-and-ready means of comparison, the stopping test has not since been employed. All the friction values given in the paper are deduced from torque-speed curves. An improvement on the stopping test would be to record on a chronograph the times of successive revolutions of the meter, beginning as soon as the currents are cut off and ending a little before the meter comes to rest. The chronograph record would enable a time-speed curve to be plotted, and the slope of the curve would give the total retardation, from which the brake torque would have of course to be deducted in order to arrive at the value of friction.

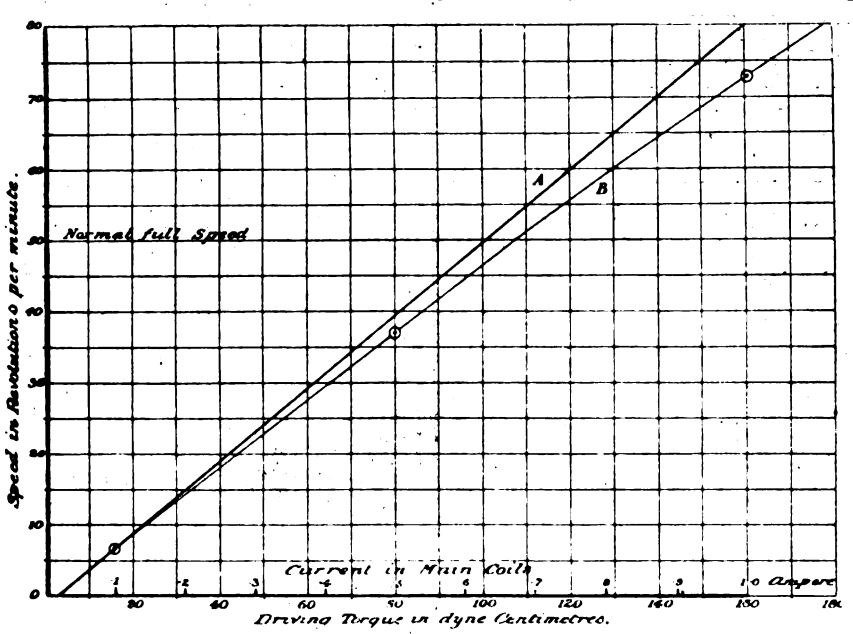

FIG. 13.—Torque-Speed Curves for Meter No. 5 (effect of air friction exaggerated by use of a weak brake).
A, Curve drawn from equation $d = 3{\cdot}16 + 1{\cdot}95\,S$. *B*, Curve drawn from equation $d = 3{\cdot}16 + 1{\cdot}95\,S + {\cdot}003\,S^2$. ○ Points determined by experiment.

CALCULATED FRICTION.

It is useful to compare the value of friction given by direct experiment with the value calculated on the assumption that the bearings are the sole cause of friction. This comparison has been made in the case of meter No. 2, and shows a considerable margin of friction unaccounted for. If the diameter of contact between the steel point and the cup forming the step bearing were measurable, the friction moment could be estimated from the formula—

$$f = \frac{k\,P\,d}{3},$$

where k is the coefficient of friction ;
P is the total pressure on the bearing ;
d is the diameter of contact.

It is, however, impossible to measure the contact diameter when the point and cup are spherical surfaces, and recourse was had to experiment. The total friction having been taken by the torque-speed method, a weight of about 50 grm. was added to the armature, and the friction again determined. The weight being removed, the first test was repeated. The result of these tests was to show that this particular point and jewel offered a frictional resistance of ·092 dyne-centi-

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metre per gramme weight pressing on the jewel. Now before the meter started running on Oct. 12, 1899, the pressure on the jewel was measured and found to be 12 grm., hence the step-bearing friction would be $\cdot092 \times 12 = 1\cdot1$ dyne-centimetres. The friction added by each brush wheel is roughly as follows: Brush wheel step bearing: pivot assumed to have a flat end in contact with flat step plate. Weight of wheel and its axle, 1·2 grm.; or P=1,200 dynes, nearly enough. Diameter of contact, say equal to diameter of pivot, namely ·035 cm. Coefficient of friction, ·20. Then using the formula $f = \frac{k\,P\,d}{3}$, we find the frictional resistance of the bearing is 2·8 dyne-centimetres. The commutator wires press against the wheels and force the brush pivots against the sides of the holes in which they run. The mean pressure on each wheel is about 50 dynes, and the radius of the pivot being ·018 cm., the friction moment is, roughly, $50 \times \cdot2 \times \cdot018 = 1\cdot8$ dyne-centimetres. Adding this to the step friction and multiplying by 2 to include both brush wheels, we find they require a torque of nearly six dyne-centimetres applied to their own axles to overcome friction. This figure must, of course, be divided by 12—the ratio of the diameters of wheels and commutator—to give the frictional moment of the brush wheels upon the armature axle. That is to say, the brush wheels account for about ·5 dyne-centimetre, while the meter-axle bearing accounts for 1·1, making a total of 1·6 dyne-centimetres estimated friction. The lowest observed friction in meter No. 2 was 2·1 dyne-centimetres (see Table IV., Oct. 12, 1899), so that, remembering that brush-wheel friction is an overestimate, there is at least ·5 dyne-centimetre unaccounted for. No doubt the rolling of the commutator wires on the brush wheels accounts for some of this, and there is also the work done in overcoming cohesion as the wires pull themselves off the wheels. This is a form of work which is probably not completely or even at all reversible, so that it is not given back when the wires come into contact with the wheels. There may also be a very small resistance to rotation due to hysteresis in the steel axle. The magnetic field of the brake magnets tends to produce a non-uniform distribution of induction at the surface of the axle, and if this want of uniform density extends to any depth below the surface, some part of the volume of steel will be going through two small magnetic cycles in each revolution of the axle.

DISCUSSION.

Mr. T. D. Lockwood, a past-president of the American Institute of Electrical Engineers, said that although he had been a member of the English Institution longer than most of those present, yet this was the first time he had been to one of their meetings. He was glad to see that, as in America, there were a large number of young faces amongst them. The title of the paper had rather disconcerted him, as it seemed to him to suggest a perpetual-motion device. After hearing the paper and seeing the diagrams, he was sorry it was impossible to reproduce experiments and the manner of the speaker, and that nothing but dry print could be given to his own society. He himself had experienced the difficulty of learning what had been done previously in any direction, and had read a great many specifications in trying to find out. Some of these were in foreign languages and some in English, though the latter might just as well have been foreign. Out of 100 such specifications 99 were bad, as if the reading matter was all right, the picture was bad, and *vice versâ*. There was a difficulty in most cases in finding what the inventor or quasi inventor was getting at. The author had said that until he had gone a long way in the production of his meter was not aware that anything of the sort had been attempted previously. This experience was a common one amongst inventors. He was forcibly reminded of a remark in the first book published on electric lighting, which said that "the people of former times had little honesty, for they have stolen all our inventions."

Mr. S. Z. de Ferranti said he could quite understand Mr. Evershed saying that he had worked for 10 years on this subject. Experiments like these took a very long time. He had also had the experience of somebody else inventing a thing at the same time as himself. He did not think Mr. Evershed appreciated how frictionless some of the other meters were. He was in 1885 struck with a very curious occurrence which happened to one of his meters, and thought he had discovered some marvellous circumstance beyond his comprehension. One day when the current was turned off, one of his mercury meters, which was frictionless, rotated without any connection with an electric circuit. It also rotated backwards, which surprised him. He formed all sorts of theories as to the cause, and watched it very carefully, it moving backwards for two days. He found out then that it was caused by the sixth or seventh wheel of the meter being jammed, and the retardation was sufficient to give driving power to run the motor at a very slow speed for two days. He should like to ask Mr. Evershed to calculate what the friction or resistance of that meter was in order to go round against its own friction for two days with such a curious driving force. He had also found that a mercury meter registered up to 300 amperes started at ·1 ampere, or $\frac{1}{3000}$ of the normal current. In this case the friction must be very small. There was another curious fact also. The fan in a mercury meter must, as they knew, be perfectly balanced, or it interfered with the starting. He had had a little difficulty in starting some of these meters owing to want of balance in the fans, even though these had been carefully balanced before being put in. He eventually found that the difficulty was due to the varnish or lacquer being just a little thicker on one side of the fan than on the other, so displacing a little more mercury on that side. He should like to point out that the Aron meter practically disregarded friction. The principle of the meter was such that friction did not matter much. It had one objection, which was that it ticked, and he recommended Mr. Evershed to consider some other arrangement by which to stop the noise in his meter, so that it should not have such a disadvantage. All his own meters were frictionless on the pivots because they were balanced, one point in air and one in mercury, and he did not think the friction due to the pivots was any greater than that of the polar pivot in Mr. Evershed's motor meter. Mr. Evershed had mentioned that he (the speaker) had had something to do with the magnetic suspension. This was so, and he could not help referring them to a Blue-book on the subject which showed some very bad forms of magnetically suspending the armature of the meter. There just happened to be one there which had not a sideways pull. Mr. Evershed's commutator was a most beautiful thing, the nearest approach to it being a device by Lord Kelvin in which the brushes were made up of a number of discs, which were split up and pressed against the commutator. His own idea on the subject of the paper was that the meter was greater in scientific merit than in commercial value. He had found that simplicity was desired by people buying meters, and one that would work with absolute simplicity would be preferred to one more accurate perhaps, but less simple. The task which Mr. Evershed now had before him was to simplify this beautiful instrument. He did not wish to detract from anything Mr. Evershed had done, and thought the apparatus most beautiful

Mr. R. Wood said that after the last two speakers he was afraid he would appear rather ungracious. He claimed to be the inventor of this magnetic suspension exactly as it was shown. It was rather a nasty thing to say, because he could not help admiring the paper, and he agreed with Mr. Ferranti that the instrument was very beautiful.

Mr. W. M. Mordey said he was glad to have the opportunity of showing them the Stanley meter. He particularly admired the scientific accuracy used in getting the wonderful range and low friction. But simplicity was more important than low friction. A great point in Mr. Evershed's meter was that it was suitable for all kinds of currents, and was good for low power factors. He then sketched on the blackboard the details of the Stanley meter, and also produced one of these meters which was sent from America, and which was, he believed, the first seen in this country. He saw the first Stanley meter in America two years ago.

Mr. H. P. Boot said he was glad to have a go at the manufacturers of meters, and to inform them of the difficulties they had to contend with. Many engineers did not appreciate the financial value to a works of a good meter. He had had experience with several meters, and had scrapped two sorts, and it had paid him to do so. The first type the consumers knocked about because it would not "mote"; the second the consumers swore at; and the third they grumbled at, saying he was always sending men to put on the dials; with the fourth type the consumers said that one could not expect a man with a Biblical name to make meters properly. A meter, in the first place, must be able to stand rough usage. It must not be affected by vibration; it must not run back or forward by itself; and it must not short on overload. It should also be simple. He admired Mr. Evershed's meter, but would personally prefer a meter which he could understand and alter if necessary. He also preferred a meter which did not depend so much on permanent magnets. As to the ticking mentioned, nearly all meters on alternating circuits gave trouble in this way. He had designed a relay which cut out the meter during the time it was not in use, and this had given satisfaction to those having them. With respect to the elimination of friction, he was going to mention that in the Aron meter this was provided for by an ingenious arrangement of cancelling out frictional effects, taking it into account. Another point he should like to impress on meter makers was that the consumers would prefer rapid delivery of the goods after ordering.

Mr. Schattner said the meter designed by Mr. Evershed was ingenious, but not simple enough. He did not think it could be produced at the price at which a meter nowadays had to be. Electrolytic meters were very simple, and could be produced cheaply. The tendency was, he thought, to sacrifice to some extent in meters accuracy to cheapness of production.

Prof. Ayrton said the paper took his memory back some 18 years, when he first thought of some such apparatus as had been shown them that evening. He had not expected, however, to have seen what might be called a "dream" of a meter, and to see exactly what he had aimed at perfected. It had been said that Mr. Evershed had only obtained this result through complexity. Another inventor also had obtained marvellous results in the clock meter by marvellous complexity, and the Aron meter was selling in thousands. Take that meter and the original clock meter of 18 years ago, and they would have said the present one would not sell owing to its complexity compared with the first one. There was, however, no sale for the first one. The gurgling of the Aron meter was a disadvantage at the present time. Delightful results could be produced by complexity. They should take the first clock and then their own watches and compare the simplicity. They would at once see that no one would buy such a complex thing as a watch. He did not wish Mr. Evershed to be despondent about his meter, which might in time rival the Waterbury watch in its sale. It had been said that the Aron meter was frictionless. This really had nothing to do with the subject of the paper. The Aron meter was not a motor meter, and it was not frictionless,

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The friction certainly did not produce any inaccuracy in the reading, but what Mr. Evershed had been trying to get was a meter which did not need the mechanical devices of the others and yet do what the others did He was interested to hear Mr. Ferranti speak of his meter, but Mr. Ferranti used a starting coil in his meter to overcome the friction. Mr. Evershed had, however, used no starting device. Another point as to the Aron meter was that during the last few years Prof. Aron had gone back to the original idea of Prof. Perry and himself—namely, to measure the electricity as paid for. All the Aron meters were now energy meters, and not quantity meters. Mr. Evershed had also made an energy meter, and, apart from the ingenuity of his invention, they should thank him for producing an energy meter instead of a quantity meter.

Mr. T. D. Lockwood said he should just like to say that at the last meeting he attended of the American Institution of Electrical Engineers the subject for discussion happened to be motor meters. The author got quite disconcerted at the end of the meeting by finding the same objections raised as had been that evening. He therefore tendered his personal thanks to Prof. Ayrton for championing the cause of complexity.

Mr. Aron said he could confirm Prof. Ayrton's statement as to the energy meter, but he took up the statement as to noise. As far as this country was concerned, he did not think that the Aron meters had been used principally for alternating current. Under these circumstances it was found necessary to produce an instrument which would not make a noise when winding up. There was not much noise when the case was shut.

Prof. S. P. Thompson said he wished to add a word of congratulation on the paper. It would be a pity if this work were lost to the world, and he honestly wished the author's efforts would meet with material success. He had a ticking meter in his own house; he was rather glad it ticked, as he then knew it was working properly.

Mr. S. Evershed, in reply, said that to bring an invention before his rivals was a task he should not care to undertake every year. He was particularly sensible of the way in which Mr. Ferranti, Mr. Mordey, and others had spoken of the meter. The criticisms practically amounted to the fact that the meter was too complicated. He could not give a better answer to this than Prof. Ayrton had done. The question of complication was one which could only be settled by the manufacturer, and not the user. If a manufacturer could make a meter and sell it at a reasonable price, it seemed to him to matter very little whether it was complicated or not, as long as it worked properly. He might remind Mr. Ferranti that he himself was rather complicated, and it seemed to him that Mr. Ferranti had worked well for a number of years, and had appreciated rather than depreciated. Many speakers had referred to the ticking of meters. The ticking in his was due to a lever striking metal stops. If these were covered with indiarubber, the meter would be quite silent. He was glad to hear something of the Stanley meter. When applying for a patent for his meter, the examiner to the United States Patent Office informed him that the Stanley meter and his own were exactly similar. The Stanley meter, however, was only suitable for alternate currents, and he believed that in the future almost all domestic electricity would be of the continuous-current type. As to the simplicity of the meter, he did not want Mr. Boot or anyone else to alter his meter. He thought electricity meters should be sealed in the same way as gas meters. With respect to Mr. Schattner's remarks, he did not know any more complicated action than electrolysis. As to the cost of meters, the first cost was by no means the last cost. Repairs and depreciation had to be taken into account. The author thanked Mr. Cox for his help in the experiments, and also Messrs. Mather and Riddel for the loan of apparatus.

The meeting closed with the customary vote of thanks.

LIGHT RAILWAYS.

On the 25th inst. the directors and committee of the Goole and Marshland Light Railway made a tour of inspection of their new line, and also a trial spin on the partly completed Isle of Axholme line, which has now reached the town of Crowle. The party alighted at Reedness Station for luncheon. The most important feature of the line inspected was the steel bridge, 120ft. wide, which spans the Warpings Drain near Reedness Junction.

The Poole Town Council have adopted a route plan showing position of posts and pillars and drawings of side pole and bracket arm for the purposes of the Poole and District Light Railway, subject to the standards being placed close to the kerbing of the footways, and also to the posts being placed along the north side instead of the south side of Parkstone-road.

Plans and statements in respect of the proposed Blackburn, Burnley, and District Light Railways have been agreed to by the Clitheroe Rural District Council. The estimated cost is £154,000, and the promoters intended conveying goods, parcels, etc.

The Twerton Parish Council have approved, with certain modifications, of the scheme submitted to them by the promoters of the Bath and District Light Railway.

Last Friday a public meeting was held at the Town Hall, Bury St. Edmunds, for the purpose of considering the Mid-Anglian Light Railway scheme. The following resolution was agreed to: "That this meeting having heard with much interest the explanation of the proposed route of the Mid-Anglian Light Railway, is of opinion that it would be to the advantage of Bury that the scheme should be completed, now that it is clearly understood that an interchange of goods can take place with the Great Eastern Railway without transhipment."

On Friday last the Light Railway Commissioners held an enquiry into the application of the Oldham, Ashton, and Hyde Electric Tramway Company, Limited, for an order authorising an extended light railway. There was considerable opposition, and finally the Commissioners announced that they could not in the face of the local authorities force a scheme of this kind upon the district. They accordingly refused the application.

QUESTIONS AND ANSWERS.

Under this heading we insert questions and answers of a practical character relating to central-station work, tramway work, or construction work; and for each suitable question offer *one shilling*, and for the best solution of any question we offer *ten shillings*. We also give *five shillings* for every other answer we print. The answers to any question should be sent within 10 days after the question has appeared. We would call the attention of those sending in answers to the fact that the neatness of any sketches (which must be *ink*) sent in is considered when marking the relative values of these answers. All formulæ must be carefully written to prevent mistakes as to symbols, and all loose sketches should be signed by the author. The matter should be written on one side only of the paper. Questions may be sent at any time.

QUESTIONS.

283. When two dynamos are running in parallel, each with full load, 200 amperes at 100 volts, if belt comes off one, will the extra current at lower voltage harm remaining armature if the starting lever is not moved? If so, how?—G. S.

284. Describe some good and cheap way of making connections from consumers to distribution mains, applicable where several adjacent houses take the supply.—P. T.

ANSWERS.

Question No. 277.—What are the general principles that should guide in the selection of units for a central station?

Best Answer to No. 277 (*awarded* 10*s.*).—It is not easy to answer such a question as this briefly, but a few broad principles may be stated, which can be developed and extended to suit particular cases. The question evidently intends the case to be considered as that of a station which is being designed for an entirely new area. In this case the probable form of the consumption curve must be determined. The simplest way to do this is to issue forms to householders to be filled up, and to find out in this way the total possible consumption for dwelling-houses, shops, factories, offices, motors, and so on. There may be some little difficulty, owing to the peculiarities of human nature, in getting these forms filled up satisfactorily, but with a little persuasion and explanation and politeness it may be accomplished to a wonderful degree of completeness. After this is done, abstracts from the returns should be made, and a table drawn up showing the different consumptions for different purposes in various quarters of the town, as well as the total consumption for each purpose in the whole town. As it is unlikely that the maximum for any particular purpose will ever occur, at any rate for any length of time, certain percentage can be taken, the amount depending on the nature of the consumption. Thus, street-lighting may be reckoned at 90 to 100 per cent. of the possible maximum; dwelling-houses, 20 to 30 per cent.; motors, 30 to 50 per cent., etc, as being the maximum load that can occur at any time during the year. Taking the curve for any one day, it is evident that the maxima in the various kinds of consumption will not all occur at the same time on that day, and each curve must be drawn for itself as it will probably occur, and then the total curve got by adding all the single curves together. This is frequently done for the maximum day (in December), the minimum day (in June), and the mean day (in spring and autumn), and thus three curves are got showing to some extent the variations throughout the year. From these curves the size of the

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units can be determined. There are, broadly speaking, two general classes—namely, small installations, for towns of only a few thousand inhabitants, with little demand for power; and large installations, for larger towns, or places where the power demand is large. In the former case, the rule is to use two machines, each capable of doing half the maximum load, and to put in an accumulator battery of the same size as one machine as regards volts and amperes, and of such a capacity that it can supply the night consumption, and so allow night running of machines to be dispensed with. This provides a reserve equal to half the total load—*i.e.*, one machine—or the battery can break down without disturbing the running. The use of the battery allows the machine to run at full load while charging—that is to say, with its highest efficiency. This is exactly what is required in a small station, because rent and interest are, as a rule, small in such a case compared with cost of coal and wages. Hence, if more coal is required owing to low efficiency of running, and if wages have to be paid for nightwork, the cost of working may be so far increased as to prevent the station paying its way. Hence the principle to be applied to small stations: use two machines, each capable of doing half the maximum, and a battery of the same output in addition.

In the second case, of large stations, the conditions are somewhat different. In a large town, rent and interest and similar expenses are much higher relatively to wages and coal cost than in the case just considered, and hence, even if machines run not fully loaded, the alteration to the extent of a few per cent. in the percentage of the whole which the working cost amounts to has nothing like the importance of the alteration by the same amount in small stations; hence the selection of units is to a great extent a matter of taste. In England, the rule seems to be in favour of a considerable number of small units, while in Germany, for example, a few very large units are used. While the number of men necessary to look after a few large machines is probably smaller than the number needed for a larger number of small machines of the same total output, on the other hand, the latter arrangement has the advantage of the former in the matter of reserve sets, which must be as large as the single machines, and will hence be dearer where the large machines are used. It is evident, however, that both methods can be made payable, as both are actually in practice.

In either case, no definite rules can be given as to whether four, six, eight, twelve, or any other number of machines can be suitably employed. This is to be found from the curves, and even if alterations in efficiency make little difference to the total cost, it is always better to choose such sizes as will give the best average as regards running at or near full load during the year.

More than this cannot well be said in an answer of so general a nature. Everything, from beginning to end, depends upon circumstances. One town may have an enormous motor load compared with its lighting load, and the conditions will then be best fulfilled by choosing a few large machines, as the load is even all the year, and hence, if they are chosen to run at full load for one day, they will run equally well all the year. Another station may have an exclusive demand for lighting current, and in this case the curve will have humps which vary in height and breadth every day. It is such a case as this that causes most difficulty. If the machines run full load in winter, they will almost certainly not do so in summer. But, as a rule, a result can be obtained which gives a fair average for the year, and it is this that must be striven after.—T. C.

Answer to No. 277 (*awarded* 5*s.*).—In the selection of units for a central station regard must be paid in the first place to the question of load. In a lighting station we have a heavy load for a few hours in the day and a light load for the greater part. If a tramway system is to be supplied from the same station, the plant will be running at its maximum output for the greater part of each day. We will take a specimen lighting scheme. Suppose a small town to take as maximum load 500 kw., and a day or light load up to 100 h.p. Now we could supply all current with a 500-kw. set, but for the greater part of the day this would be running and simply eating steam and coal. This, for the first, is against one large plant of 500 kw., as it is found to be more economical to run engines fully loaded when possible. Another point against a large unit is the trouble of breakdowns, and to guard against this we should have to provide two plants of 500 kw., and the interest on the spare plant would be a considerable drag on the expense of generating. Suppose we have, instead of the large unit, several smaller ones, say three of 200 kw. and one 100-kw. machine. This gives a total of 700 kw., as against 1,000 kw. installed before, and this at once brings the money invested, and with it the interest, down. We have a 100-kw. machine for the day load, which will be very economical, running fully loaded, and with the two 200-kw. machines will take the heavy load, whilst we have a 200-kw. machine as spare.

From the above it will be seen that the selection of units in a station should depend upon (1) a number of units, these being as large as possible, at the same time having due regard to economical running; (2) the day load (a smaller machine fully loaded runs more economically than a larger one at half load); (3) cost of plant and interest as applied to spare plant, which should be as small as possible, some engineers preferring two spare plants, others only one. A table taken from Mr. P. Dawson's "Electric Tramways," and giving the powers required, is given below. This table is only for tramways with a constant load:

Max. I.H.P. required on line.	No. of engines.	I.H.P. of each engine.
200	2	200
400	3	200
600	3	300
1,000	3	500
1,500	4	500
2,000	4	750
5,000	6	1,000
10,000	8	2,000

—E. M. M.

Answer to No. 277 (*awarded* 5*s.*).—When consideration is given to the various sizes and requirements of central stations, it would appear as though no general principles could exist which would apply equally to all stations, where the motive power may be either steam, gas, or water, more especially when at some stations a large day load is obtained; at another station the traction plant is interchangeable with the lighting plant; while at a third, in some remote village, the current is only required for a few hours in the evening, and is arbitrarily cut off at a specific hour. To the varying conditions and requirements which obtain locally must be added the individual idiosyncrasies of the consulting engineers, with the result that it is difficult to find two stations built upon the same lines—one authority will advise a large number of small units, another will suggest a fewer number of big units. On one point, however, nearly all seem to agree—viz, that it is a *sine quâ non* to duplicate all steam-pipes and pumps, and to allow a very large margin of plant for emergency loads and stand-by purposes. Now, while quite admitting the serious consequences which might result in any community through the failure of the light, is this amount of duplication and stand-by plant necessary? We do not find duplication of steam-pipes on board ship or in connection with mill engines, and these are not only working continuously, but a stoppage would be as serious for the owners as would be to the supply company a break in the continuity of the supply of current. Why, then, is the duplication necessary in central stations? Is it that electrical engineers are such poor mechanical engineers that they cannot trust themselves to look after a plant which is not designed to prevent any possibility of an absolute breakdown? Or is it because they object to the principle of overhauling and repairing during such periods as when the station is not loaded?

The above becomes of moment when we take into consideration the size of the units required. Provided no traction sets are required, the plant must be equal to the maximum load, plus a certain margin for contingencies. The enquiry with reference to the various power schemes has proved, what was known before, that the larger the size of the unit the more efficient will be both engine and dynamo, and the cheaper per kilowatt will be the initial cost. Hence it would appear as though the rational conclusion to be drawn from the argument would be to put

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down one big set equal to the whole contemplated maximum load. This, however, would not be advisable, since, as a spare set must be kept in case of accident, it would mean a complete duplication; something smaller must, therefore, be arranged, and the selection of the unit should be that which will allow of the largest units being employed, consistent with the lying idle of the least money in stand by plant. This is the sound economic principle which should be borne in mind in the case of every station, for it must be remembered that the good engineer is he who runs the station without a breakdown, and until there is a breakdown the stand-by plant represents simply so much dead capital. In all large sets it is customary to specify a certain output as the normal or economical load, and also a higher output, probably an increase of 25 per cent., as the occasional or emergency load. Here we have a solution to the question. If the units are chosen of such a size that five will supply the maximum load, and a breakdown occurs to one set, if the other four sets are run up to their emergency load the continuity of the station will be maintained without need of any stand-by plant, and as the full load is never on for prolonged periods there will be no undue straining of the sets. In large stations, such as Manchester, 10 or more sets might be found advisable, as a limit must be reached in the size of the units, but this will still agree with the economic principle enunciated above—that there is a minimum of capital lying idle in stand-by plant. It may be advanced that two sets *might* break down at one time. Quite so; and the plant might be triplicated and the station burnt down. Reasonable men should only guard against reasonable and likely accidents, not against the improbable and unlikely.—M.

COMPANIES' MEETINGS AND REPORTS.

WEST AFRICAN TELEGRAPH.

The report of the directors to be presented to the meeting to-day shows a revenue of £77,008, against which £20,297 is charged for ordinary expenses and £11,482 for expenditure relating to repairs of cables, etc. After providing £328 for income tax, there remains a balance of £44,899, to which is added £2,179 brought forward, making £47,078. From this £8,746 is debited to interest on debentures, and £15,033 for sinking fund, leaving £23,298. The directors propose to place £23,000 to the general reserve fund, and to carry forward £298. The revenue includes a further sum of £12,000 in respect of subsidy still owing by the French Government. This arrear, together with the sums withheld in previous years, now amounts to £56,415. Steps are being taken for the establishment of staff pension and superannuation funds.

ELECTRIC AND GENERAL INVESTMENT.

The ordinary general meeting was held at Winchester House on the 26th inst. Mr. George Herring presided. The report and dividend (noted by us in a previous issue) were adopted.

The **Chairman** said the directors were very proud of the wonderful success of the British Electric Traction Company. There was still plenty of room for enormous development in electrical traction in this country. It would require millions to complete the orders of the British Electric Traction Company, and many more millions to equip Great Britain in a manner it would be equipped sooner or later.

UNITED RIVER PLATE TELEPHONE.

The report for the year ended March 31 states that the gross receipts in the River Plate were £101,169, as against £85,248 for the year before, and the working expenses in London and the River Plate £50,335. After deducting debenture interest and interim dividends, etc., there remains a profit of £35,180, which, with £7,889 brought forward, makes an available balance of £43,069. The directors propose to transfer £5,000 to depreciation fund and £20,000 to reserve fund, and to pay a final dividend of 4½ per cent. upon the ordinary shares, making, with the interim dividend paid Dec. 30 last, a return of 7 per cent. for the year, leaving a balance of £5,019 to be carried forward. An early issue of the remaining 5 per cent. cumulative preference shares is announced on account of large extensions required to the plant at Buenos Ayres.

GIFFRE ELECTRO-CHEMICAL AND POWER.

The report for the year ended March 31 last stated that the directors regretted that it had not been possible to obtain the immediate results anticipated when the Company was formed. The output of carbide had been irregular and small, as it was found that the type of turbines adopted was unsuitable. The order for the four additional turbines had been cancelled and some of a different type ordered. These turbines were only now being erected. One type of dynamo also gave some trouble, and last September and October electrodes had been unobtainable for a time. Since the beginning of the year a notable improvement had taken place. As against an intermittent output during last year of 633 tons, there was a steady output for the first three months of this year of 475 tons, already increased to 50 tons a week. It was found advisable to maintain the Société Electro-Chimique du Giffre as a separate company, and therefore not to complete the purchase of the whole of the shares. The rent of the water power for 1899 amounted to 125,000fr.; this was, in accordance with the lease, to be raised from January, 1900, to 250,000fr. In consequence, the French company had bought the water power outright. The Company now acquired it at less than half its value, in accordance with the very advantageous terms made by the Société Electro-Chimique du Giffre before the value of water powers had been appreciated. Mr. F. H. Haviland had been elected to a seat on the Board, and Mr. John Paddon had, owing to continued ill-health, resigned. The directors had not considered it necessary to fill up the vacancy.

ISLE OF MAN TRAMWAYS.

At an extraordinary meeting last week the resolution passed at the previous meeting reducing the directors' qualification from 1,000 to 500 shares was confirmed.

An adjourned general meeting followed, at which the following new directors were elected: Mr. T. H. Ward, of Wellington, Salop; Mr. Ellis Harrison, Blackpool; Mr. Richard Farrell, Douglas; Mr. Joseph Clare, Warrington; Dr. E. Hopkinson, Salford; Mr. Emmanuel Shackleton, Littleborough; and Mr. John Hodson, of Liverpool. Messrs John Gee, Edward Martin, W. E. Young, and R. D. Callister were appointed a committee to advise the directors. The directors were recommended to take immediate steps to oppose the creditors' petition for compulsory liquidation. The meeting adjourned for four weeks.

The adjourned petition for the winding up of the Company (referred to in our last issue) came before Sir James Gill in the Manx Chancery Court on the 21st inst. On behalf of the Company, it was submitted that a new Board had been formed, and a further adjournment until 11th prox. was granted to allow the directors to submit a scheme. The appointment of Mr. William H. Walker (Liverpool) as receiver was agreed to.

THOMAS PARKER, LIMITED.

In their report for the year ended April 30, to be presented to the shareholders of this Company at the sixth annual general meeting to be held at Wolverhampton to-day, the directors state that after writing off the various depreciations the balance standing to the credit of profit and loss account is £14,135. 10s. 7d. Out of this the directors propose to pay a dividend at the rate of 10 per cent. per annum, less income tax, to place £5,000 to the reserve fund, bringing it to £15,000, and to carry the balance forward to next year's account. The director who retires by rotation is Mr. C. T. Mander, who is eligible and offers himself for re-election. The auditors, Messrs Allen, Edwards, and Smith, also retire, are eligible, and offer themselves for re-election.

BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital—viz., 7,500 ordinary £10 shares, fully paid	75,000	0	0
Debentures issued, £50,000; deposited with the bankers, £21,900	28,100	0	0
Sundry creditors (less reserve for discounts)	11,117	15	10
Amount due to bankers	9,739	10	0
Reserve fund	10,000	0	0
Profit and loss account	14,135	10	7
	£148,092	16	5

Cr. Assets.	£	s.	d.
Sundry debtors (less reserve for discounts, etc.)	41,883	10	8
Freehold land and building, plant and machinery, etc.	77,306	9	9
Stocks on hand and work in progress	27,807	16	0
Investments at cost	1,095	0	0
	£148,092	16	5

WYCOMBE (BOROUGH) ELECTRIC LIGHT AND POWER.

Directors: Alfred Slatter. M.I.E.E. (chairman); Walter Birch; F. E. Gripper, M.I.E.E. Engineer and secretary: E. Salthouse, A.I.E.E.

Report of the directors (with abstract of accounts) for the year ended Dec. 31, 1899:

The directors are pleased to report that the progress of the Company during the past year, its first year of complete working, has been satisfactory. At the beginning of the year the equivalent of 1,746 8 c.p. lamps were connected. This number had increased at the end of the year to 7,636, and a further 4,225 have already been applied for this year. In the above are included motors equivalent to over 130 h.p., which are giving satisfaction and provide a most useful load for the machinery during the hours of daylight. The profit of the year's working, after providing for debenture interest, is £438. 18s. 4d., out of

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which the directors propose to pay off £144. 13s. 9d. preliminary expenses, and to pay a dividend of 2½ per cent. per annum on the share capital, leaving £238. 13s. 4d. to be carried to the next account. One of the directors, Mr. Gripper, retires by rotation, and, being eligible, offers himself for re-election.

Dr. Revenue Account.	£	s.	d
Generation of electricity	751	0	8
Distribution of electricity	63	4	6
Public lamps	54	4	10
Rents, rates, and taxes	143	4	6
Management expenses	237	8	8
Insurances, superannuation, etc.	10	0	0
Total expenditure	1,259	3	2
Balance carried to net revenue	677	1	11
	£1,936	5	1

Cr.	£	s.	d.
Sale of current per meter	1,839	14	1
Rental of meters and other apparatus	87	9	0
Rents receivable	9	2	0
	£1,936	5	1

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received for works	22,815	0	0
Sundry tradesmen and others	12,962	8	2
Net revenue account, balance at credit thereof	438	18	4
	£36,216	6	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	32,306	5	8
Stores on hand	911	1	8
Preliminary expenses	144	13	9
Sundry debtors for current supplied	904	15	4
Other debtors	1,464	2	1
Unfinished wiring work	339	17	7
Cash at bankers and in hand	145	10	5
	£36,216	6	6

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			122,044
Quantity sold	Public lamps	55,428	102,194
	Contract	3,828	
	Private consumers by meter	42,938	
Quantity used on works			5,975
Total quantity accounted for			108,669
Quantity not accounted for			13,375
Total maximum supply demanded (kilowatts)			130

Number of public lamps: 211 incandescent, 5 arcs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Leeds.—The Tramways Committee invite tenders for raising and extending the Hunslet car-sheds. Tenders by July 2.

King's Lynn.—The Corporation invite tenders for extensions to the electricity station at the old waterworks. Tenders by July 9.

Croydon.—The Council invite tenders for the erection of car sheds at the Thornton Heath and Brighton-road depôts. Tenders by July 18.

Lowestoft.—The Corporation invite tenders for meters (direct-current) and cut-outs. Tenders by July 3. Details in our advertisement columns.

Beckenham.—The Urban District Council invite tenders for Section G, free wiring contract. Tenders by July 16. Details in our advertisement columns.

London, N.E.—The Electric Lighting Committee of the Hackney Vestry invite tenders for the supply of 220 arc lamp pillars. Tenders by July 11.

Edinburgh.—The Corporation invite tenders for the supply of copper strip for electric conductors. Tenders by July 9. Details in our advertisement columns.

Southend-on-Sea.—Tenders are invited for the supply and delivery of about 1,180 tons of steel girder rails and about 46 tons of steel fishplates. Tenders by July 25.

Stockport.—The Corporation invite tenders for the supply of materials and necessary work entailed in the wiring of the technical school, Stockport. Tenders by July 5.

Madrid.—The Secretary for Public Works invites tenders for the construction and working of an electric tramway from Puerto de Hierro to Aravaca and Pozuelo. Tenders by July 7.

Birkenhead.—The Corporation invite tenders for constructing and erecting a new car shed in connection with the electric tramways in Laird-street, Birkenhead. Tenders by July 24.

Stoke-upon-Trent.—The Guardians of Stoke-upon-Trent Union invite tenders for the electric wiring of the new cottage homes at Penkhull, including overhead cables. Tenders by July 4.

Algemesi (Valencia, Spain).—The Municipal Authorities will receive tenders for the installation and working of the electric lighting by July 21. Specifications may be inspected at this office.

Tunbridge Wells.—The Corporation invite tenders for the supplying, laying, and jointing of armoured telephone cables; also instruments, etc. Tenders by July 12. Details in our advertisement columns.

Swansea.—The Corporation invite tenders for the supply and erection of main switchboard and instruments, and battery of accumulators and accessories. Tenders by July 5. Details in our advertisement columns.

Limerick.—The Council invite tenders for the supply, delivery, and erection of cables, arc lamps, engines, dynamos, boosters, balancer, switchboard, instruments, and gas plant. Tenders by July 4.

Huddersfield.—The Electricity Committee invite tenders for a single-phase steam generating plant, having an output of about 1,000 kw. Tenders by July 12. Details in our advertisement columns.

Leeds.—The Tramways Committee of the Leeds Corporation invite tenders for supplying and fixing two, four, or six steel boilers (Lancashire type) at the generating station, Crown Point, Leeds. Tenders by July 9.

Beckenham.—The Urban District Council invite tenders for the erection of brick transformer stations, 11ft. by 11ft. in size internally, and six in number, the sites of the stations being at various points in the district. Tenders by July 9.

Cardiff.—The Corporation invite tenders for the manufacture of about 1,000 tons of steel tramway rails; also for fishplates, sole-plates, tie bars, bolts and nuts, points and crossings, drain rails, copper rail bonds, etc. Tenders by July 12.

London, E.C.—The Aron Electricity Meter, Limited, 46, Upper Thames street, London, E.C., invite tenders for the supply of part six months' supply of A.C. and D.C. large and small metal cases; estimated quantity, about 2,500 in all. Tenders by July 2.

Salford.—The Corporation invite tenders for the supply, delivery, and erection of the overhead equipment for the tramways in the borough, exclusive of the steel poles, but inclusive of their erection. Tenders by July 16. Details in our advertisement columns.

Hammersmith.—The Electricity and Lighting Committee invite tenders for the supply and delivery of insulated high and low-tension cables, junction boxes, etc., cast-iron pipes, drawbox covers, etc. Tenders by July 12. Details in our advertisement columns.

Southend-on-Sea.—The Corporation invite tenders for the supply and erection of boilers and auxiliaries, steam generators and switchboard and cranes, feeders and distributors, line equipments, trucks and car equipments. Tenders by July 25. Details in our advertisement columns.

Blackpool.—The Corporation invite tenders for the following works in connection with tramways extension: (Section A) trolley poles; (B) cables and trolley wires; (C) boosters and switchboards; (D) storage battery. Tenders will be received for any one or more sections, but not for part of a section. Tenders by July 23.

Partick.—The Commissioners invite tenders for the supply and laying of insulated electric mains, conduits, junction-boxes, etc., the supply and erection of cast-iron arc and incandescent lamp standards, arc lamps, automatic switches, and other fittings. Tenders by July 10. Full details in our advertisement columns.

South Shields.—The Guardians invite tenders for the complete installation of the electric light at the union workhouse, Harton, South Shields. The proposed works consist of (Section A) engines, dynamos, battery, and main switchboard; (B) wiring, cables, and fittings. Tenders by July 14. Details in our advertisement columns.

Grays Thurrock.—The Council invite tenders for the supply, delivery, and erection of two Lancashire boilers and pipework, two 100-kw. steam dynamos, with boosters and balancer, fuel economiser, switchboard, battery, travelling crane, and mains and street lamp fittings. Tenders by Aug. 9. Details in our advertisement columns.

London, S.W.—Tenders are invited for the supply, within three months of the order being given, of about 70 arc-lamp standards, required in connection with the electric light installation for the Victoria-embankment, for the London County Council. The standards are to carry the lamps suspended, at about 23ft. from the ground level, at the end of a curved arm extending over the carriageway. Each person tendering is to submit his own design for the standard, or, if he so desire, he may submit alternative designs. A short description of the standard, showing generally what is required, may be obtained at once on application to the Clerk to the Council. Specification may be obtained at the Engineer's Department, County Hall, Spring-gardens, S.W. Tenders by 10 a.m. on July 10.

Alexandria.—Tenders will be received at the Central Office of the Administration of Ports and Lighthouses, up to 12 noon on July 1, for supply of the whole or part of an electric generating machine for the Port Said lighthouse, and the tools for the lighthouses workshop at Alexandria. Persons wishing to tender can consult the conditions of tender and the specification, on all days on which public offices are open, from 9 a.m. to 1 p.m., at the office of the Administration of Ports and Lighthouses, Alexandria. Copies of conditions and specification can also be had on application to the Controller-General of Ports and Lighthouses, Alexandria. Tenders must be submitted on stamped paper and addressed to the Controller-General of Ports and Lighthouses, Alexandria, in sealed envelopes, bearing the inscription

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'Tender for the Supply of Electric Generating Machinery for Port Said Lighthouse," or "Tender for the Supply of Tools for the Lighthouses' Workshop, Alexandria."

Durban.—The Corporation invite tenders for supply, delivery, and erection of materials under the three following sections: (Part A) comprising the supply, delivery, and erection of the entire overhead equipment for about 16 miles of equivalent single track, including poles, overhead trolley wire, distribution boxes, etc.; (B) comprising the supply, delivery, and erection of 22 double-deck motorcars, complete; (C) comprising the supply and putting into working order of a complete steam and electric generating plant in a power station to be built by the Corporation, including three 250-kw. direct-coupled generators, boilers, condensers, cooling tower, switchboard, etc. Parts A and B will not be separated, but will be let to one contractor. Part C may be let separately. Preference will, however, be given to a contractor who will undertake all three sections, and a separate form of tender for all three sections will be supplied. Specifications, bills of quantities, forms of tender, and lithographic drawings may be obtained on application to Messrs. Webster, Steel, and Co., 5, East India-avenue, Leadenhall-street, London, E.C., agents to the Durban Corporation. A deposit of £10. 10s. must accompany application for specifications and forms of tender. The deposit will be returned on the receipt of a bona fide tender. Sealed tenders, in duplicate, under separate cover, in specially-provided envelopes, to be delivered to Messrs. Webster, Steel, and Co., by June 29, or to the Town Clerk of Durban by mail delivery on or about July 23. The successful tender will be accepted by cable from Durban.

RESULTS OF TENDERS.

Luton.—The tender of Main, Kendall, and Main, of Loughborough, at £4,175, for the erection of the electricity works, has been accepted.

Hammersmith.—The Vestry have entered into a contract with Messrs. Johnson and Phillips for the supply of 12 25 kw. transformers, at the rate of £63 each.

Glasgow.—The Corporation have accepted the tender of A. Thomson and Sons, Glasgow, at £61,000, for carrying out the brickwork contract in connection with the erection of the Pinkston tramway electric power station, in place of tender of £56,800 from J. Green and Co., withdrawn since acceptance.

Larne.—The Urban District Council have received a tender from the Larne Electric Light Works, Limited, Suffolk House, Laurence Pountney-hill, Cannon-street, E.C., at £526, for lighting their district by electricity for three years from Aug. 1. The tender has been referred to the Lighting Committee for a report.

Bermondsey.—The Vestry have received the following tenders for the supply and laying of insulated electric mains, conduits, and junction boxes in connection with the electric lighting scheme: Siemens Bros., £8,113. 9s. 11d.; St. Helen's Cable Company, £8,109. 16s. 8d.; British Insulated Wire Company, £8,643. 16s. 8d.; Western Electric Company, £7,819, with £400 specially added; Callender Cable Company, £8,212. 7s. 1d.; and W. T. Glover and Co., £8,018. 4s. 8d.

BUSINESS NOTES.

TRACTION.

Bexhill.—The Urban District Council have decided not to consent to the insertion of the proposed clause giving the Hastings Tramway Company power to take a transfer of the Bexhill electric light order.

Swansea.—Acting on the advice of the consulting engineers, it is intended to substitute a tramway through Christina-street to Oxford-street for the proposed Henrietta-street and Richardson-street line, and to abandon the Clydach section.

Rishton.—The U.D.C. have decided not to assent to the proposed light railways scheme, and have appointed a sub-committee to confer with Blackburn Corporation with regard to the proposed extension of the Blackburn tramways to Rishton.

Cambridge.—It has been decided not to accept the tramway company's amended proposals, and under the circumstances no further steps will be taken to carry out the resolution of the Council to acquire the company's undertaking passed on May 18, 1899.

Ipswich.—Prof. Kennedy, who is preparing specifications for lighting, has been asked at the same time to prepare the necessary specifications for laying and completing the tramway system as authorised in the Bill already passed through the House of Lords, with overhead wires, provided he considers that is the best system for all or any part of the borough.

Bilston and Willenhall.—The tramways question was again discussed at the last meeting of the Bilston District Council. The suggested temporary arrangement has been declined by the Wolverhampton Corporation. It was stated that the British Electric Traction Company were waiting the confirmation of the Board of Trade before commencing their lines.

Hull.—At a meeting of the City Improvement Committee on Monday the Mayor introduced improvement schemes, including several new tramway routes to various parts of the city. The proceedings were private, but we are informed that the committee accepted the schemes brought forward by the Mayor, and resolved to recommend them to the Council for adoption.

Liverpool Overhead.—From a statistical statement we find that while in the year 1895 the number of passengers carried was 7,240,435, the gross receipts amounted to £58,789, dividend paid per annum to 2⅞ per cent., and the balance carried forward was £2,074, the corresponding figures for the year ending Dec. 31, 1899, were 9,690,236, £77,971, 3⅜ per cent., and £4,591.

Manchester.—The Tramways Committee's report, which has been adopted by the City Council, recommends that power should be obtained for the following expenditure: purchase of 600 cars, £360,000; reconstruction of the permanent way, £250,000; overhead equipment, £150,000; lands and car-shed in Queen's-road, £90,000; preliminary expenses, £10,000—making the respectable total of £860,000.

Oldbury.—The District Council have accepted the offer of the British Electric Traction Company, who own the tramway lines from Smethwick to Dudley, to work the tramways on condition that the Council waived their right to purchase the lines in their district. The company thus obtains the lease of the lines for 21 years. We learn that the electric cars from Oldbury to Dudley will commence to run shortly.

Swindon.—At a recent joint meeting of the Swindon District Councils the routes of the proposed electric tramways were agreed to. It was decided that Mr. Lacey should prepare the plans and estimates for applying to the Board of Trade or Parliament, as may be resolved upon. It was also decided that the Old Swindon Urban District Council be asked to pay one-fifth of the preliminary expenses for electric light and tramway purposes.

Portsmouth.—The Tramway Committee have decided with regard to the new power station at Fratton, that instead of adhering to the original plan and providing for extensions later on, it would be better and cheaper to build in the first place a station large enough for 120 cars, and to erect at once machinery capable of supplying 80 cars with current. The estimate will therefore be increased by a third, so that the total cost of the new power station would come to about £32,000.

Luton.—The Council have decided to write to Messrs. Berr and Reynolds, and thank them for attending and explaining their proposed scheme, and inform them that their committee would consider the question of the provision of tramways at a future meeting. They are also about to inform the British Electric Traction Company that the question of tramways has been brought before the Town Council, and to enquire whether the company were disposed to entertain the question of providing tramways in the borough.

Glasgow.—The report on the working of Glasgow Corporation tramways for the year ending May 31 states that the revenue amounted to £469,965, and the working expenses to £344 661, leaving a gross balance of £125,304, compared with £121,118 12 months ago. The balance has been thus applied: rent of Govan and Ibrox tramways, £4,985; interest on capital, £17,295; sinking fund, £11,636; depreciation on capital, £32,079; common good fund of the city, £12,500; and to general reserve fund, £46,809. The traffic revenue shows an increase of £31,658. The electric car revenue was about 1s. 2d. per car mile, and that from the horse cars 11¼d.

Hampstead.—On Monday night a meeting of the General Committee formed for opposing the London County Council (Hampstead Heath) tramway scheme was held at the Drill Hall, Heath-street. An Executive Committee was appointed as follows: Messrs. S. Figgis, I. S. Lister Wells, W. S. Gard, H. Sharpe, G. Barham, G. Monro, T. Adams, Eliot P. S. Reed, E. Comson Crump, Sydney Gross, G. W. Potter, E. A. Squire, Dr. J. Andrewes, and Dr. Gwynn. It was further decided to issue a manifesto to the public, copies of which would be sent to the London County Council and the Vestry, and that a letter of thanks be sent to the Vestry for what they had done in the matter.

Twerton.—The Parish Council on Tuesday discussed the proposed tramway scheme promoted jointly by the Bath Corporation and Sir James Sivewright and Mr. Leopold Hirsch. The following resolution was carried: "That this Council approve of the scheme submitted to us by the promoters of the Bath and District Light Railways, subject to the following suggestions: (1) that the trams run below the Twerton Station to Messrs. Carr's bridge and 300 yards lower down than the railway station; (2) that the fare to Bridge road, Oldfield Park, be 1d. (this not being specially mentioned); (3) that the rates for parcels be considerably reduced; and (4) that the space between the rails should be laid with wood."

Dundee.—The wages of tramway motormen and conductors in the tramway service when the electric traction is started have been fixed as follows for a working day of 10 hours: During the first six months motormen will be paid at the rate of 4s. per day and conductors at 3s. 8d. a day; in the second six months, 4s. 2d. and 3s. 10d. respectively. In each of the second, third, and fourth years of service the pay is to be increased by 2d. per day. Conductors under 21 years of age will be paid at a special rate. Conductors who show the necessary qualifications are to be promoted to motormen as vacancies occur. Motormen, in addition to the scale of pay above mentioned, will be awarded merit badges, by which they will be entitled to an additional 1s. per week. Approved men will receive 2s. per day while learning the duties.

Wandsworth.—The London County Council having written that the Highways Committee had decided to recommend the Council to adopt the proposal to construct a tramway from Tooting terminus to High street, Wandsworth, but that with reference to the construction of a line along the extension of York-road, Red Lion-street, Buckhold-road, and Merton-road to the Wandsworth

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parish boundary the committee were not prepared at present to take that course, which would involve street widenings of an extensive character, the Board of Works have decided to point out to the London County Council that the proposed tramway along the extension of York-road and Red Lion-street was apparently included in the proposed tramway along Garratt-lane, etc., and that the Board anticipated that when the tramway was constructed through Red Lion-street the existing line of the South London Tramways Company in North-street would be discontinued when such line became the property of the Council.

Camberwell.—At a special meeting of the Vestry on the 27th inst., the General Purposes Committee reported on a letter from the Improvements Committee of the London County Council with respect to the proposal for the widening of Camberwell New-road, between Warner-road and Camberwell-green, in connection with the suggested reconstruction as a double line for electrical traction of the single line of tramway between Camberwell-green and Vauxhall. That committee asked whether, in the event of the Council resolving to submit the proposal to Parliament again, the Vestry would be prepared to consent to the doubling of the tramway along the portion of the thoroughfare within the parish of Camberwell, and would renew its offer to contribute £5,000 towards the cost of the necessary street improvement, that the Vestry of Lambeth had agreed to consent to the double line of tramway within its parish. It was recommended that consent be given to the doubling of the tramways along Camberwell New-road, and that £5,000 be contributed towards the widening, provided the Bill was carried in the next session of Parliament, and that the amount be obtained by loan for a period of 50 years.

Gloucester Engineering Society.—On Saturday last the members of this society paid a visit to Bristol to inspect the electric power stations of the tramway company. They were met by Mr. Challenger, the traffic manager, and conducted by him in a special car to the St. George's power-house. This building—formerly the horse depôt—was altered and adapted for the new traction, but has been found insufficient for the work demanded of it. The tramway company are now in the process of replacing horse traction by electric power on the overhead system, and over a large part of the city the work is already completed, other parts being in a forward state. To provide for future extensions the company are building a new power-house at Counterslip, this being a composite structure, more common in the States than here, and consisting of a skeleton steel framework covered and lined with brick and stonework. It has three floors, the lower providing accommodation for engines, dynamos, etc., the second floor for several sets of Babcock and Wilcox boilers, and the third carrying the coal hoppers, flues from boilers to shafts, and economisers. The shafts is of steel framing, plated inside and out, and lined with firebrick. It is 200ft. high, and is carried on a brick tower 60ft. high. The company will have ample power for present needs and a large margin for future extensions. They expected the cost of power not to exceed ½d. per unit.

Kingston.—The Corporation have informed the Surrey County Council that they have decided to make application to the next session of Parliament for powers to construct and work electric tramways for the borough. The Corporation are willing, in any way consistent with the due carrying out of this proposal, to enter into such arrangements with the County Council as may be for the mutual benefit of the borough and the county. With that view, the Corporation will be prepared, if so desired by the County Council, to arrange that the County Council shall have such running powers over the tramways in the borough as may be necessary for through communication. The Corporation will also, of course, see that the gauge of their lines shall be in accord with the gauge of the lines that are likely to be laid in the neighbourhood. They also propose to construct their lines so as to make effective junctions with the lines that may be laid in their proximity. The Corporation will also be prepared to arrange with the County Council such financial adjustments as may be found fair and equitable in regard to the maintenance of the main roads in the borough along which the tramways will pass. A report of the Tramways Special Committee has also been adopted stating that intimation had been received that the British Electric Traction Company, Limited, have taken over from Messrs. Greenwood and Batley the promotion of their scheme, and propose to extend the scheme so as to include the following additional routes in the neighbourhood—namely, along Kingston Hill to Beverly Brook, from Eden-street along High-street and Portsmouth-road to the Orleans Arms, Ditton, and from Surbiton-road, up Surbiton Hill-road through Surbiton to the Red Lion, Tolworth. Notice of the opposition of the Corporation to the scheme of the new promoters has been duly given, and it is intended to take the necessary measures to follow up such opposition in the event of an enquiry being held.

Seaforth and Waterloo.—The opening of this service took place last week, as indicated in our last issue. The termini of this line are at Seaforth Sands Station and the Welsh Presbyterian Church at Waterloo. The whole of the generating plant, transforming plant, and tramcars have been constructed to the specifications of Mr. S. B. Cottrell, chief engineer of the Liverpool Overhead Railway Company. The line was laid by Mr. Edmund Nuttall, of Manchester, under the superintendence of Mr. F. Spencer Yates, Mr. George Oliver being the clerk of the works. The mode of construction is the ordinary heavy girder rail, bedded on concrete, the streets being paved with granite setts and cubes. The arrangement made with the District Council was that they should lay the rails and pave the streets, the railway company providing all the overhead electrical equipment and the tramcars, etc. The line will be worked by the overhead trolley system, poles being placed on one side of the road only, with overhanging ornamental brackets. The power will be generated at the railway company's main station, at the Bramley Moore Dock, delivering up to a pressure of 1,200 volts, transmitted at this pressure to Seaforth, and then transformed down to the line pressure of 500 volts. To provide for the requirements of the trams and other requirements of the railway, a 1,500-h.p. high-speed engine has been built by Messrs. Browett, Lindley, and Co., of Patricroft, and will drive a British Schuckert 800-kw. generator. The transformer plant has been supplied by Messrs. C. and A. Musker. The cars have been built by Messrs. Dick, Kerr, and Co., and in general appearance are very similar to those running in Liverpool, and in winter they will be heated by electricity. The overhead trolley construction has been carried out by Messrs. R. W. Blackwell and Co. The railway company have built a sub-station and the tramway car-shed under Seaforth Sands Station; the building of these, as well as the laying of the company's tramways, has been carried out by Messrs. Holme and King. It is anticipated that the entire road to Great Crosby will be completed within the next few weeks.

LIGHTING AND GENERAL.

Wrexham.—The electric light works are making fair progress.

Fleetwood.—We regret to hear that Mr. Burton, the electrical engineer, has met with an accident.

Stirling.—The electric lighting of the burgh police offices and of the Parish Council offices is being considered.

Barnes.—The Urban District Council have received sanction to a loan of £30,963 for purposes of electric lighting.

Torquay.—An enquiry has been held into the Council's application to borrow £15,000 for electric light extensions.

Peterborough.—The charges for current have been fixed at 6d. per unit for electric light and 3d. for power supply.

Bermondsey.—Plans of the elevation of the dust destructor and electricity supply buildings are now on view at the vestry hall.

Colliery Lighting.—The trustees of the Duke of Bridgewater have had a powerful electric light installation put down at their Bridgewater Colliery.

Tamworth.—A telephone is to be fixed between the workhouse and the clerk's office, and between the latter and the exchange, at an annual cost of £18.

Glasgow.—The permission of the police department has been granted to the telephone department to open up the streets for the laying of culverts, etc.

Luton.—Sanction has been obtained to the borrowing of £26,000 by the Town Council for electric lighting purposes, to be repaid with interest within 25 years.

Welshpool.—The Town Council will support the proposal to induce the Postmaster-General to connect the local telephone exchanges with the trunk line at Oswestry.

Gloucester.—The supply of electric light to private customers was inaugurated last Monday. The standards in the streets are fixed and wired, but not yet supplied with arc lamps.

Dover.—The Council are arranging with the electric light company to illuminate the sea-front during the season with festoons of incandescent electric lamps, in addition to the large arc lamps.

Dundee.—At the annual meeting of the Dundee Gas Corporation last week it was reported that in the electric department the income last year was £15,450. 1s. 10d., and the expenditure £14 535.

Kilmarnock.—A recommendation that a building be erected at Riverbank, Riccarton, as an electrical station, at an estimated cost of £5,150, will shortly come before an adjourned meeting of the Council.

Manchester.—A memorial from the Mutual Telephone Company in reference to their application for a municipal license has been referred to the special committee appointed to deal with this question.

Tunbridge Wells.—The extensions at the electric lighting station, referred to in our note in a previous issue, have been adopted by the Council, and they are to be carried out by Sir W. H. Preece.

Winding-Up.—In the Chancery Division recently Mr. Justice Cozens-Hardy heard a petition for the winding-up of the River Plate Electric Light and Traction Company, Limited. The company did not appear, and his Lordship made the usual compulsory order.

Accident.—Last Friday, as an electric car from Horton to Bradford was turning into All Saints'-road, the overhead cable snapped. There were about six passengers on the top of the car at the time, but no one was injured, and the traffic was only delayed about 10 minutes.

Southwark.—The Vestry have agreed to the application of the superintending engineer of the Post Office to take up the roadway and footway on the west side of and crossing Weston-street for the purpose of laying a 1in. telegraph wire pipe from 172, Weston-street to the parish boundary.

Tewkesbury.—At a meeting of the Town Council on Monday a proposition that a provisional order for electric lighting be applied for was discussed, and ultimately an amendment that the question remain open until September, with a view to giving the ratepayers an opportunity of considering it, was adopted.

British Electric Works.—With reference to a note in our last issue, we learn that Mr. John Walton has been appointed repre-

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sentative for the Manchester district lying between Warrington, Todmorden, and Blackpool, having relinquished his appointment as inspector of installations for the Manchester Corporation.

Cardiff.—The Lighting Committee of the Corporation have decided to extend the mains eastwards from Clifton-street to the Taff Vale Railway bridge on Newport-road to supply light for private consumers; also, that application be made to the Local Government Board to borrow £909, which will be required for the purpose.

Thornhill.—At a recent meeting to protest against the proposed advanced price of gas in Thornhill by the Corporation of Dewsbury, a resolution was passed in favour of an electric lighting company being introduced into the township unless the Corporation withdrew from the position taken up by the Gas Committee.

Salford.—At the last meeting of the City Council the following resolution was proposed: "That this Council do take immediate steps to carry out the provisions of the St. Albans Electric Lighting Provisional Order, 1898, by constructing and laying down the works thereby authorised." A long discussion took place, after which the matter was referred back to the committee.

Hart Accumulators.—We learn that the Edison and Swan Company, who have already the sole agency for the Hart accumulator cells for the towns of Glasgow and Dublin, have now completed arrangements by which they have the sole agency for the whole of Ireland. Addresses of the branches are as follows: Belfast, 134, Royal-avenue; Dublin, 12, Dawson-street.

Norwich.—The Town Council have entered into an agreement with her Majesty's Postmaster-General to supply electric current, for five years at £12 per annum, to a time signal proposed to be fixed at the top of the Castle Keep. The Mayor has received requisitions asking him to call a special meeting of the Council on Tuesday next for the purpose of dealing with the telephone question.

Holborn.—The Board of Works last Monday decided to invite the electric lighting companies to send in estimates of the cost of lighting the district with electricity. A sum of 150 guineas was voted to the clerk, 100 guineas to the surveyor, and 50 guineas to the clerk's assistant for extra services performed in connection with the preparation of evidence, etc., to be placed before the commissioners at the recent enquiries held relative to the municipal boundaries.

Southwold.—We notice in a local paper a report of a private meeting of the subscribers to the Southwold telephone, originated and carried on by Mr. L. Francis. The meeting was called in consequence of auctioneer's bills appearing, announcing the sale of articles of furniture in the residence of Mr. Francis and a portion of the telephone apparatus under a sheriff's order. The meeting appointed a committee to meet Mr. Francis and see what arrangements can be made.

Hammersmith.—A large extension of electric mains is contemplated. The Electricity Committee have gone into the whole question of extension of mains, and have decided to recommend that a number of streets be scheduled, the work being estimated to cost £8,877. 9s. 1d. It is proposed to obtain another loan of £15,500 from the London County Council for the carrying out of this and other work. The committee's report will be considered at the next meeting of the Vestry.

Electrical Standardising, Testing, and Training Institution. We have been asked to rectify the impression created, in consequence of an advertisement in the daily papers referring to the sale of leasehold property in St. Martin's-lane and Charing Cross-road, that the above institution proposes to move from Faraday House. We are informed that the proprietors hold a long lease of the institution premises, and have every intention of remaining there until its expiration. The sale of the superior lease will not affect them.

Brighton.—The report of the Telephone Committee, which has been adopted by the Town Council, and which is referred to by us elsewhere, proposes that a license should be applied for on the basis of a system for 2,000 subscribers, and that the maximum charge should be fixed at £7, though the committee believed £5. 10s. would be the actual charge. The scheme will involve a capital of £43,000. The Tramways Committee have decided to recommend the appointment of Mr. T. B. Holliday as tramway engineer at £600 per annum.

Refusing to Stop a Tramcar.—Before a bench of magistrates at York on the 25th inst. Henry Mallard, tramcar conductor, was charged with refusing to stop his car for a person desirous of travelling, and for whom there was room. It appears that a tramcar got off the line, the passengers descended, amongst them a lady and child, whom the defendant refused to allow to resume their seats. The child fell from the footboard when the car moved on and had her knee grazed. The conductor was fined 5s. and costs, which hardly appears adequate.

Maidstone.—The Council have adopted a report of the Electric Light and Dust Destructor Committee, stating that at the Local Government Board enquiry with reference to the application of the Council to borrow £40,000 for a combined electric light and dust destructor scheme, it was found advisable to drop the combined scheme in the Fair Meadow, and consequently the application for the electric lighting scheme only was proceeded with, and a loan of £34,000 applied for. The committee were now considering the question of a dust destructor.

Bridgwater.—The Lighting Committee's report, adopted at the last meeting of the Town Council, stated that they had opened the several tenders for certain works to be carried out in connection with the erection of electricity supply works, which were referred to the consulting engineer to examine and report thereon. Tenders for the erection of an electric light generating station were opened and the consideration deferred. The town clerk was directed to ask the Property Committee upon what terms they were prepared to let the Lighting Committee the property in Northgate.

Kensington.—At last week's meeting of the Vestry a letter was read from the St. Marylebone Vestry inviting the Vestry, in view of the great importance of the principle involved, to take joint action with them in opposing the passage through Parliament of the provisional order of the Marylebone Electric Supply Company, Limited, the confirmation of which would, in their opinion, gravely endanger the consistent efforts made by that Vestry to obtain powers to themselves supply their parish with electricity. The matter was referred to the Law and Parliamentary Committee.

Fire.—A fire broke out on Sunday at the premises of Siemens Bros. and Co., Limited, the telegraph and electrical engineers, Bowater-road, Woolwich. The fire originated in the T block, a building 120ft. long and 30ft. wide, used as a rubber curing shop, and the flames spread to the V block, which is a three-floored structure of similar dimensions, used as a wire-covering shop. We learn that the firm's own fire brigade subdued the flames before the arrival of the other engines, and that the accounts published in the daily papers have greatly exaggerated the damage done, which, however, was of a very serious character.

Ashton-under-Lyne.—On Wednesday the chairman of the Finance Committee made his annual statement on the accounts. He said that the actual expenditure, after deducting electricity and public works lighting account to the amount of £6,436. 7s. 11d., had been £57,767. 4s. 2d. The income, after deducting electricity and public works lighting account of £5,543 14s. 10d., had been £60,428. 19s. 11d., showing a surplus on the year of £2,661. 15s. 9d. The past year had been started with a deficiency of £410. 19s. 5d., and after clearing off that deficiency a surplus was left to be carried forward of £2,250. 16s. 4d. They might claim that as being satisfactory under the circumstances. There was a deficiency on the electricity revenue account for the year of £1,060. 11s. 8d. No doubt this account would soon rectify itself and show a surplus instead of a deficiency. When the total deficiency of £2,074. 13s. 11d. from the commencement of the works (which was more or less anticipated) had been taken into account they would still have a surplus, looking at the whole of the accounts together, of nearly £200. The electricity department was still undeveloped, but it was advancing towards considerable prosperity.

Appointments Vacant.—The following appointments are vacant at the Northampton Institute, London, E.C.: mechanical engineering department—(1) senior lecturer and assistant, full time, commencing salary £130 per annum; electrical engineering and applied physics department—(2) junior demonstrator, full time, salary £80 per annum; (3) junior technical assistant, full time, salary £65 per annum; (4) junior lecture assistant, full time, salary £39 per annum; (5) optical demonstrator, two evenings per week, salary £30 per session. Further particulars appear in our advertisement columns.—The Borough of Tunbridge Wells require a jointer, and an improver is required at Barrow.—The British Electric Traction Company invite applications for the appointment of additional secretaries and accountants to its subsidiary companies.—The Wimbledon Urban District Council require at once a junior assistant engineer at their electric light station, Wimbledon.—There is also wanted immediately an engineering assistant for the Ayr electric tramways.—The Johnson-Lundell Electric Traction Company invite applications for the position of general manager. Full particulars in our advertisement columns.

Parliament.—In the House of Lords on June 21 the Baker-street and Waterloo Railway Bill was read a second time; the Great Grimsby-street Tramways Bill was read a third time, amended, and passed. On the 25th the London United Tramway Bill was read a third time. During the last week the Lincoln Tramways Bill was passed for third reading in the House of Commons. The Bill of the Sheffield Corporation to extend the boundaries of the city and to construct additional tramways was ordered to be reported for a second reading. The preamble of the Plymouth, Stonehouse, and Devonport Tramways Bill has passed the Court of Referees at the House of Commons. The Bournemouth Corporation Tramways Bill and the question of running powers came again before the Select Committee on an application to reconsider the decision. This was refused. The Croydon Tramways and Improvements Bills came before a committee. There were objections from owners of Wellesley-road, on whose behalf it was urged that the standards, brackets, and wires would be an eyesore. The residents of Wellesley-road did not require the trams for their own use, and they did not think the trams were needed for the passengers using West Croydon Station. The committee, having conferred in private, announced that the case for the tramway scheme, including the Wellesley-road line, had been proved to their satisfaction. The Bill of the Great Grimsby Street Tramways Company was ordered to be reported for second reading. The Bill promoted by the Batley Corporation to confirm a provisional order of the Local Government Board authorising the Corporation of Batley to construct certain tramways within their borough, has passed the committee of the House of Commons. At the end of the enquiry the Chairman said: The committee find that the preamble is proved, but they think that Sub Section 4 of Clause 40 should be modified, so as to make it quite clear that the Corporation should not be able to impede unduly the exercise of the company's rights over the line. It was then stated that the suggestion of the committee would be carried out. The consideration of clauses was postponed.

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Dorking.—The Urban District Council have adopted a report of the General Purposes Committee recommending the Council to consider the advisability of leasing their provisional order to a company or a firm for a period of years, upon terms to be hereafter arranged, and that an advertisement be issued in suitable papers inviting tenders for such a lease. The further consideration of the question has been adjourned for a fortnight.

Driffield.—The question of electric lighting was before the Council last week, and a notice was received from the Northern Counties Electricity Supply Association of intention to apply for a provisional order for the urban district of Driffield, and asking the Council to appoint a deputation to meet representatives of the company. The Council decided to reply that they would not consent to the granting of the provisional order. If there was any demand for the light, the Council would supply it, and would not allow any second lighting power to gain a footing in the town.

Swansea.—Steps are to be taken to extend the compulsory area under the electric lighting order so as to include cables to Morriston, Port Tennant, Cwmbwrla, Sketty-road, and Brynmill. The following have been appointed members of the Parliamentary Committee in the matter of the opposition to the South Wales Electrical Power Bill—viz, the Mayor, the Chairman, and Mr. Councillor Tutton. Applications are to be invited for the post of resident electrical engineer, at a salary of £300 per annum. Candidates must have central electric light station experience, and the person appointed will take charge of the works during construction.

Islington.—At the last meeting of the Vestry it was reported that the National Telephone Company had on several occasions placed overhead wires at spans exceeding 115 yards, the limit allowed by the by-laws made by the London County Council in pursuance of the London Overhead Wires Act, 1891, without obtaining the permission of the Vestry to the erection of a longer span, and the statements required by the by-laws to be furnished to the Vestry from time to time were often found to contain inaccurate information and were consequently unreliable. The report was adopted, and proceedings are to be entered into against the company in respect of the breaches of the by-laws in two instances.

Liverpool.—At the meeting of the Electric Power and Lighting Committee of the Corporation last week it was reported that for private lighting in the corresponding month of last year 177,688 units of electricity were used, as against 218,169 this year. For Corporation lighting 25,071 units were required last year, and 31,107 in four weeks of May June this year. For electric cars and other service last year 137,895 units were used, as compared with 362,269 in the corresponding month this year. The total consumption for the month last year was 340,654 units, as against 611 545 in the corresponding four weeks this year. Extensions of mains were sanctioned for Vauxhall-road, Walton-road, and Brownlow-street.

London Gazette.—The discharge of Mr. J. A. Hirst, Oak Cottage, Upton, Cheshire, has been suspended for two years, bankrupt to be discharged as from May 17, 1902; assets are not of a value equal to 10s. in the pound, etc.—A receiving order has been made out *re* W. J. S. Green, 45, Birchfield-road, Aston, Warwick, on debtor's petition.—A first and final dividend of 4⅜ per pound has been declared *re* H. L. Howard (trading as Thompson, Howard, and Co.), Wyvestow, Dragon-parade, Harrogate, York, payable at official receiver's office, 28, Stonegate, York, on July 5.—The Improved Electric Glow Lamp Company, Limited, is being wound up voluntarily; Mr. F. Firman Fuller has been appointed liquidator.

Telephones on the Bedford Estate.—The National Telephone Company on the 21st inst., in the Westminster County Court, sued the Transvaal and Australian Gold Concessions for £18. 5s. for the hire of a telephone, the company having informed their customers that there was no prospect of their service being continued, underground wires being objected to by the London County Council and overhead wires by the Duke of Bedford, except upon terms which the company declined. The defendants claimed that therefore they were not liable to pay for the rent of the telephone in advance. The plaintiff company obtained judgment on the grounds that the service was still supplied, and that the company were bound by contract to return money for any period of the year ending November next during which the service was discontinued.

Eastbourne.—We note from the report of the borough engineer, Mr. R. M. Gloyne, A.I.M.C.E., on the work done in connection with his department during the past year, that since Jan. 1, 1900, the electric light works have been in the hands of the Corporation. There are 25 electric arc lamps of 2,000 nominal candle-power each on the parades and 1,222 gas lamps, of which 843 are fitted with incandescent burners. For 23 of the arc lamps current was up to Dec. 31, 1899, supplied by the electric light company, who also cleaned, attended to, and renewed the carbons, charging £30 per lamp per annum, the remaining two, one on each side of the western bandstand, being the property of the Corporation, and only lit during the season and at the Easter and Whit-week holidays. The charge for electric current, attention, etc., to these was £7 each for three months' lighting.

St. George (Hanover-square).—The Vestry have passed the resolution noted in our last issue with reference to the lighting extensions. The Clerk in reply to questions as to the details of the offers of the Westminster Electric Supply Corporation, explained that they offer to supply and light 600 lamps at a cost of £13,500 per year, or 756, which the committee considered necessary, for £16,932 per year, without any capital expenditure on the part of the Vestry, and the total cost was to be subject to an annual reduction. At this cost the Westminster Supply Corporation's right would extend over a period of 32 years, but if the period of supply was limited to 10 years only, the annual cost would be £15,000 for 600 lamps, and £19,230 for 756 lamps. Replying to a further question, the Clerk said that the gas now cost over £10,000 a year, so that a penny rate would cover the additional cost of the electric light.

Mangotsfield.—At the last meeting of the Parochial Committee the question of public lighting was considered, and the following figures as to the cost of lighting were submitted: Oil, initial cost, £256. 10s.; rate per annum (all night lighting), 4d. Acetylene, initial cost, £651. 12s.; rate per annum, 6d. Gas (old burner), initial cost, £369; rate per annum, 4d. Gas (incandescent), initial cost, £331. 4s.; rate per annum, 3½d. Electricity (gross), initial cost, £6,400. Electricity (net), rate per annum, 4d. It was stated that the net cost for electricity was based on the assumption that about 150 private consumers purchased 66,272 units per annum, at the same price as charged in Bristol—viz, 4½d. per unit. In the event of electricity being adopted, the annual cost would be reduced as the number of private consumers increased. The estimate was for 72 lamps, at about 60 or 70 yards apart. Finally the matter was referred back to the Lighting Committee, with a view of ascertaining the cost of lighting the whole of the populous part of the parish.

Pemberton.—Mr. F. H. Tulloch has held an enquiry into the application of the Town Council for sanction to borrow £20,000 for purposes of electric lighting. Mr. T. Ratcliffe Ellis, for the Council, stated that the Council having decided to supply electric light for the township, obtained the assistance of Mr. Salter in the preparation of a scheme. There was a general opinion in favour of the proposal. The Council had also this advantage in the way of consumers: The tramway from Lamberhead Green to Wigan was the property of the Wigan Corporation, who leased the lines to the tramway company, and the Council had power by which they could give notice in the course of two months' time to purchase the tramway so far as it plied in their own township, and the present intention of the Council was to make the purchase. The Wigan Corporation proposed to supply electric traction to tramways within their own district, and that energy would be supplied by someone in the Pemberton district. At a low estimate it was reasonably expected that there would be a profit of about £900 a year.

Cambridge.—Recently an application was made to the Town Council by the National Telephone Company to permit the company to lay down a system of underground wires. The Town Council have adopted a report from a committee affirming the desirability of substituting an underground system of telephonic communication for that now in use. The committee thought that if a license were obtained the Corporation might themselves establish such a system. They, however, could not recommend the Council to apply for a license at the present time. At present they thought that no active steps should be taken, but that any fresh application made by a company for a license should receive careful consideration; or, if the National Telephone Company would consent to make a substantial reduction in their charges, that, in that case, the application made by them should be entertained. The Council have granted an application made on behalf of her Majesty's Postmaster General for permission to erect a line of poles and wires on condition that the poles in the lane be placed next the wall of Corpus Christi College, and that steps be taken to prevent persons climbing up the poles and damaging the wall. The Paving, Drainage, and Lighting Committee has submitted a report recommending that the services of a competent electrician should be obtained to test the variation of electric pressure at the terminals of such consumers as may from time to time desire to have their electric supply tested. They also recommended that a recording voltmeter be purchased at a cost of about £16 for the use of the electrician acting on behalf of the Corporation. The report has been referred back to the committee.

Coventry.—The City Council have adopted a report of the Electric Light Committee stating that there had been an increase in the number of customers during the year from 135 to 226, and the lamps connected had increased from 10,699 (8 c.p.) to 17,806, and further connections are being made. The number of units sold increased from 149,547 to 229,607, and the revenue from sale of current and meter rental from £3,597. 2s. 9d. to £4,188. 16s. 7½d. In comparing these figures, the committee state it must be borne in mind that last year's report covered a period of 15 months, and also that during the year which has just expired electric street-lighting has been inaugurated. If the comparison is confined to private lighting only, and the figures taken for the periods of 12 months ending March 31, 1900, and 1899 respectively, the units sold have been 169 657, against 110,106, and the revenue from sale of current £3,500. 8s. 4d., against £2,640. 10s. 1d. The increase in receipts has not been proportionately so great as the increase in sales, owing to the alteration in the scale of rebates, which came into effect at the commencement of the year. The profit on working is £786. 19s. 8½d., against £338. 8s. 5½d. for the previous 15 months. This would have been substantially greater but for the rise in the price of coal. Deducting the working profit of £786. 19s. 8½d., the net charge on the rates is £1,745. 3s. 5½d., against £1,629. 9s. 3½d. last year. The quarterly statement of the Electric Light Committee contained the following items: Electricity supplied during the quarter ending March 31, 88,339 units; 1889, 37,248 units. Rentals for quarter, £1,857. 6s. 3d.; 1899, £945. 19s. 5d. Number of consumers on March 31, 226; 1899, 135.

New Issues.—The Calcutta Electric Supply Corporation are about to offer to the shareholders for subscription until July 18

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10,000 shares of £5 each, to rank in all respects with the existing issued shares of the company when fully paid up, at £5. 10s., or 10s. premium for each £5 share. These shares are offered *pro rata* to the existing members in the proportion of one share for every two shares now held.—The Liverpool Overhead Railway Company invite subscriptions, until June 30, for 5,000 ordinary shares of £10 each at £8 per share. The shares will rank for dividend upon the whole amount (£10 per share) as from July 1, 1900. The additional capital is required for the electrical equipment of the tramways, leased to the company by the Waterloo-with Seaforth and Great Crosby District Councils under the company's Act, 1899, for additional rolling stock, the acceleration of the railway service, improving the lighting of the carriages, and other expenditure of the company on capital account.—The *Financial News* understands that the prospectus of the Typewriting Telegraph Corporation, Limited, will shortly be issued to the public. The capital of the company will be £100,000 in ordinary shares of £1, of which the present issue is 80,000. Of this 26,666 shares will be taken by the vendors in part payment of the purchase consideration, and 53 334 shares will be offered for public subscription at par. The directors will be the Right Hon. Sir James Ferguson, Bart., G.C.S I., M.P., 80, Cornwall-gardens, S.W. (chairman); Mr. H. Knatchbull-Hugessen, Lynstead, Sittingbourne, Kent; Colonel H. C. Seddon, R.E. (retired), 67, West Cromwell-road, road, S.W. (late superintending engineer, H.M. Dockyard, Portsmouth); and Mr. C. E. Spagnoletti, M.I.C.E., 2, Craven-terrace, Ealing; and one other director to be nominated by the Exchange Telegraph Company, Limited, from its Board after allotment.

Cork.—The following report has been adopted by the Corporation: "*Re* extension of electric lighting, your Electric Lighting Sub-Committee which met on May 14, 17, and 22 was represented by Alderman Phair, Councillors Firmo, Scully, O'Shea, Millard, Kinmonth, and Newman, and visited all the thoroughfares to which their attention was directed by the Council. Your committee selected sites for the erection of 84 arc lamps of the same power as those at present existing, and instructed me to mark them on the accompanying plan; also to prepare a report showing the number of gas lamps which would be rendered unnecessary by the adoption of electric light, and the relative efficiency of the two illuminants. The accompanying table gives the number of arc lamps proposed in the different thoroughfares, the number of gas lamps superseded, and the illuminating power of each. From the table it will be seen that the total cost of 84 arc lamps will be £1,260, and the cost of the existing 270 5 gas lamps, £766. 8s. 4d., showing an extra cost of £498. 11s. 8d. if arc lights are adopted. On the other hand, the illuminating power of 84 arcs would be 168,000 c.p., while the 270½ gas lamps have only an illuminating power equal to 2,705 candles, showing an increase in illumination in favour of electric light equal to 165 295 candles, or, in other words, the arc light will give 62 times the light of the present gas lamps. As it will be necessary to arrange the lamps in series of five, it will be necessary to increase the number of arcs to 85, and I would suggest the corner of the Military-road and Welling-road as the most suitable site. This would mean an increase in cost of £15, and a deduction of £11. 6s. 4d. for four gas lamps, making the extra expenditure for electric lighting £502. 5s. per annum. If the Council decide to erect the lamps, the Great Southern and Western Railway Company should contribute the cost of one lamp, as it will save them a large expenditure in gas.—(Signed) HENRY A. CUTLER, city engineer."

London County Council.—The following reports came before Tuesday's meeting: "The Asylums Committee reported recommending (*a*) that the scheme for the provision of a central station for the supply of water and electricity to the asylums to be erected on the Horton Estate be approved; (*b*) that the estimate submitted by the Finance Committee for a further expenditure of £39,000 for the above purpose be approved. The estimated cost is as follows: for all buildings, cooling reservoir, and 40,000 gallon steel water-tank, as per quantities taken out, £14,500; electric lighting plant, £18,000; deep-well pumps, force pumps, water-softening plant, and water-mains to boundary of station site, £3,700; oak pale fence enclosing site, £550; machine tools and equipment, £700; clerk of works, travelling expenses, stationery, printing, and items for quantity surveyors, £800; contingencies, £750." The Highways Committee reported that they had considered an application, dated May 31, 1900, from the engineer of the City of London Electric Lighting Company, for permission to substitute 14in. by 11in. troughing for the 9in. by 6in. troughing at present in the Queen Victoria-street subway between Blackfriars and St. Andrew's-hill. There appeared to be no objection to the proposed substitution, and they had, acting on behalf of the Council, sanctioned the execution of the work, such sanction being subject, however, to the following conditions: that the work be carried out, and any damage that may be done to the subway in the execution of the work be made good, to the satisfaction of the Council's chief engineer, and at the cost of the company; that the company do pay increased rent in accordance with the scale laid down by the Council in respect of the space which will be occupied in the subway by the larger troughing; and that the work be in all respects carried out in conformity with the regulations of the Board of Trade. The same committee reported that the Charing Cross and Strand Electricity Supply Corporation had given a notice, under the City of London Order, 1899, of intention to lay mains along the Victoria-embankment subway between Carmelite-street and New Bridge-street, and along a part of that street which was within the City. They thought that the proposed works might be approved, subject to the usual conditions relative to works affecting the Council's subways, and they recommended accordingly. Both these recommendations were agreed to.

Personal.—Mr. R. J. Wilton, who has resigned his position as outside superintendent for the Sheffield Corporation tramways in order to become the general manager of the Southport tramway service, was recently the recipient of a number of presents subscribed for by the tramway servants of all grades, and the spirit with which these presents were given left no doubt as to the high esteem in which that gentleman was held throughout the service. The gathering took place at the Corner Pin Hotel, Wicker, and was well attended. Councillor J. C. Whiteley, who presided, said that they much regretted to lose Mr. Wilton, though they had the satisfaction of knowing he was going to a better position. He believed that whatever friction might have occurred in tramway matters, no part of it had existed so far as Mr. Wilton was concerned. Mr. A. H. Lowe (mechanical engineer at the power station), on behalf of the tramway employés and friends, presented Mr. Wilton with a handsome gold watch and chain, suitably inscribed. He seconded the sentiments expressed by the chairman, and said it gave him great pleasure to be the means of handing Mr. Wilton that token of esteem from the men with whom he had come in contact. Mr. A. King (wire construction department) presented an umbrella and a meerschaum pipe in case on behalf of the construction (wire) men, and said that all he had to say was that he hoped the next "boss" they got would be equal to Mr. Wilton. Mr. J. Orme, on behalf of the permanent-way department, handed Mr. Wilton a silver cigarette case, saying that they wished Mr. Wilton every success, health, and happiness in his new office. Other speakers also referred to the energetic manner in which Mr. Wilton had performed his duties, and the interest he had appeared to take in his workmen. The whole proceedings suggest that it might have been well worth while for the Sheffield Corporation to retain the services of a man at once so capable and so universally liked. Mr. Wilton thanked the various speakers for the kind opinions expressed, and for the presentations, of which he was proud, especially, because of the spirit in which they were given. He was sorry to leave Sheffield in one way, because he had been treated with great respect by the men, and he only hoped he would be treated as well by the men among whom he was going. He hoped the Sheffield electric trams would flourish. He regretted the absence of Mr. Fell, who, he was sure, would try to do what was right by the men, and now the management had been reorganised he had no doubt that the tramway concern would prove very successful. Other addresses, recitals, and songs completed the entertainment.

PHYSICAL SOCIETY.

At the ordinary meeting of this society held on June 22, Mr. T. H. Blakesley (vice-president) in the chair, a paper entitled "**Notes on Gas Thermometry,**" by **Dr. P. Chappuis**, was read by Dr. Hasker. The author having been led to recognise that hydrogen could not be used as a thermometric substance at high temperatures on account of its action on the walls of the glass reservoirs, has had recourse to a constant-volume nitrogen thermometer with an initial pressure slightly under 800mm. The value of the coefficient of expansion of nitrogen at constant volume is variable, diminishing up to 80deg. C. and then increasing slightly. In fact, nitrogen at 100deg. C. behaves like hydrogen at the ordinary temperatures, its compressibility being less than that required by Boyle's law. A table of corrections was therefore prepared. The readings of the constant-volume nitrogen thermometer are too low, but the corrections are small, amounting to about 0·04deg. C. at the temperature of boiling sulphur. The mean result of the author's experiments for the boiling point of sulphur is 445·2deg. under a pressure of 767mm. Callendar and Griffiths's result obtained with a constant-pressure air thermometer is 444·53deg. The difference is attributed to the joint action of several causes: (1) The corrections for a constant-pressure thermometer are about double those of a constant-volume instrument. This correction applied to Callendar and Griffiths's result, would raise it about 0·1deg. (2) Callendar and Griffiths have used a value for the gas constant which is larger than that obtained by more recent experiments. Adopting the latter value, the boiling point would be raised to 445deg. (3) The divergence may be due to the expansion of the reservoir. The most accurate way of determining this is by the interference method of Fizeau. This method is used with small pieces of the material, and the author has employed it to determine the coefficient of expansion between 0deg. and 100deg. Extrapolation to 450deg. might cause errors. The linear expansion has recently been determined by Bedford between 0deg. and 840deg. by a comparator method. The homogeneity of porcelain is doubtful, especially when glazed, and the great differences occurring between the expansions obtained from the above methods is attributed to the change in form of the tube in Bedford's experiments, brought about by unequal thickness and want of homogeneity and consequent unequal expansion. The author, therefore, adheres to his value of the boiling point obtained from the expansion of the Fizeau method, whilst recognising the uncertainty attaching to the application of the coefficient of expansion of the reservoir over an interval four times as great as that over which it was determined.

A paper on "**A Comparison of Impure Platinum Thermometers,**" by **Mr. H. M. Tory**, was read by Prof. Callendar. The object of this paper is to investigate the probable order of accuracy attainable in the determination of high temperatures by the use of ordinary commercial specimens of platinum wire. Five wires were compared from 400deg. to 1,000deg. C. The funda-

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mental coefficients of the wires varied within 40 per cent. of the maximum value, but the temperatures observed by them when calculated on the platinum scale by means of the ordinary simple formula did not differ by more than 9deg. at 1,000deg. C. Each wire was directly compared with a pure standard wire, the two being wound side by side in the same tube. Curves have been drawn with the platinum temperatures of the standard wire as abscissæ, and the differences between the temperatures indicated by the two wires compared as ordinates. These curves are all straight lines within the limits of observation, and hence the determination of two constants as sufficient to enable us to compare an impure platinum thermometer with the standard, and therefore with the scale of the gas thermometer. The two constants can at once be obtained from observations at the boiling point of sulphur and the freezing point of silver, and thus a practical thermometric scale can be established, which between 0deg.-1,000deg. never differs by more than two or three degrees from the gas scale.

Prof. Callendar said he was unable to agree with the correction to his observations suggested by M. P. Chappuis. He considered that the uncertainty in the coefficient of expansion of the gas was due to uncertain changes in the volume of the bulb, and to uncertainty in the coefficient of expansion of mercury. The fundamental coefficient of mercury was ·00018153 according to Regnault, ·00018216 according to the later reduction of Broch, and ·00018256 according to experiments by Chappuis with a hard glass bulb. It made a difference of no less than 4 per cent. in the fundamental coefficient of expansion of the glass according as the original results of Regnault, or the value found by Chappuis assuming the linear expansion of the glass, were adopted. The importance of the changes in the volume of the bulb had been fully pointed out, and a method of taking approximate account of these changes had been explained in the paper on the boiling point of sulphur in 1890. Unfortunately, the glass employed was rather soft, and the changes of volume which occurred were too great to permit of the most accurate determination of the coefficient. The boiling point when corrected for the smaller expansion of the bulb came out lower than 444·53deg. With regard to porcelain, Prof. Callendar did not consider it a good material on account of the glaze. He did not think that the average coefficient of a tube or bulb over a large range of temperature could be inferred from a small and possibly asymmetric specimen. The results might be less inconsistent in the case of homogeneous and well annealed metallic bulbs. The correction for the expansion of the bulb was, he believed, given by the expression $dt=(c+b\theta)t(t-100)$. He did not agree with M. P. Chappuis that the correction was independent of c, although the value of b was certainly most important at high temperatures. He also wished to take exception to the method adopted by Chappuis of calculating the correction of the nitrogen thermometer. According to Joule and Thomson, the correction should be greater; according to other authorities it might be less. He hoped to discuss this in a future communication to the society.

Mr. Glazebrook said that although he placed confidence in Chappius's formula for a definite piece of porcelain between certain temperatures, he thought further and careful work was necessary before fixing on a formula for ordinary use.

Prof. Carhart said he would like to see a comparison made between the results of experiments with gas thermometers and those with platinum and platinum-rhodium couples.

Mr. Rose-Innes expressed his interest in the behaviour of nitrogen about 100deg. C., as mentioned in M. Chappius's paper.

Dr. Lehfeldt said the peculiarities of the nitrogen scale between 70deg. to 80deg. might be explained by the reversal of the properties of nitrogen between 0deg. and 100deg.

The society then adjourned until October.

PROVISIONAL PATENTS, 1900.

JUNE 18.

11011. Improvements in electrical switches for heavy currents and high potentials. Henry W. Clothier, Fulwood, Hope, near Sheffield.

11020. Improvements in or connected with electric lamps. William Miller Walters, 4, Clayton-square, Liverpool.

11022. An electrical apparatus for adjusting tramrail points. Joseph Edward Macaulay, 3, Sorrento-terrace, Dalkey, co. Dublin. (Complete specification.)

11025. Improvements in electric apparatus for lifebuoys and light to facilitate the rescue of persons from drowning, and for other purposes. Henry Binks, 34, Leadenhall-street, London.

11026. Improvements in cord grips for electric light fittings. Andreas Peter Lundberg and Gustaf Charles Lundberg, 18, Fulham-place, Paddington, London. (Complete specification.)

11054. Electrically-operated cloth-cutting machines. Nicholas Garland, 4, South-street, Finsbury, London.

JUNE 19.

11097. Improvements in electrical accumulators or secondary batteries, and in the manufacture of the same. Henry Woodward, 77, Colmore-row, Birmingham.

11099. Improvements in electric targets. James Paterson, 30, Boleyn-road, Forest Gate, London. (Complete specification.)

11101. Improvements relating to the measurement of the magnetic properties of iron and steel. Frederick William Le Tall, Westinghouse-building, Norfolk-street, Strand, London. (Miles Walker, United States.)

11107. Improvements in electric patterns for punching machines, for embroidering machines, and for Jacquard looms. Edmund Edwards, 65, Chancery-lane, London. (Curt Handwerck, Germany.) (Complete specification.)

11120. Improvement in ploughs for conduit electric railway cars. James Banker Gottsberger, 70, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, Jan. 4, 1900, being date of application in United States. (Complete specification.)

JUNE 20.

11149. Improvements in telephone switchboards. Alfred Whalley, Ashville, Helsby, near Warrington.

11190. An improvement in switches for high-tension electrical currents. Siemens Bros. and Co., Limited, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Siemens und Halske Aktien-Gesellschaft, Germany.) (Complete specification.)

11206. Improvements in electric switches and like apparatus for making and breaking electric circuits. Gerald William Partridge and George Keith Buller Elphinstone, 46, Lincoln's-inn-fields, London.

11207. Improvements in or relating to the distribution of electricity. Leonard Andrews, 46, Lincoln's-inn-fields, London.

11208. Improvements in electric signalling apparatus. Frederic Joseph Warden-Stevens, 46, Lincoln's-inn-fields, London.

11217. Improvements in the method of and material for covering electric cables, conductors, or wires with insulating material. George Edward Heyl-Dia, 6, Lord-street, Liverpool.

11218. Improvements in telegraph transmitting devices. Henry Vincent Gill, 6, Lord-street, Liverpool.

JUNE 21.

11243. Improvements in polarised electric bells for alternating current. The British Electric Works Company, Limited, and Bertel Brander, 24, Temple-row, Birmingham.

11255. A new or improved composition used for making electrical insulators and other articles. Arthur William Bundy Pearson, 114A, Chancery-lane, London.

11260. Improvements in electric accumulators and in electrodes therefor. Alberto Tribelhorn, 11, Southampton-buildings, Chancery-lane, London.

11263. Improvements in or relating to electric lamps and fittings therefor. Hugo Hirst, 165, Queen Victoria-street, London.

11264. Improvements in or relating to switchboards for electric distribution. Hugo Hirst, 165, Queen Victoria street, London.

11272. Improved means of and apparatus for preventing the premature starting of dynamos or the like used in connection with electric lifts. Johann Hofbauer, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11287. Improvements in or relating to conduits for electric conductors. Frank Jones, 6, Lord-street, Liverpool.

JUNE 22.

11302. Improved fuseboard or distributing box, also applicable as a junction or connecting box. Ralph Gooch Tyler and William Evan David Duncan, 20, New Bridge-street, London.

11340. Improvements in and connected with electric clockwork. Martin Fischer, 42, Neuenweg, Barmen, Germany.

11344. Improvements in the manufacture of filaments for incandescing electric lamps. William Lawrence Voelker, Clun House, Surrey-street, Strand, London.

11358. Improvements in or connected with secondary batteries. Henry Uppleby Wollaston and Thomas Vaughan Sherrin, 4, South-street, Finsbury, London.

11361. Improvements in ceiling roses or attachments for pendant electric lamps. John Griffiths Sanders Lee, 70, Chancery-lane, London.

JUNE 23.

11406. Improvements in the electrical equipment of railway vehicles for the purpose of lighting, heating, and ventilation. Alfred Zehden, 28, New Bridge-street, London. (Complete specification.)

11429. An improved electromagnet of high attractive force. Max Vogelsang and Friedrich Lindenstruth, 6, Lord-street, Liverpool. (Complete specification.)

11437. Improvements in electric insulators. Emil Risler, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London.

11438. Improvements in casings for the jointings of underground electric cables. Siemens Bros. and Co., Limited, William Dieselhorst, and Frederick John Budd, Birkbeck Bank-chambers, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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COMPLETE SPECIFICATIONS ACCEPTED.

To be published on July 14.

1899.

8188. Rheostats or electric resistance switches. Marr Laidler and Sunderland Forge and Engineering Company, Limited.

12730. Galvanic cell. Offenbroich and Rockel.

12767. Coin-freed electricity meters. Beaumont.

12883. Apparatus for repairing incandescence electric lamps. Dumont. (Date applied for under International Convention, April 12, 1899.)

12962. Electrically-propelled road vehicles. Northey, and Electric Motive Power Company, Limited.

13111. Electrical switches. Wade, and Electric Motive Power Company, Limited.

13174. Electric signalling apparatus. Herzog.

13271. Telephone exchange systems. Sinclair and Aitken.

13509. Electric cranes. Aldridge.

14906. Fuse blocks for electric circuits. Davis. (Date applied for under International Convention, Jan. 30, 1899.)

14908. Method of and apparatus for indicating potential in systems of electrical distribution. Mershom. (Date applied for under International Convention, Feb. 1, 1899.)

15138. Electric generators and motors. Lamme and Mallet. (Date applied for under International Convention, Feb. 6, 1899.)

15139. Automatic electric circuit breakers. Wright and Aalborg. (Date applied for under International Convention, March 23, 1899.)

15581. Switch and ceiling rose or other like fitting for electric lighting purposes. Jevons and Lloyd.

15599. Electric switches and like apparatus for making and breaking electric circuits. Partridge and Elphinstone.

16410. Electric arc lamps. Eckstein and Angold.

17262 Arrangements of connections and conductors for railways worked by electricity. Winter and Fütter.

17410. Electric accumulators. Haddan. (Goldstein.)

18414. Electric contacts or current-taking devices. Greil and Audiger.

21778. Electrically-controlled elevators or lifts. Rowntree.

22807. Manufacture of lead peroxide, and its application to electrical storage batteries. Beckmann.

1900.

839. Incandescence electric lamps. Lake. (Shearman.)

2119. Junction-boxes for electric conductors. Waterhouse, and Simplex Steel Conduit Company, Limited.

7198. Method of producing complex chemical compounds by electrolysis with alternating currents. Thompson. (Sinding-Larsen.)

8152. Electric transformers. Wise. (Actien-Gesellschaft Elektricitatswerke, vorm. O. L. Kummer und Co.)

8300. Two-liquid primary batteries and regenerating same. Johnson. (Dercum.)

8433. Process for the production of electrically conductive illuminating bodies. Dannert.

8536. Galvanic battery. Albert Charles Martin.

8824. Electric smelting furnaces. Koller.

9464. Manufacture of filaments for incandescent electric lights. Husselman.

TRAFFIC RETURNS.

Line.	Returns for week Ending	1900.	1899.	Increase or decrease.	Total receipts for half-year. 1900.	1899.
		£	£	£	£	£
Aberdeen Corp'rat'n	June 23	710	611	+ 99	2,164	1,885
Birmingham Tramways Co.	,, 23	4 561	4,180	+ 381	105,740	99,393
Blackburn Corp'rat'n	,, 23	419	482	- 63	9,194	10 590
Blackpool Corporatn.	,, 21	762	513	+ 249	6,588	5 267
Blackpool-Fleetwood	,, 23	683	611	+ 72	9,401	9,321
Bolton Corporation..	—	—	—	—	—	—
Bradford City Trams	,, 24	458	374	+ 84	5 956*a*	4,670
Bristol Tramways Co.	,, 22	3,201	3 023	+ 177	—	—
City & South London	,, 24	1,500	933	+ 567	32,234	25,914
Dover Tramways ...	,, 23	216	202	+ 14	4,288	4,021
Dublin U.T., elec. cars	,, 22	3,670	1,275	+2,395	—	—
Dublin S.D. Electric	,, 22	956	1,085	- 129	—	—
Halifax Corporation	,, 25	780	589	+ 191	8,715	6,116
Hull Corporat'n E.S.	,, 23	1,347	—	—	14,106*a*	—
Liverpool Corporat'n	,, 16*b*	8,043	7,442	+ 601	172,751	151.766
Liverpool Overhead	,, 24	1,606	1,439	+ 167	35,820	34,730
Sheffield Corporation	,, 24	2,330	—	—	—	—
South Staffordshire	,, 22	714	656	+ 58	16,915	15,826

a Since April 1. *b* Partly electrical.

COMPANIES' STOCK AND SHARE LIST.

Name.	Amount paid.		Price last Monday.
Commercial and Industrial.—			
Aron Electricity Meter, 6 p.c. Cum. Pref. Shares, 1-125,000	1	—	½-½
British Insulated Wire, Ord., 1-40,000	5	—	11-12
—— 6 per cent. Cum. Pref., 1-27,500	5	..	6 6¼
—— 5 per cent. Mortgage Debentures	100	—	98-103
British Electric Works, Ordinary, 50,001-95,000	1	—	½-1
—— 6 per cent. Cum. Pref., 1-50,000	1	—	13/16-15/16
—— 4½ per cent. First Mortgage Debentures	100	—	99-101
British Westinghouse Elec. and Manuf., 6 per cent. Pref.	5	—	4¾-5¼
Brush Electrical Engineering, Ordinary	2	—	1¾-1¾
—— Non. Cum., 6 per cent. Pref.	2	—	2-2¼
—— 4½ per cent. Debenture Stock	100	..	109-114
—— 4½ per cent. 2nd Debenture Stock	100	—	103-106
Callender's Cable, Debentures	100	—	112-116
—— Ordinary	5	—	13½-14½
—— 5 per cent. Pref.	5	—	5¼-6
Crompton and Co.	5	—	3¾ 4
—— 5 per cent. Debentures	—	—	100-103
Edison and Swan United, Ordinary	5	—	2-2¼
—— 5 per cent. Debentures	5	—	2¼-4¼
—— 4 per cent. Deb. Stock, Red.	100	—	98-95
Electric Construction	2	—	2-2¼
—— 7 per cent. Cumulative Pref.	2	—	2-2¼
—— 4 per cent. Perp. 1st Mort. Deb.	100	—	103-106
W. T. Henley's Telegraph Works, Ordinary	5	—	13-14
—— 4½ per cent. Preference	5	—	5¼-5¾
—— 4½ per cent. Debentures	100	—	110-114
India Rubber, Gutta Percha, and Telegraph Works	10	—	21-22
—— 4 per cent. Debentures	100	—	100-103
Telegraph Construction and Maintenance	12	—	35 39
—— 5 per cent. Bonds	100	—	102-105
Telegraph Manufacturing, Ordinary	5	—	10½-11½
—— 5 per cent. Cum. Pref.	5	—	5¼-6
Willans and Robinson, Ordinary, 1-80,000	5	..	11-12
—— 6 per cent. Cum. Pref., 80,001-90,000	5	—	6¾-7¼
—— 4½ per cent. First Mortgage Debenture Stock, Red.	100	..	104-106
Electric Lighting and Supply.—			
Blackheath & Greenwich District Ordinary 1,201-101,200	1	..	¾-⅞
Bournemouth and Poole, Ordinary	10	..	11½-12½
—— 4½ per cent. Cum. Pref.	10	..	10-11
Brompton and Kensington, Ordinary	5	..	7-8
—— 7 per cent. Preference	5	—	8¼-8½
Calcutta Electric Supply Corp., Ordinary, Nos. 1-20,000	5	—	6¾-7½
Charing Cross and Strand	5	..	9½-10½
—— 4½ per cent. Cum. Pref.	5	—	5¼-6
Chelsea Electricity Supply	5	—	6¾-7½
—— 4½ per cent. Debentures	100	—	107-110
City of London, Ordinary	10	..	8¼-9½
—— 6 per cent. Cumulative Pref.	10	..	12½-13½
—— 5 per cent. Debenture Stock	100	..	124-129
County of London and Brush Provincial, Ordinary	10	..	9-10
—— 6 per cent. Cum. Pref.	10	—	11½-12½
—— 4½ per cent. Debentures Prov. Certs. All pd. Rd.	—	—	110-113
Edmundsons' Electricity Corporation, Ordinary, 1-17,400	5	—	4¼-5
—— 4½ per cent. First Mort. Deb.	100	..	101-104
Kidderminster and Dist. Elec. Lighting and Traction, Pref.	10	—	9¾-10
London Electric, Ordinary	2	..	1-1½
—— 6 per cent. Pref.	5	..	4-4¾
—— 4 per cent. 1st Mortgage Debenture Stock, Red.	100	..	98-100
Metropolitan, Ordinary	10	..	13¾-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	..	113-116
—— 3½ per cent. Mortgage Debenture, Red	100	..	97-99
Notting Hill Electric Lighting	10	..	16-17
Oriental, 1879	1	..	1½-1¾
—— £5 Shares	5	..	7-7¾
—— £4½ Shares, New	4½	..	6¼-6¾
Oxford Electric, Ordinary, 1-96 and 407-10,310	5	..	6-6¾
River Plate Electric Light and Traction, Deb.	100	..	75-85
Royal Electrical Company of Montreal	$100	..	165-185
—— 4½ per cent. First Shares Mortgage Debentures	$100	..	104-107
Smithfield Markets Electric Supply, Ltd., Ord., 1-12,000	5	..	2-2¼
—— 4 per cent. Debenture Stock	100	..	85-95
South London, Ordinary	2	..	2¼-4½
St. James's and Pall Mall, Ordinary, 101-20,080	5	..	14½-16½
—— 7 per cent. Pref.	5	..	8¼-9½
Westminster, Ordinary	5	—	11-12
Electric Railways.—			
Central London, Ordinary	10	—	10½-10
—— Pref. Half-Shares	5	..	4¾-5¼
—— ,, ,, deferred	5	..	5¼-5
City and South London, Consolidated Ordinary	100	..	66-68
—— Ordinary	10	—	6-7
—— 4 per cent. Debenture Stock	100	—	123 128
—— 5 per cent. Pref. Stock '91	100	..	140-145
—— ,, ,, ,, '96	100	..	132-137
Liverpool Overhead, 5 per cent. Pref.	—	—	13½-13¾
Waterloo and City, Ordinary	100	..	100-103
Electric Tramways.—			
Blackpool and Fleetwood Tramroad	10	..	17½-18½
Brisbane Tramway	100	..	103-105
British Columbia Electric Railway Co., 5 per cent. Pref.	10	..	10½-10¾
British Electric Traction, Ordinary, 1-80,000	10	..	16-17
—— 60,001-75,000	10	..	16-17
—— 6 per cent. Cm. Pf. 80,001-60,000	10	—	12½-13½
—— 5 per cent. Perpetual Debenture Stock	100	—	124-127
—— ,, ,, 1900	100	—	120-123
B. Ayres & Belgrano Tram., "A" 6 per cent. Cm. Pf., 1-40,000	5	—	5-5½
—— "B" 6 per cent. Cm. Pf., 1-27,500	5	..	4-4¼
—— 5 per cent. Deb. Stock, Red.	100	..	101-104
Isle of Man Electric Power, 1-95,000	1	..	¼-5/16
—— 6 per cent. Preference, 100,001-170,000	1	..	5/16-½
Kidderminster and District Lighting and Traction, Pref.	10	..	9¾-10
New General Traction, Ordinary	5	—	3¼-3¾
—— 6 per cent. Cum. Pref.	5	..	4¾-5¼
Oldham, Aston, and Hyde Tramway, Ordinary	10	..	16-18
—— 5 per cent. Cum. Pref.	10	..	10¾
Potteries Electric Traction, Ordinary, 26,667-40,000	10	—	11½-12½
—— 5 per cent. Cum. Pref., 1-20,000	10	—	9¼-10¼
Telephones.—			
National Telephone, Ordinary	5	..	5-5¼
—— 6 per cent. Cum. First Pref.	10	..	13-14
—— 6 per cent. Cum. Second Pref.	10	..	13-14
—— 5 per cent. Non. Cum. Third Pref.	5	..	5-5¼
—— 3½ per cent. Deb. Stock, Red.	100	—	98-101
Oriental Telephone and Electric Company	1	—	15/16-1 1/16

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